2022 On-Farm Research RESULTS

NEBRASKA ON-FARM RESEARCH

EC3030

NEBRASKA ON-FARM RESEARCH NETWORK

2023 Results Update Meetings

ALLIANCE | Feb. 15 | Knight Museum and Sandhills Center
YORK | Feb. 15 | Holthus Convention Center
FREMONT | Feb. 17 | Dodge County Extension Office
NORTH PLATTE | Mar. 1 | West Central REEC
KEARNEY | Mar. 2 | Buffalo County Extension Office
BEATRICE| Mar. 3 | Holiday Inn

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NEBRASKA ON-FARM RESEARCH

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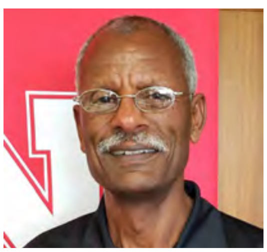

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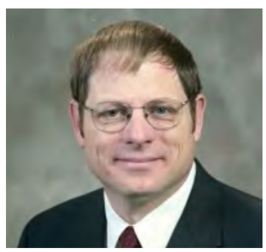

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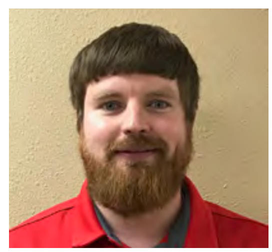

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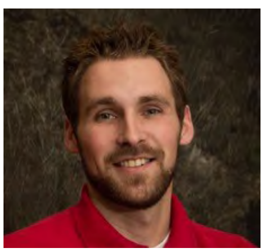

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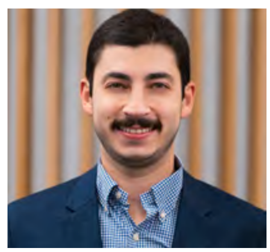

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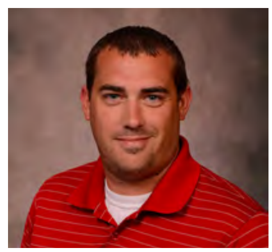

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NEBRASKA ON-FARM RESEARCH NETWORK

Reliable, research-based information for your farm

Nebraska Extension On-Farm Research Network Introduction

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

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 Growers Association, Nebraska Soybean Board, and the 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 onfarmresearch.unl.edu, or find us on Facebook and Twitter.

Statistics 101

Replication: In statistics, replication is the repetition of an experiment 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.

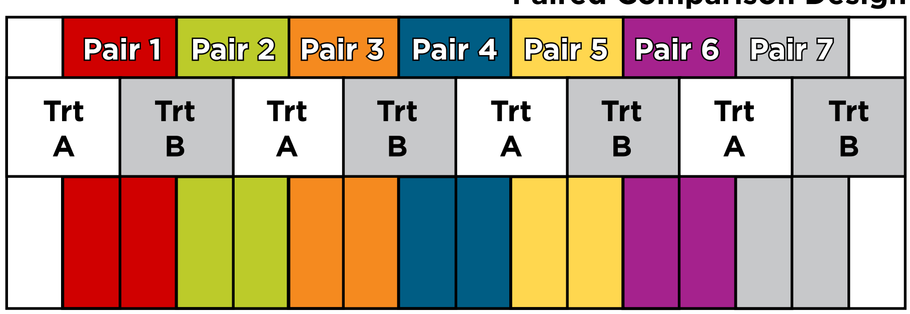
What is the P-Value? In field research studies we impose a treatment – this treatment may be a new product or practice that is being compared to a standard management. Both the **treatments** that we are testing and **random error** (such as field variability) influence research results (such as yield). 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 decrease, 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).

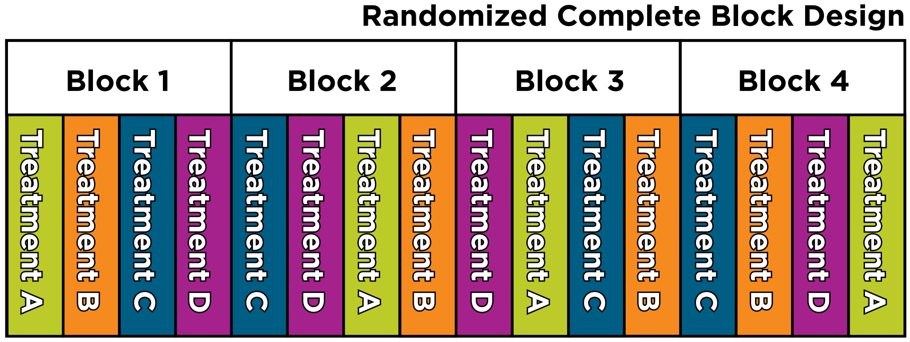
For these studies, we have chosen a cutoff P-Value of 10%; therefore, if the P-value is greater than 10%, we declare that there are not statistically significant differences due to the treatments. If the value is less than 10%, we declare that differences between treatments are statistically significant. 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.

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.

Paired Comparison Design



Randomized Complete Block Design



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 x 1.2 mile grids.

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 revennue for our research plots we use input costs provided by the producer, application costs from Nebraska Extension's 2021 Nebraska Farm Custom Rates and an average commodity market price for 2022.
Average market commodity prices for the 2022 report are:

Wheat:	$9.58/bu
Corn:	$6.57/bu
Soybeans:	$13.97/bu
Pinto Beans:	$38/cwt ($22.80/bu at 60 lb/bu)
Great Northern Beans:	$40/cwt ($24/bu at 60 lb/bu)

For each study, net return is calculated as follows:
Net Return = gross income (yield x 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.

NEBRASKA EXTENSION
FARMBITS PODCAST

NEBRASKA EXTENSION - INVESTING IN THE FUTURE OF RESEARCH

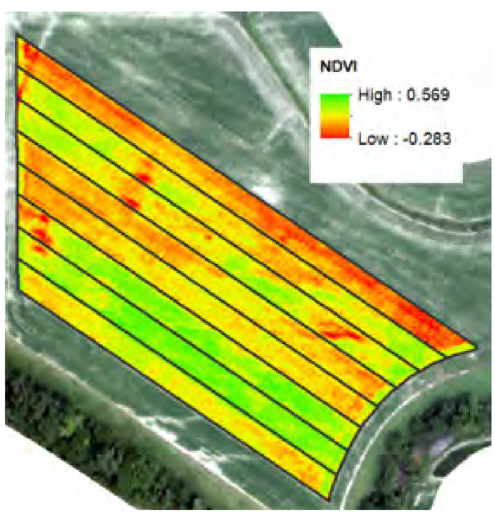
Hosts Kelsey Swantek and Taylor Cross sit down with Laura Thompson, Digital Ag Extension Educator, and Taylor Lexow, Nebraska On-Farm Research Network Coordinator, to kick off the Summer Series focusing on research taking place at the University through Nebraska Extension and it's On-Farm Research Network. With the episode, we hope you learn more about Nebraska Extension and what it has to offer, not only to farmers and producers across the state but industry leaders across the United States and other countries where you might be listening from.

AERIAL IMAGERY

For many studies, aerial imagery was captured using a drone, airplane or satellite.

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 Vegegtation Index (NDVI):

NDVI is calculated using the red and near-infared (NIR) wavebands as follows: NDVI = (NIR-Red)/(NIR+Red). This index is often correlated with 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.

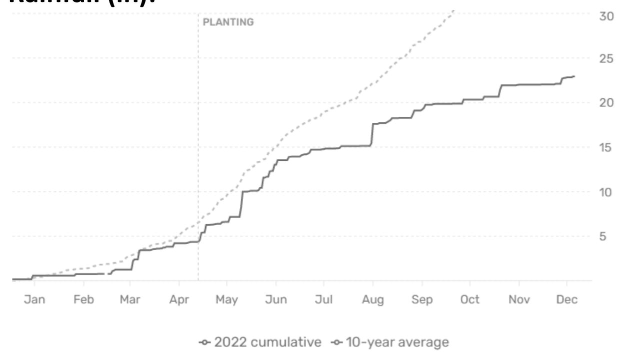
Normalized Difference Red Edge (NRDE) Index:

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

Corn Seeding Rate with Fastand™

Study ID: 1252025202201
County: Cass
Soil Type: Colo-Nodaway complex frequently flooded; Judson silt loam 2-6% slopes; Marshall silty clay loam 6-11% slopes, eroded; Marshall silty clay 2-6% slopes, eroded; Nodaway silt loam occasionally flooded
Planting Date: 4/27/22
Harvest Date: 10/15-18/22
Seeding Rate: 27k, 30k, 33k, 36k
Row Spacing (in): 30
Hybrid: DEKALB® DKC59-82RIB
Reps: 11
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** 75 oz/ac Harness® MAX, 1 qt/ac atrazine 4L, 0.5 pt/ac 2,4-D LV4, 19 oz/ac Roundup®, and 0.5 pt/ac EFFICAX®
Foliar Insecticides: None
Foliar Fungicides: 10.5 oz/ac Quilt Xcel® on 8/1/22
Fertilizer: MAP and potash VR applied by grid sampling in March 2021; 180 lb N/ac anhydrous ammonia on 11/20/21
Irrigation: None
Rainfall (in):



Introduction: This study evaluated four corn seeding rates: 27,000, 30,000, 33,000, and 36,000 seeds/ac. Each seeding rate was split so that half was applied with Helena® Agri-Enterprises Fastand™ seed treatment and fluency agent. The purpose of this product is to replace talc and graphite seed lubricants and is promoted to improve early corn growth and stand. The objectives of this study were to evaluate the effect of Fastand™ application on plant stand and emergence, and to determine the optimum seeding rate with and without Fastand™.

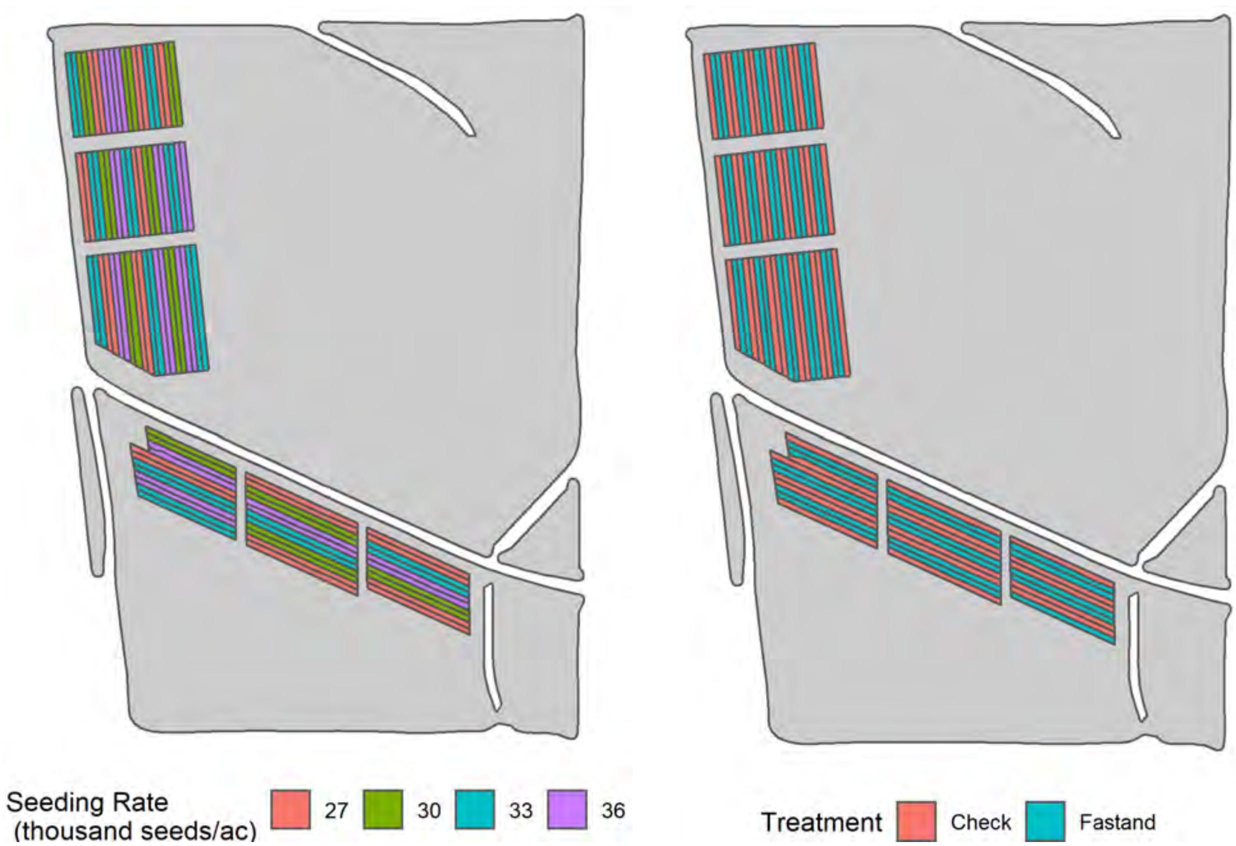


Figure 1. Variable-rate seeding treatment map showing 4 seeding rates, replicated 11 times (left); treatment map showing check and Fastand™ treatment, replicated 11 times (right).

Seeding rate treatments were randomized and replicated in 40' wide by 400' long blocks across the field (Figure 1). Each plot was split in half such that half received Fastand™ and half did not. 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. The as-planted data were evaluated, and only areas where the recorded seeding rate was within 10% of the target seeding rate were included for yield analysis. Yield data points which were excluded from analysis occured primarily along the transition zones between seeding rate treatments; no replications were removed. Stand counts were collected on May 20, 2022. Moisture, yield, and net return were evaluated.

Results:

	Early Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
		Fastand™ Treatment		
Fastand™	28,975 A	14.2 B	237 A	1,450 A
Check	28,850 A	14.5 A	234 A	1,435 A
P-Value	0.899	0.004	0.350	0.408
		Seeding Rate Treatment		
27,000 seeds/ac	24,678 D	14.5 A	224.7 B	1,384 B
30,000 seeds/ac	27,567 C	14.5 A	236.6 A	1,453 A
33,000 seeds/ac	30,622 B	14.2 AB	238.4 A	1,454 A
36,000 seeds/ac	32,733 A	14.1 B	243.8 A	1,479 A
P-Value	<0.0001	0.031	<0.0001	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 $6.57/bu corn, $269/unit of 80,000 seeds, and $2.53/ac for Fastand™.

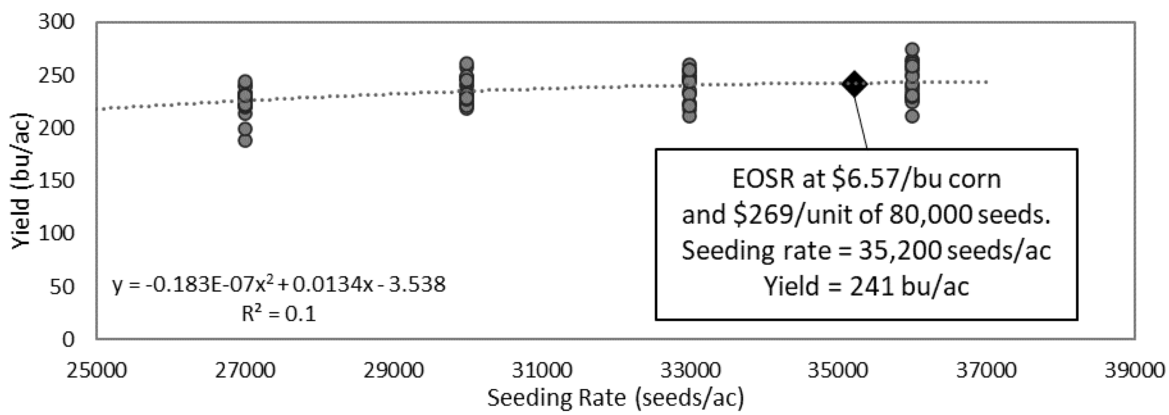


Figure 2. Yield response to seeding rate and economic optimum seeding rate (EOSR).

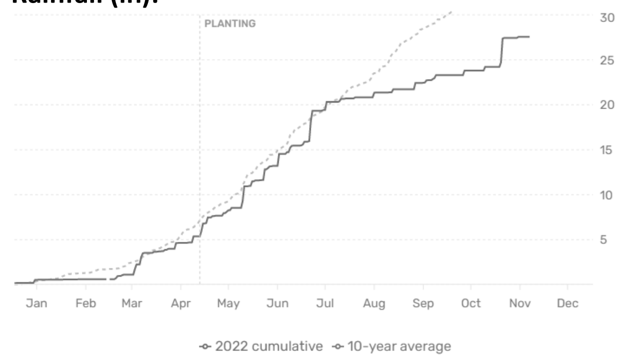
Summary:

- There were no interactions of seeding rate and Fastand™; therefore, these factors are analyzed and reported separately.
- Grain moisture varied among treatments, and was higher for the lower seeding rates (27,000 and 30,000 seeds/ac) compared to the highest seeding rate (36,000 seeds/ac).
- Stand counts were significantly different among the seeding rate treatments, and were 90% to 93% of the target seeding rate.
- Yield was significantly lower for the 27,000 seeds/ac treatment. The economic optimum seeding rate was 35,200 seeds/ac (Figure 2).
- The Fastand™ treatment had lower grain moisture at harvest compared to the untreated check. There were no differences in stand count, yield, or marginal net return between the Fastand™ treatment and check.

Non-Irrigated Corn Population Study

Study ID: 0416147202204
County: Richardson
Soil Type: Zook silty clay loam occasionally flooded; Kennebec silt loam rarely flooded
Planting Date: 4/27/22
Harvest Date: 10/7/22
Seeding Rate: 30k, 33k, 36k
Row Spacing (in): 30
Hybrid: Pioneer® P1572AM
Reps: 4
Previous Crop: Soybean
Tillage: Strip-till
Herbicides: ***Pre:*** 0.825 oz/ac Basis® Blend, 1.4 pt/ac atrazine 4L, 16 oz/ac dicamba ***Post:*** 2.2 qt/ac Keystone® NXT, 24 oz/ac glyphosate, 5.33 oz/ac mesotrione
Foliar Fungicides: 7 oz/ac Veltyma® on 7/13/22

Fertilizer: 170 lb N/ac as anhydrous ammonia on 11/24/21; variable-rate 11-52-0 averaging 25 lb/ac; variable-rate gypsum averaging 113 lb/ac; variable-rate 0-0-60 averaging 113 lb/ac
Irrigation: None
Rainfall (in):



Introduction: The objectives of this study were to determine the impact of planting rate on corn yield and profitability for a productive bottom field. The planting rates evaluated were 30,000, 33,000, and 36,000 seeds/ac. There were four replications. Yield, grain moisture, and net return were evaluated.

Results:

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
30,000 seeds/ac	15.5 A	267 B	1,651 B
33,000 seeds/ac	15.5 A	275 A	1,696 A
36,000 seeds/ac	15.6 A	277 A	1,695 A
P-Value	0.409	0.026	0.083

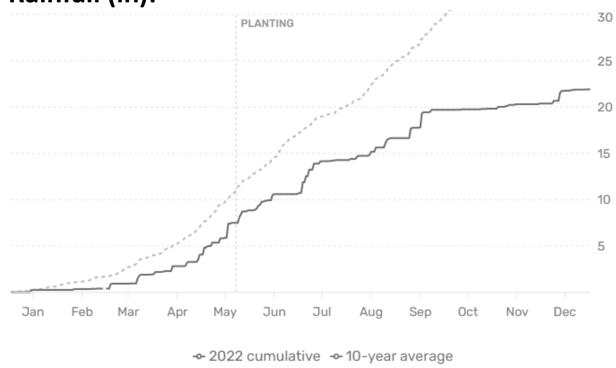
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $6.57/bu corn and $272.80/bag of 80,000 seeds.

Summary:
- There were no differences in grain moisture among the seeding rates evaluated.
- Yield was 9 bu/ac lower for the 30,000 seeds/ac treatment. The 33,000 and 36,000 seeds/ac treatments yielded similarly.
- Marginal net return was approximately $45/ac lower for the 30,000 seeds/ac treatment. There were no differences in marginal net return between the 33,000 and 36,000 seeds/ac treatments.

Non-Irrigated Corn Population Study

Study ID: 1409021202201
County: Burt
Soil Type: Alcester silty clay loam 2-6% slopes; Steinauer clay loam 11-30% slopes, eroded
Planting Date: 5/22/22
Harvest Date: 10/15/22
Seeding Rate: Varies based on treatment
Row Spacing (in): 30
Hybrid: Channel® 209-15VT2
Reps: 3
Previous Crop: Soybean
Tillage: Disked three times
Herbicides: ***Pre:*** 0.7 oz/ac 2,4-D LV4, 0.45 oz/ac Harness®, and 0.07 oz.ac CVA® Elite. ***Post:*** 0.07 oz/ac Choice®, 0.02 oz/ac Laudis®, 0.10 oz/ac atrazine, 0.32 oz/ac Mad Dog®, and 0.13 Plexus®

Fertilizer: 40.5 lb/ac 21-0-0-24S (8.5 lb N/ac) and 24.5 lb N/ac as urea
Irrigation: None
Rainfall (in):



Introduction: This study evaluated the impact of corn seeding rate on yield and net return. Three seeding rates were evaluated: 26,318, 28,423, and 30,628 seeds/ac. Stand counts were collected on June 5, 2022.

Results:

Target Seeding Rate (seeds/ac)	Early Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
26,318	24,833 C*	14.7 A	162 A	970 A
28,423	27,167 B	15.1 A	164 A	972 A
30,628	28,833 A	15.6 A	173 A	1,023 A
P-Value	0.001	0.372	0.495	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 $6.57/bu corn and $292.12/unit of 80,000 seeds/ac.

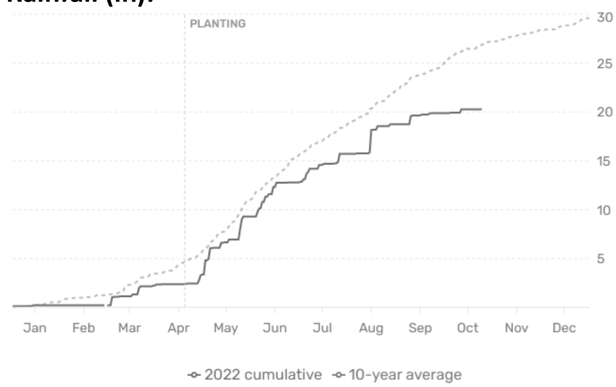
Summary:

- The stand counts were significantly different between the seeding rates, and were approximately 94-95% of the seeding rate.
- While there was a trend of yield and net return increasing with increasing seeding rate, these increases were not statistically significant.

Irrigated Soybean Population Study

Study ID: 1348185202201
County: York
Soil Type: Hastings silt loam; Hall silt loam; Hobbs silt loam; Hord silt loam
Planting Date: 4/19/22
Harvest Date: 9/30/22
Seeding Rate: 100k, 130k, 160k
Row Spacing (in): 30
Hybrid: NK® 28-T3XF
Reps: 3
Previous Crop: Corn
Tillage: Strip-till
Herbicides: ***Pre:*** 4.5 oz/ac Anthem® MAXX, 32 oz/ac glyphosate, and 3 oz/ac Glory® on 4/27/22
Post: 22 oz/ac XtendiMax®, 32 oz/ac glyphosate, and 4 pt/ac Warrant® on 6/27/22
Seed Treatment: UpSurge™ STS, Hustle™, Saltro®, Optimize® XC

Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 120 lb/ac MAP and 40 lb/ac potash applied with strip-till on 4/10/22
Irrigation: Pivot, Total: 6.84"
Rainfall (in):



Introduction: Previous on-farm research in Nebraska has demonstrated that soybean planting rates of 80,000 to 120,000 seeds/ac resulted in the highest profitability. This producer was interested in evaluating the impact of soybean seeding rate in their own operation. Three seeding rates were evaluated: 100,000, 130,000, and 160,000 seeds/ac. Seeding rate treatments were applied in field-length strips and replicated three times. The field was planted on April 19. Stand counts were conducted to document rate of emergence in May and before harvest in September (Figure 1). This field experienced frost damage on May 22.

Results:

Target Rate (seeds/ac)	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
100,000	94,000 C*	86,000 C	71 A	921 A
130,000	120,667 B	103,333 B	72 A	919 A
160,000	152,000 A	129,333 A	73 A	918 A
P-Value	<0.0001	0.004	0.508	0.992

*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 $13.97/bu soybean and $90.51/unit of 140,000 seeds.

Figure 1. Early season soybean emergence was documented by placing different colored stakes at newly emerged plants on each day of counting.

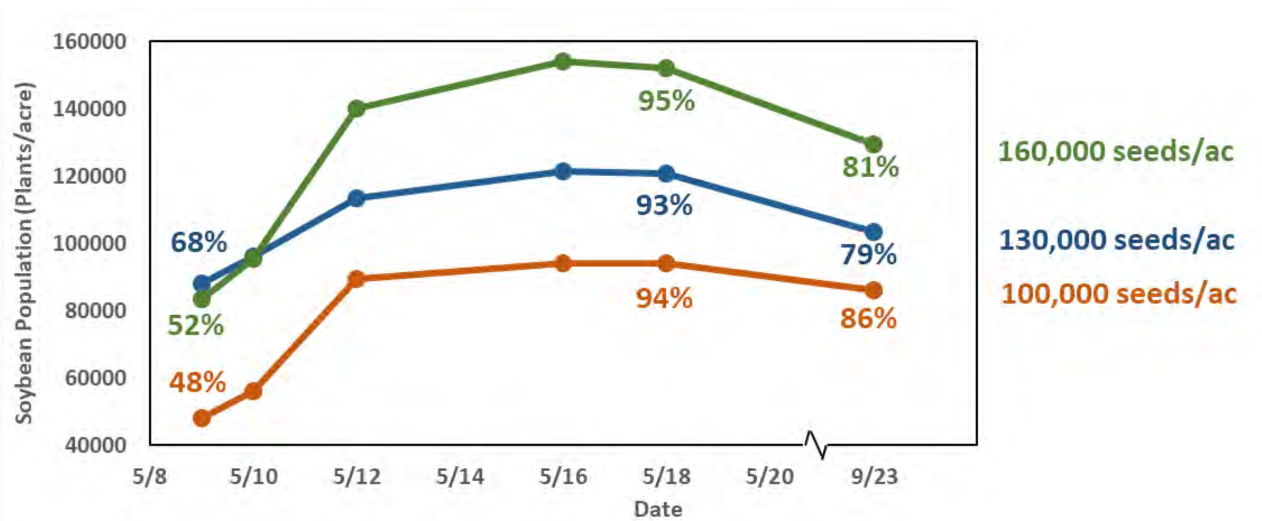


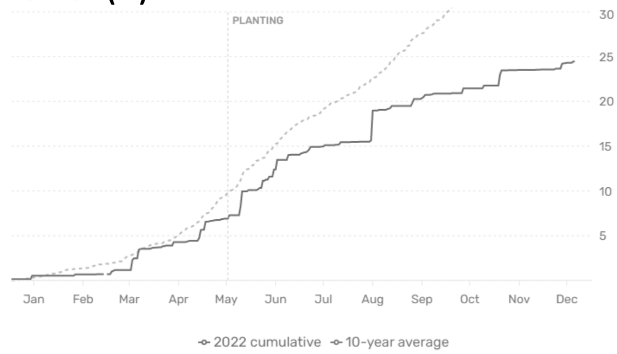
Figure 2. Soybean emergence and harvest stand counts for 100,000, 130,000, and 160,000 seeding rate treatments.

Summary:

- Emergence stand counts initially showed higher percent emergence for the 130,000 seeds/ac rate (Figure 2; 68% compared to 48% and 52% for the 100,000 and 160,000 seeds/ac treatments, respectively). By May 18, all treatments had comparable percent emergence averaging 94% of the planted rate (Figure 2).
- Frost damage on May 22 resulted in a stand reduction. Harvest stand counts were, on average, 82% of the planted rate.
- There were no significant differences in yield or net return between the three seeding rates evaluated.

Non-Irrigated Soybean Population Study

Study ID: 1252025202202
County: Cass
Soil Type: Marshall silty clay loam 2-6% slopes; Marshall silty clay loam 2-6% slopes, eroded; Marshall silty clay loam 6-11% slopes, eroded
Planting Date: 5/16/22
Harvest Date: 10/13/22
Seeding Rate: 70k, 90k, 110k
Row Spacing (in): 15
Hybrid: Golden Harvest® GH3582E3
Reps: 4
Previous Crop: Corn
Tillage: No-till
Herbicides: ***Pre:*** 3 oz/ac Authority® XL, 6 oz/ac Authority® Supreme, 1 pt/ac 2,4-D LV4, and 3.6 oz/ac RENEGADE-EA® ***Post:*** 32 oz/ac Enlist One®, 25 oz/ac Buccaneer® 5 Extra, 9 oz/ac VAQUERO®, 4 oz/ac CYNDER®, 8 oz/ac Penatrol™, and 4 oz/ac Resource®
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: MAP and potash VR applied by grid sampling on 2/14/22
Irrigation: None
Rainfall (in):



Introduction: Previous on-farm research in Nebraska 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 three seeding rates to determine the seeding rate that maximized yield and profit. The target seeding rates were 70,000, 90,000, and 110,000 seeds/ac. The remainder of the field was planted at 120,000 seeds/ac. Treatments were randomized and replicated in approximately 120' wide by 400' 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. The as-planted data were evaluated, and only areas where the recorded seeding rate was within 10% of the target seeding rate were included for yield analysis. Yield data points which were excluded from analysis occured primarily along the transition zones between seeding rate treatments; no replications were removed. Stand counts were taken in each seeding rate on June 14. Yield, moisture, and net return were evaluated.

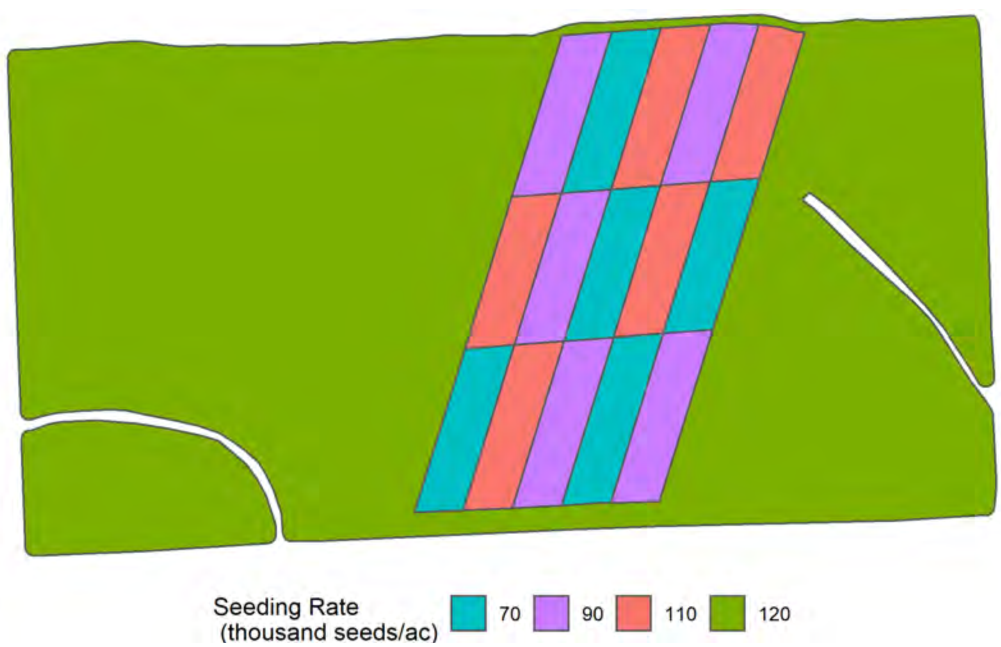


Figure 1. Soybean seeding rate prescription map for 2022 field site.

Results:

Target Seeding Rate (seeds/ac)	Stand Count (plants/ac)	% of Planted Seeds Emerged	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
70,000	64,000 A*	91 A	8.9 A	54 A	733 A
90,000	69,750 A	78 A	8.9 A	54 A	724 A
110,000	76,250 A	69 A	8.6 A	56 A	746 A
P-Value	0.400	0.213	0.676	0.331	0.544

*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 $13.97/bu soybean and $43/140,000 unit of seed.

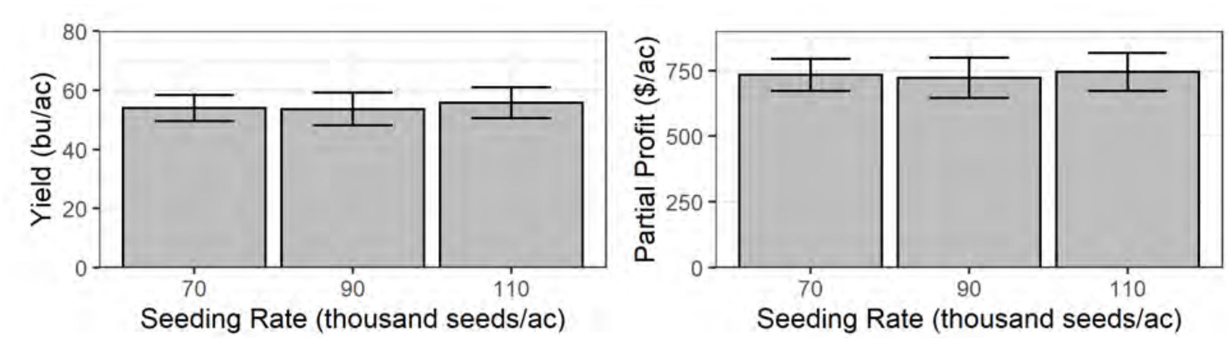


Figure 2. Soybean yield and partial profit for three seeding rates evaluated.

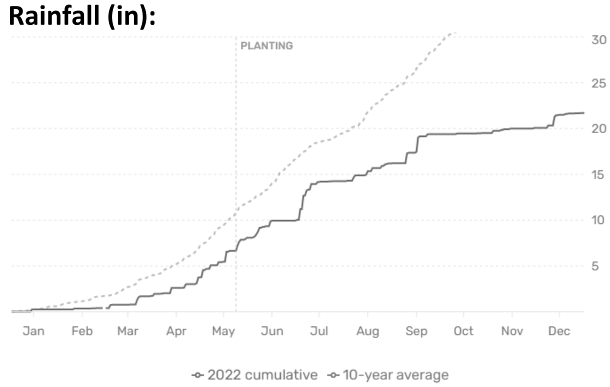
Summary:

- There was no significant difference in stand count among the seeding rates evaluated. The average difference between seeding rates was approximately 6,000 plants/ac rather than the 20,000 plants/ac difference that was intended between each treatment. Stand counts showed that actual stands ranged from 69% to 91% of the target seeding rates.
- This was a relatively dry year. There was no difference in yield or moisture, consistent with this producer's findings from 2021 when seeding rates of 80,000, 110,000, and 140,000 seeds/ac were evaluated.
- There was no difference in net return among the seeding rates evaluated. In 2021, the 80,000 seeds/ac treatment (lowest rate evaluated) resulted in the greatest net return.

Non-Irrigated Soybean Population Study

Study ID: 1409021202202
County: Burt
Soil Type: Forney silty clay rarely flooded; Owego silty clay occasionally flooded
Planting Date: 5/23/22
Harvest Date: 10/8/22
Seeding Rate: 100k, 130k, 156k
Row Spacing (in): 30
Hybrid: Golden Harvest® GH3088
Reps: 4
Previous Crop: Corn
Tillage: Spring tillage

Herbicides: ***Pre:*** 0.19 oz/ac Sentris™, 0.19 oz/ac Astonish™ DRA, 0.29 oz/ac Engenia®, 0.29 oz/ac clethodim, 0.07 oz/ac Sniper®, 0.68 oz/ac Honcho®, and 0.19 oz/ac R-Way®
Irrigation: None
Rainfall (in):



Introduction: Previous on-farm research in Nebraska 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 three seeding rates to determine the seeding rate that maximized yield and profit. The target seeding rates were 100,000, 130,000, and 156,000 seeds/ac. Stand counts were taken on September 20, 2022. Yield, moisture, and net return were evaluated.

Results:

Target Seeding Rate (seeds/ac)	Late Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
100,000	77,000 C*	10.2 A	32 B	382 A
130,000	109,750 B	10.4 A	34 A	400 A
156,000	126,625 A	10.3 A	36 A	404 A
P-Value	<0.0001	0.388	0.023	0.351

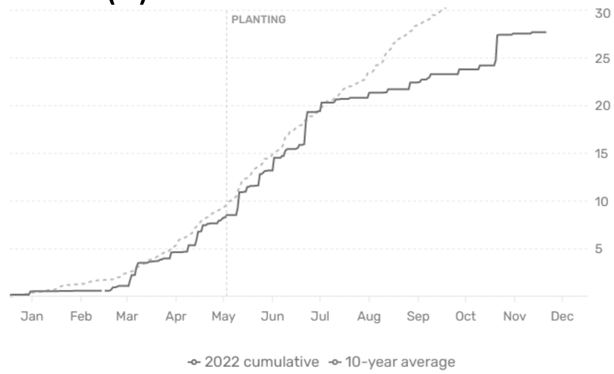
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $13.97/bu soybean and $85.34/unit of 140,000 seeds.

Summary:

- Stand counts were significantly different between the treatments. The 100,000 seeds/ac treatment had a lower final stand percent (77%) compared to the other treatments, which averaged 81-84%.
- There was no difference in grain moisture between the seeding rates evaluated.
- Yield was significantly lower (3-4 bu/ac) for the 100,000 seeds/ac treatment, but it was not enough to statistically impact net return.

Non-Irrigated Soybean Planting Population, Date, and Variety

Study ID: 0510147202202
County: Richardson
Soil Type: Nodaway silt loam occasionally flooded
Planting Date: 4/21/22 and 5/17/22
Harvest Date: 10/6/22
Seeding Rate: 80k, 100k, 120k, 140k
Row Spacing (in): 15
Hybrid: Pioneer® P33A53X and Pioneer® P39A45X
Reps: 4
Previous Crop: Corn
Tillage: No-till
Herbicides: ***Pre:*** 9 oz/ac Authority® Supreme, 12.8 oz/ac dicamba, 20 oz/ac glyphosate ***Post:*** 2.5 pt/ac Warrant®, 12.8 oz/ac Engenia®, 12 oz/ac clethodim
Seed Treatment: L120+, Pioneer Premium Seed Treatment (PPST) L2030 G, Gaucho®, EverGol® Energy, Lumisena™, ILeVO®, Lumiderm®
Foliar Insecticides: 5 oz/ac Hero® on 7/30/22
Foliar Fungicides: 8 oz/ac Revytek® on 7/30/22
Fertilizer: Variable-rate 11-52-0 averaging 45 lb/ac; variable-rate 0-0-60 averaging 97 lb/ac; variable-rate gypsum averaging 65 lb/ac
Irrigation: None
Rainfall (in):



Introduction: Previous studies in have shown soybean yield may be increased by using longer maturity groups and planting soybeans earlier. Studies on soybean seeding rates have shown that seeding rates of 80,000 to 120,000 seeds/ac resulted in the highest profitability. Yet little has been done to evaluate the interaction of seeding date, rate, and maturity group in production fields. This study evaluated two planting dates (April 21, 2022, and May 17, 2022), four seeding rates (80,000, 100,000, 120,000, and 140,000 seeds/ac), and two varieties (Pioneer® P33A53X and Pioneer® P39A45X).

Treatments were randomized and replicated in 30' wide by 400' long blocks across the field (Figure 1). A variable-rate prescription map was created and uploaded to the in-cab monitor to implement the seeding rate changes in the study. Geospatial yield monitor data were collected at the end of the growing season, and post-processed to remove errors. The as-planted data were evaluated, and only areas where the recorded seeding rate was within 10% of the target seeding rate were included for yield analysis. Stand counts were taken in each seeding rate on June 9. Yield and net return were evaluated.

The objectives of the study were to (1) identify the impact of planting date on optimal seeding rate; and (2) evaluate if optimal seeding rate and planting date varies by maturity group.

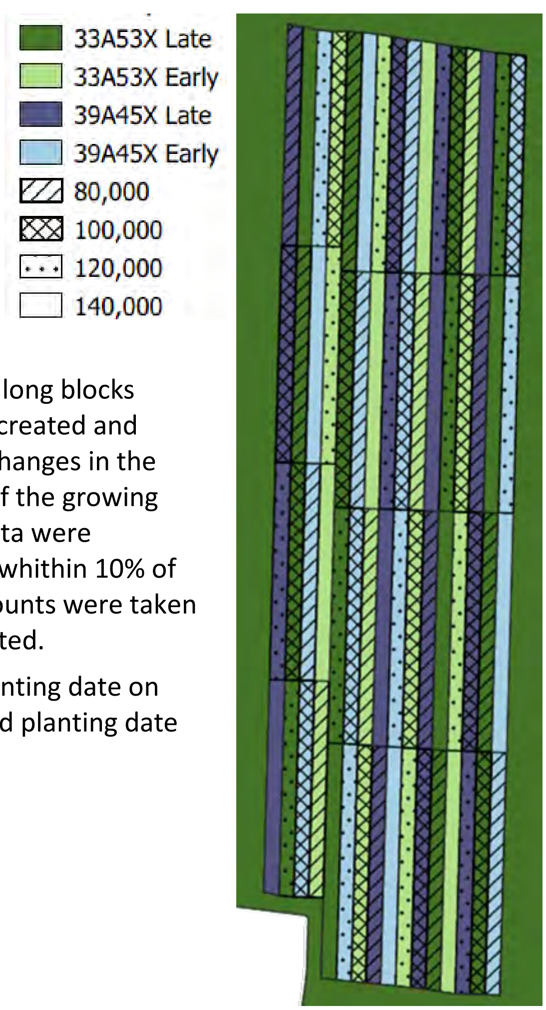


Figure 1. Treatment map showing 4 seeding rates, 2 varieties, and 2 planting dates replicated 4 times.

Results:

There were no interactions between seeding rate, variety, and planting date; therefore, each factor was analyzed separately.

Table 1. Early season stand counts, percent of planted seeds emerged, yield, and marginal net return for two soybean varieties (Pioneer® P33A53X and P39A45X).

Variety	Early Season Stand Count (plants/ac)	% of Planted Seeds Emerged	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Pioneer® P33A53X	87,641 A*	80 A	80 B	1,064 B
Pioneer® P39A45X	80,875 A	74 B	84 A	1,110 A
P-Value	0.176	0.008	0.0005	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 13% moisture.
‡Marginal net return based on $13.97/bu soybean, $73.91/unit of 140,000 seeds for Pioneer® P33A53X, and $78.17/unit of 150,000 seeds for Pioneer® P39A45X.

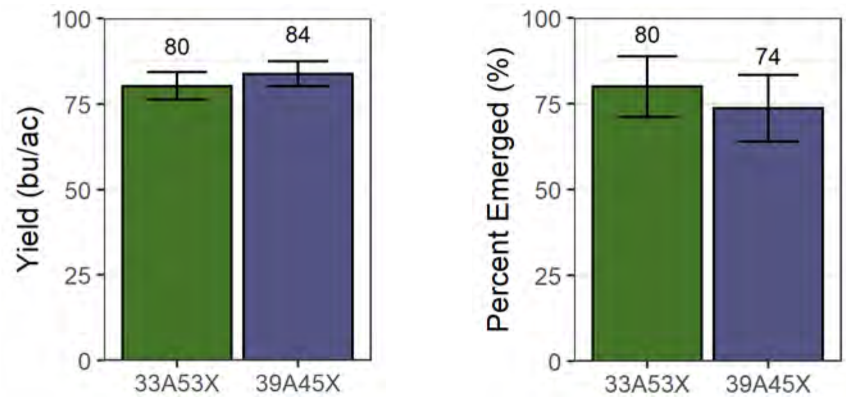


Figure 2. Yield and percent emerged for two soybean varieties (Pioneer® P33A53X and P39A45X).

Table 2. Early season stand counts, percent of planted seeds emerged, yield, and marginal net return for two planting dates: early (April 21, 2022) and late (May 17, 2022).

Date	Early Season Stand Count (plants/ac)	% of Planted Seeds Emerged	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Early	78,594 B*	72 B	83 A	1,099 A
Late	89,922 A	82 A	81 B	1,075 B
P-Value	0.021	<0.0001	0.097	0.099

*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 $13.97/bu soybean, $73.91/unit of 140,000 seeds for Pioneer® P33A53X, and $78.17/unit of 150,000 seeds for Pioneer® P39A45X.

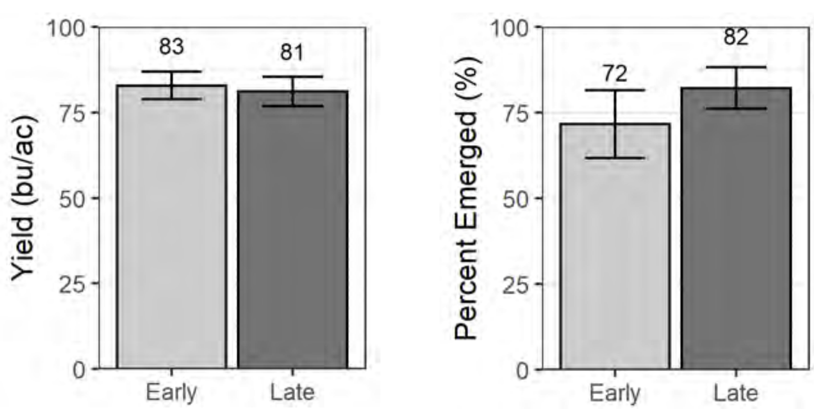


Figure 3. Yield and percent emerged for two planting dates: early (April 21, 2022) and late (May 17, 2022).

Table 3. Early season stand counts, percent of planted seeds emerged, yield, and marginal net return for four soybean seeding rate treatments (80,000, 100,000, 120,000, and 140,000 seeds/ac).

Seeding Rate (seeds/ac)	Early Season Stand Count (plants/ac)	% of Planted Seeds Emerged	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
80,000	60,500 D*	76 A	81 A	1,085 A
100,000	79,656 C	80 A	83 A	1,102 A
120,000	91,906 B	77 A	82 A	1,081 A
140,000	104,969 A	75 A	83 A	1,079 A
P-Value	<0.0001	0.498	0.550	0.698

*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 $13.97/bu soybean, $73.91/unit of 140,000 seeds for Pioneer® P33A53X, and $78.17/unit of 150,000 seeds for Pioneer® P39A45X.

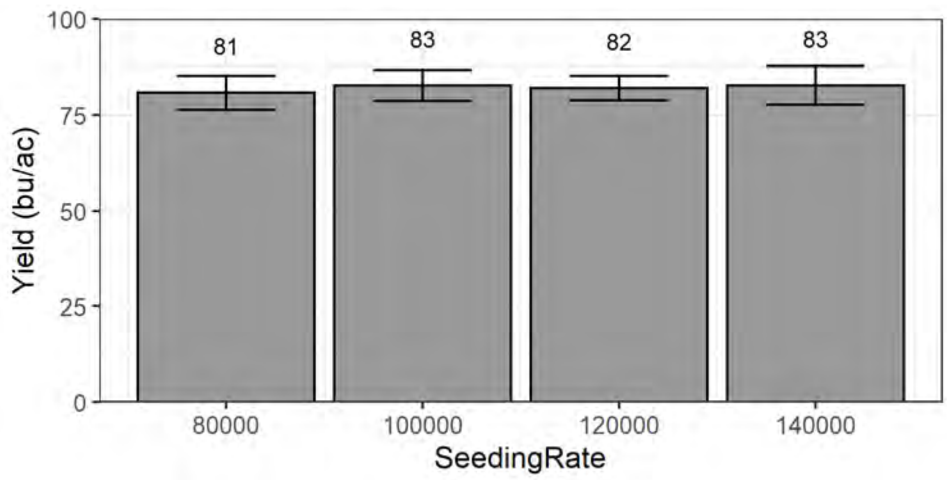


Figure 4. Yield for four soybean seeding rate treatments (80,000, 100,000, 120,000, and 140,000 seeds/ac).

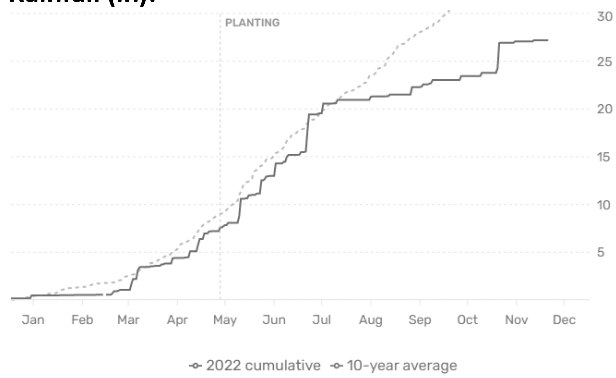
Summary:

- The longer maturity group (Pioneer® P39A45X) resulted in a 4 bu/ac higher yield and $46/ac profit increase, despite lower emergence.
- Similarly, planting soybeans early resulted in a 2 bu/ac yield increase and $24/ac profit increase, despite lower emergence due to poorer planting conditions.
- There were no emergence, yield, or profit differences. Optimal seeding rate was not impacted by variety or planting date.

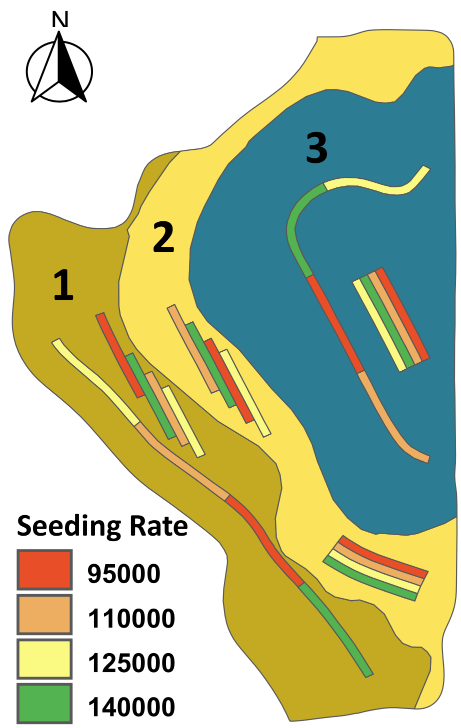
Soybean Planting Population in Three Management Zones

Study ID: 0510147202203
County: Richardson
Soil Type: Monona silt loam 6-11% slopes; Judson silt loam 2-6% slopes; Kennebec silt loam rarely flooded
Planting Date: 5/12/22
Harvest Date: 10/21/22
Seeding Rate: 95k, 110k, 125k, 140k
Row Spacing (in): 15
Hybrid: Pioneer® P33A53X
Reps: 6
Previous Crop: Corn
Tillage: No-till
Herbicides: ***Pre:*** 9 oz/ac Authority® Supreme, 12.8 oz/ac dicamba, 20 oz/ac glyphosate ***Post:*** 2.5 pt/ac Warrant®, 12.8 oz/ac Engenia®, 12 oz/ac clethodim
Seed Treatment: L120+, Pioneer Premium Seed Treatment (PPST) L2030 G, Gaucho®, EverGol® Energy, Lumisena™, ILeVO®, Lumiderm®

Foliar Insecticides: 5 oz/ac Hero® on 7/30/22
Foliar Fungicides: 8 oz/ac Revytek® on 7/30/22
Fertilizer: Variable-rate 11-52-0 averaging 92 lb/ac; variable-rate 0-0-60 averaging 86 lb/ac; variable-rate gypsum averaging 58 lb/ac
Irrigation: None
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. With planting capabilities that allow soybean seeding rates to be changed on-the-go and the increasing cost of soybean seed, there is interest in implementing variable-rate seeding (VRS) for soybeans. However, producers are challenged to know the where and why to increasing or decreasing seeding rates in a VRS strategy. Therefore, the purpose of this study was to evaluate four seeding rates in three contrasting field zones to determine the optimal seeding rate for each zone and determine if the optimal seeding rate variation warrants a VRS approach. The four seeding rates selected were 95,000, 110,000, 125,000, and 140,000 seeds/ac. The three contrasting field zones were determined by using soil series that reflected differences in soil texture and slope (Figure 1). Treatments were randomized and replicated in 30' wide by 300' long blocks across the field (Figure 1). There were two replications of the four seeding rates in each zone. 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. The as-planted data were evaluated, and only areas that achieved within 10% of the target seeding rate were included for yield analysis. Stand counts were taken in each seeding rate on June 9. Yield and net return were evaluated.



	SOIL SERIES DESCRIPTION	OM (%) (0-48")	SAND (%) (0-8")	SILT (%) (0-8")	CLAY (%) (0-8")
ZONE 1	Kennebec silt loam, 0-1% slopes	2.4	7	68	25
ZONE 2	Judson silt loam, 2-6% slopes	2.2	4	69	27
ZONE 3	Monona silt loam, 6-11% slopes	1.3	4	73	23

Figure 1. (top) Variable-rate seeding treatment map showing 4 seeding rates, replicated 2 times in each of three zones. **(bottom)** Zone descriptions of soil series, OM, sand, silt, and clay from Web Soil Survey.

Results:

Table 1. Early season stand counts, percent of planted seeds emerged, yield, and marginal net return for four soybean seeding rate treatments (95,000, 110,000, 125,000, and 140,000 seeds/ac).

Seeding Rate (seeds/ac)	Early Season Stand Count (plants/ac)	% of Planted Seeds Emerged	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
95,000	83,833 C*	88 A	68 A	892 A
110,000	94,833 B	86 A	72 A	950 A
125,000	109,250 A	87 A	72 A	936 A
140,000	118,167 A	84 A	71 A	916 A
P-Value	<0.0001	0.713	0.591	0.712

*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 $13.97/bu soybean and $75.84/unit of 140,000 seeds.

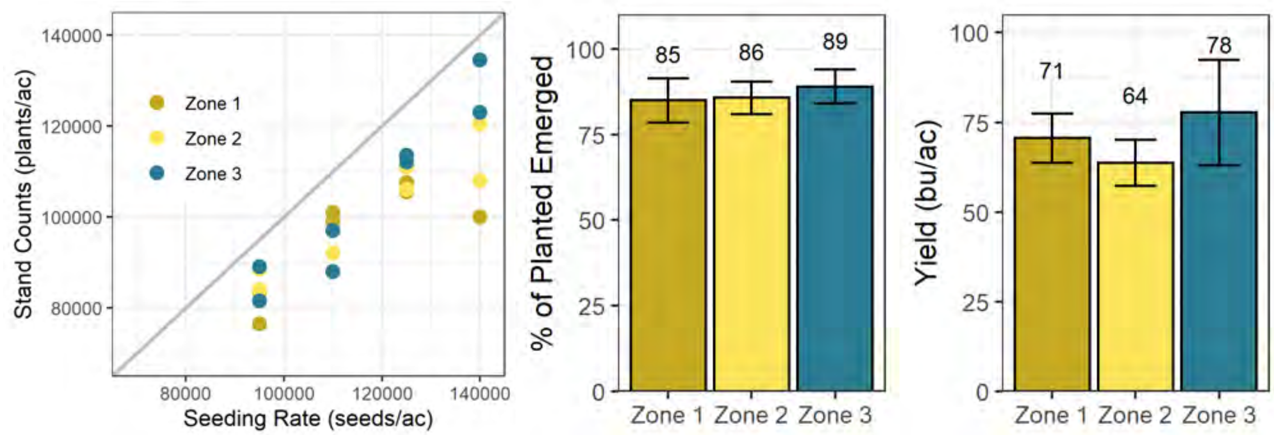


Figure 1. (left) Target soybean seeding rate compared to stand counts for each zone. (middle) Percent of planted seeds that emerged by zone. (right) Soybean yield by zone.

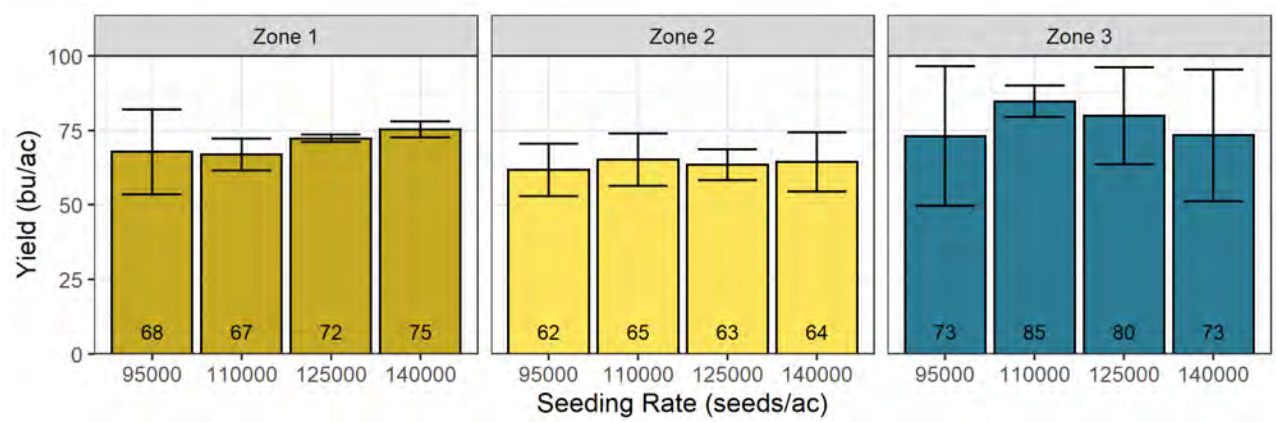


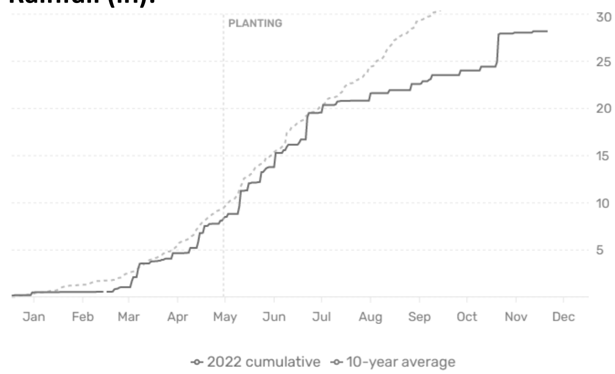
Figure 2. Yield by four seeding rates averaged across two replications in each of three zones.

Summary:

- Across all zones, there were no differences in the percent of planted seeds emerged, yield, or marginal net return among treatments (Table 1).
- Comparing stand counts to seeding rate (Figure 1, left), the greatest variation occurred in the 140,000 seed/ac target rate, where stand counts for zone 1 and 2 fell short of the seeding rate.
- There was a trend of greater percent emergence for zone 3 (Figure 1, middle), indicating potential for even lower seeding rates to be used in this zone.
- Zone three was the highest yielding zone, but also had the greatest yield variability (Figure 1, right).
- Further work is needed to understand the potential for VRS in this field and the optimal strategy over multiple growing season conditions.

Soybean Planting Population in Three Management Zones

Study ID: 0510KS013202204
County: Brown, Kansas
Soil Type: Marshall silty clay loam 5-9% slopes; Marshall silt loam 2-5% slopes
Planting Date: 5/14/22
Harvest Date: 9/29/22
Seeding Rate: 95k, 110k, 125k, 140k
Row Spacing (in): 15
Hybrid: Pioneer® P33A53X
Reps: 6
Previous Crop: Corn
Tillage: No-till
Herbicides: ***Pre:*** 9 oz/ac Authority® Supreme, 12.8 oz/ac dicamba, 20 oz/ac glyphosate ***Post:*** 2.5 pt/ac Warrant®, 12.8 oz/ac Engenia®, 12 oz/ac clethodim
Seed Treatment: L120+, Pioneer Premium Seed Treatment (PPST) L2030 G, Gaucho®, EverGol® Energy, Lumisena™, ILeVO®, Lumiderm®
Foliar Insecticides: 5 oz/ac Hero® on 7/30/22
Foliar Fungicides: 8 oz/ac Revytek® on 7/30/22
Fertilizer: Variable-rate 11-52-0 averaging 145 lb/ac; variable-rate 0-0-60 averaging 60 lb/ac; variable-rate gypsum averaging 40 lb/ac
Irrigation: None
Rainfall (in):



Introduction: Previous on-farm research in Nebraska has demonstrated that soybean planting rates of 80,000 to 120,000 seeds/ac resulted in the highest profitability. With planting capabilities that allow soybean seeding rates to be changed on-the-go and the increasing cost of soybean seed, there is interest in implementing variable-rate seeding (VRS) for soybeans. However, producers are challenged to know the where and why to increasing or decreasing seeding rates in a VRS strategy. Therefore, the purpose of this study was to evaluate four seeding rates in three contrasting field zones to determine the optimal seeding rate for each zone and determine if the optimal seeding rate variation warrants a VRS approach. The four seeding rates selected were 95,000, 110,000, 125,000, and 140,000 seeds/ac. The three contrasting field zones were determined by creating normalized yield maps based on 5 years of previous corn and soybean yields and classifying normalized yield into low, medium, and high yielding areas of the field (Figure 1). Seeding rate treatments were randomized and replicated in 30' wide by 300' long blocks across the field (Figure 1). There were two replications of the four seeding rates in each zone. 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. The as-planted data were evaluated, and only areas that achieved within 10% of the target seeding rate were included for yield analysis. Stand counts were taken in each seeding rate on June 9. Yield and net return were evaluated.

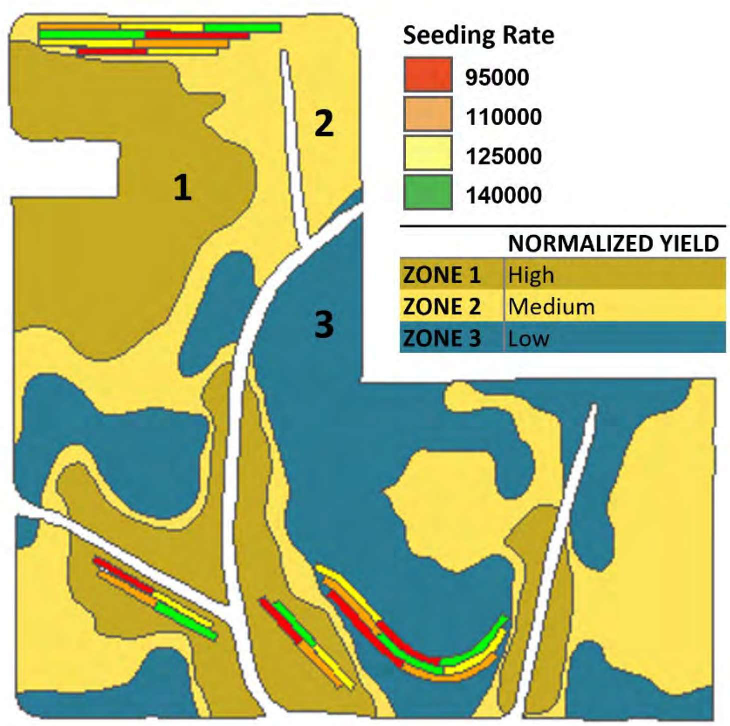


Figure 1. Variable-rate seeding treatment map showing 4 seeding rates, replicated 2 times in each of three zones.

Results:

Table 1. Early season stand counts, percent of planted seeds emerged, yield, and marginal net return for four soybean seeding rate treatments (95,000, 110,000, 125,000, and 140,000 seeds/ac).

Seeding Rate (seeds/ac)	Early Season Stand Count (plants/ac)	% of Planted Seeds Emerged	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
95,000	78,333 C*	83 A	78 A	1,044 A
110,000	87,167 C	79 A	75 A	984 A
125,000	101,167 B	81 A	77 A	1,010 A
140,000	111,583 A	80 A	76 A	979 A
P-Value	<0.0001	0.754	0.498	0.288

*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 $13.97/bu soybean and $75.84/unit of 140,000 seeds.

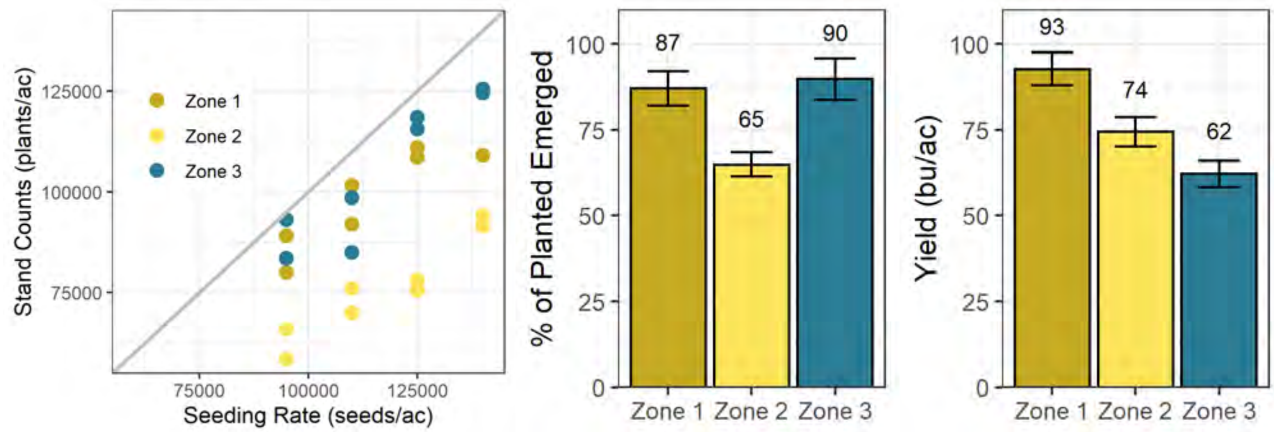


Figure 1. (left) Target soybean seeding rate compared to stand counts for each zone. (middle) Percent of planted seeds that emerged by zone. (right) Soybean yield by zone.

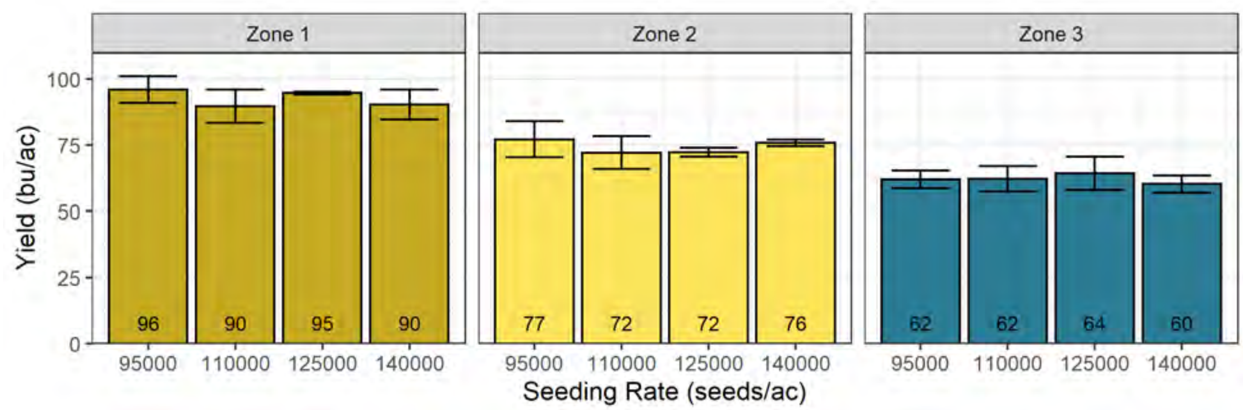


Figure 2. Yield by four seeding rates averaged across two replications in each of three zones.

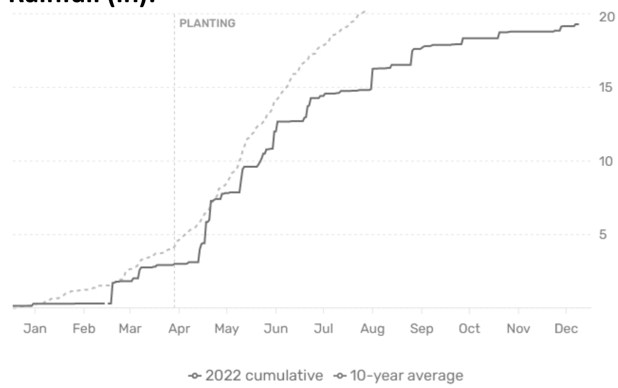
Summary:

- There were no interactions between seeding rate and zone. Across all zones, there were no differences in the percent of planted seeds emerged, yield, or marginal net return among treatments (Table 1).
- Zone 2 had the lowest stand counts compared to seeding rate (Figure 1, left) and the lowest percent emergence (Figure 1, middle), which was due to poor planting conditions when this zone was planted, leading to crusting.
- Normalized yield classifications of high, medium, and low performed as expected, with zone 1 averaging 93 bu/ac, zone 2 averaging 74 bu/ac, and zone 3 averaging 62 bu/ac.
- Further work is needed to understand the potential for VRS in this field and the optimal strategy over multiple growing season conditions.

Group 2.0 versus Group 3.1 Soybean Maturity

Study ID: 0802159202202
County: Seward
Soil Type: Muir silt loam 1-3% slope; Hastings silt loam 7-11% slopes; Hall silt loam 0-1% slope
Planting Date: 4/12/22
Harvest Date: 9/16/22 and 9/28/22
Seeding Rate: 140,000
Row Spacing (in): 30
Hybrid: Pioneer® P20A22X, P31A95BX
Reps: 3
Previous Crop: Corn
Tillage: No-till
Herbicides: ***Pre:*** Engenia®, 22 oz/ac Roundup PowerMAX® 3, 6 oz/ac Zidua® PRO Powered by Kixor®, and All-In Elite ***Post:*** Engenia®, 22 oz/ac Roundup PowerMAX® 3, and All-In Elite

Fertilizer: 150 lb/ac MicroEssentials® SZ® (MESZ) in fall 2021
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 under irrigation. The goal of this study was to determine if growers may want to consider planting a longer-season maturity soybean to achieve optimum yields when planting early in a non-irrigated field. This is the fifth year of evaluations of different soybean maturity groups in the Nebraska On-Farm Research Network.

This study compared a group 2.0 (Pioneer® P20A22X) and a group 3.1 (Pioneer® P31A95BX) soybean. Soybeans were planted on April 12. The 2.0 maturity soybeans were harvested on September 16, and the 3.1 maturity group soybeans were harvested on September 28.

Results:

	Harvest Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Group 2.0 (Pioneer® P20A22X)	70,500 B*	55 A	10.4 A	44 A	548 A
Group 3.1 (Pioneer® P31A95BX)	86,667 A	55 A	10.8 A	50 A	623 A
P-Value	0.045	0.691	0.581	0.197	0.220

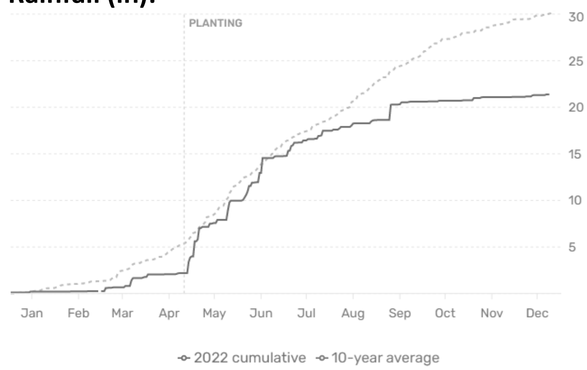
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $13.97/bu soybean, $71/ac for Pioneer® P20A22X, and $77/ac for Pioneer® P31A95BX.

Summary:

- Stand counts were significantly different between the varieties evaluated, with the 3.1 maturity group having 16,000 greater plants/ac compared to the 2.0 maturity group. The low plant stands relative to seeding rate are due to stand reduction resulting from a frost on May 22, 2022.
- There were no differences in test weight, grain moisture, yield, or marginal net return. Timing of rain events throughout the season can impact the varieties differently because they are at different developmental stages. This can contribute to yield differences.
- The results of this study are consistent with previous on-farm research studies in 2018, 2019, and 2020 that found no difference in yield between group 2 and group 3 soybeans across 10 site-years (p-value=0.698).

Group 2.0 versus Group 2.5 versus Group 2.8 versus Group 3.1 Soybean Maturity

Study ID: 0802159202203
County: Seward
Soil Type: Hastings silt loam 0-1% slope; Fillmore silt loam frequently flooded
Planting Date: 4/25/22
Harvest Date: 9/19/22 and 9/28/22
Seeding Rate: 140,000
Row Spacing (in): 30
Hybrid: Pioneer® P20A22X, P25A04X, P28A42X, P31A95BX
Reps: 4
Previous Crop: Corn
Tillage: Ridge-till
Herbicides: ***Pre:*** Engenia®, 22 oz/ac Roundup PowerMAX® 3, 6 oz/ac Zidua® PRO Powered by Kixor®, and All-In Elite ***Post:*** Engenia®, 22 oz/ac Roundup PowerMAX® 3, and All-In Elite
Irrigation: Gravity, Total: 18.22"
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 obtaining high yields with mid-group 2 varieties. The goal of this study was to determine if growers may want to consider planting a longer-season maturity soybean to achieve optimum yields when planting early. This is the fifth year of evaluations of different soybean maturity groups in the Nebraska On-Farm Research Network. This study compared a group 2.0 (Pioneer® P20A22X), a group 2.5 (Pioneer® P25A04X), a group 2.8 (Pioneer® P28A42X), and a group 3.1 (Pioneer® P31A95BX) soybean. Soybeans were planted on April 25. The 2.0, 2.5, and 2.8 maturity soybeans were harvested on September 19, whereas the 3.1 maturity group was harvested on September 28.

Results:

	Harvest Stand Count (plants/ac)	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Group 2.0 (Pioneer® P20A22X)	75,000 B*	54 B	11.4 B	53 C	664 D
Group 2.5 (Pioneer® P25A04X)	89,250 A	55 A	11.3 B	64 B	814 C
Group 2.8 (Pioneer® P28A42X)	98,250 A	54 AB	13.4 A	68 A	870 B
Group 3.1 (Pioneer® P31A95BX)	84,750 AB	55 AB	8.7 C	71 A	908 A
P-Value	0.010	0.042	0.0001	<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 $13.97/bu soybean, $71/ac for Pioneer® P20A22X, $75/ac for Pioneer® P25A04X, $78/ac for Pioneer® P28A42X, and $77/ac for Pioneer® P31A95X.

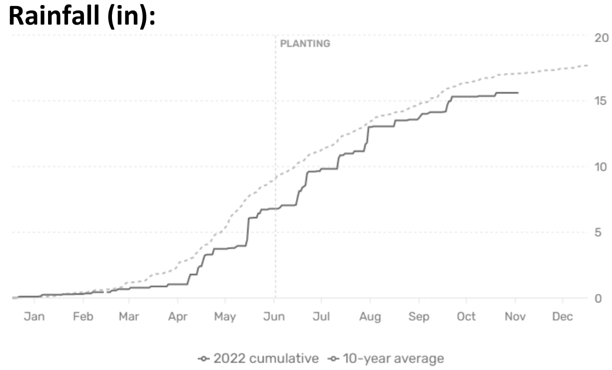
Summary:

- Harvest stand counts for the group 2.5 and group 2.8 soybeans were significantly higher than for the group 2.0 soybeans (14,000 to 23,000 plants/ac higher, respectively). Low stand counts relative to seeding rate are likely due to stand reduction that occurred as a result of a frost on May 22, 2022.
- Among the three varieties harvested on September 19 (2.0, 2.5, and 2.8) the group 2.8 had significantly wetter grain (2% wetter) than the other two varieties. The group 3.1 harvested on September 28 was significantly drier (2-5% drier) than the other three varieties harvested on September 19.
- Test weight varied between the varieties with the group 2.5 having a higher test weight than the group 2.0.
- Yield was significantly higher for the group 3.1 and 2.8 soybeans. The group 2.5 soybeans were the next highest yielding, whereas group 2.0 soybeans were the lowest yielding. The yield difference between the longest and shortest maturity group was 18 bu/ac.
- Net return was significantly different, and was greatest for the longest maturity group and lowest for the shortest maturity group. The difference in marginal net return between the longest and shortest maturity group was $244/ac.

Pinto Bean Varieties for Direct Harvest

Study ID: 0152013202202
County: Box Butte
Soil Type: Keith loam 0-1% slope; Keith loam 1-3% slope
Planting Date: 6/16/22
Harvest Date: 10/10/22
Seeding Rate: 90,000
Row Spacing (in): 15
Hybrid: 4 varieties
Reps: 4
Previous Crop: Corn
Tillage: Disked and rolled before planting
Herbicides: ***Pre:*** 30 oz/ac Prowl® H2O, 15 oz/ac Outlook®, and 32 oz/ac Roundup® on 6/9/22. ***Post:*** 4 oz/ac Raptor®, 30 oz/ac Basagran®, and 15 oz/ac Select® on 7/13/22; 25 oz/ac Basagran® and 15 oz/ac Select® on 7/13/22; 3 oz/ac Sharpen®, 2 oz/ac Valor®, 2 pt/ac Gramoxone®, and 10 oz/ac crop oil applied for desiccation on 9/21/22

Seed Treatment: Apron® XL, Maxim®, Rancona®, and Vibrance®
Foliar Insecticides: None
Foliar Fungicides: 28 oz/ac Praiz®, 1 lb/ac Nu-Cop® HB, 1 qt/100 gal InterLock®, and 1 pt/100 gal Preference® on 8/12/22
Fertilizer: 30 lb N/ac, 30 lb P/ac, and 1 lb Z/ac applied 6/7/22
Irrigation: Pivot, Total: 8-10"
Rainfall (in):



Baseline Soil Samples, 0-8” (November 2021):

	pH	OM LOI %	Nitrate – N ppm N	Bicarb- P ppm	Sulfate-S ppm S	-------Melich lll------- K	Ca	Mg	Na	CEC me/100g	Zn	Fe	Mn	Cu
											(DTPA ppm)			
Sample	7.7	1.4	10	10	9	488	1860	291	68	13.3	2.7	3.6	1.1	0.3

Introduction: This study evaluated four different pinto bean varieties in a direct-harvest bean production system, looking at both yield and harvest loss. Currently, most dry beans in western Nebraska are harvested in a two-step process starting with a cutting-windrowing operation, then combining. Direct-harvest is simply one pass through the field with the combine. A well-suited upright bean variety, planting on a level field surface, and a combine header suitable for direct harvest are essential to minimize harvest loss and economically justify direct harvest.

This study evaluated varieties Rattler, Cancun, 33503-14, and Cowboy. The target population for the study was 90,000 plants/ac. Because of the inaccuracy of drills as a result of seed size and flow through the machine, actual plant populations determined by early season stand counts were 84,729 plants/ac for Rattler, 74,819 for Cancun, 71,769 for 33503-14, and 91,372 for Cowboy. Actual seeding rates were therefore assumed to be 10% greater than the stand counts with approximately 93,202 seeds/ac for Rattler, 82,301 for Cancun, 78,946 for 33503-14, and 100,509 for Cowboy.

Samples from each plot were analyzed for bean quality parameters. Low-hanging pods are a major cause of harvest loss in the direct-harvest process; therefore, pod height measurements were taken to determine the percent of pods greater than 2" above the ground just before harvest. The field was harvested with a Case IH 7088 combine with a MacDon® 30-foot FlexDraper® head. The temperature at harvest was 73° F with 18% relative humidity. Hot and dry weather conditions at harvest generally result in greater harvest loss through pod shattering. Harvest loss estimates were determined by taking counts in one-square-foot frames randomly chosen in the harvested area, but equally representing the left, center, and right side of the header area behind the combine.

Results:

	Stand Count (plants/ac)	Pods > 2" Aboveground (%)	Harvest Loss (bu/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Rattler	84,729 AB*	75 AB	4 A	62 A	1,326 A
Cancun	74,819 BC	65 BC	4 A	48 BC	1,013 BC
33503-14	71,769 C	61 C	4 A	42 C	893 C
Cowboy	91,372 A	79 A	4 A	52 B	1,095 B
P-Value	0.002	0.015	0.897	0.0001	0.0001

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

†Bushels per acre corrected to 14% moisture.

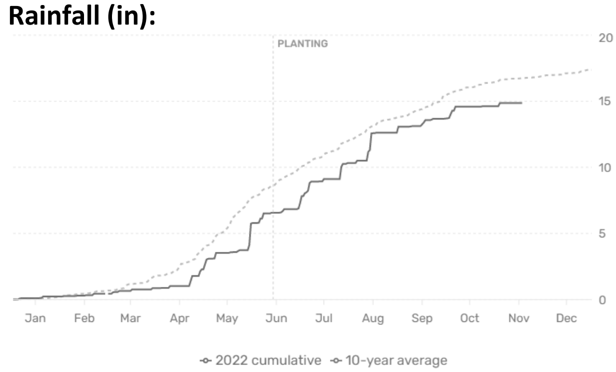
‡Marginal net return based on $38/cwt ($22.80/bu at 60lb/bu). Cost for the bean seed was $90/100,000 seeds. Seed costs for each treatment were adjusted to represent the estimated actual seeding rate based on stand counts: $83.88/ac for Rattler, $74.07/ac for Cancun, $90.46/ac for Cowboy, and $71.05/ac for 33503-14.

Summary:

- There were significant differences in stand counts among the treatments. Cowboy and Rattler had the highest stand counts, whereas Cancun and 33503-14 had the lowest stand counts.
- Pod height varied among varieties as well, with Cancun and 33503-14 having the lowest percent of pods above 2", which may be due to lower stand counts. Cowboy and Rattler had the highest percent of pods above 2", which corresponded to the highest stand counts.
- Despite pod height differences, all varieties had harvest losses of approximately 4 bu/ac.
- Yields varied by 20 bu/ac among the varieties. Rattler had the highest yield, with a 10 bu/ac advantage over the next highest yielding variety (Cowboy).
- Correspondingly, Rattler had the highest marginal net return, $232/ac higher than the next most profitable variety (Cowboy).

Pod Ceal® on Dry Edible Beans

Study ID: 0152013202201
County: Box Butte
Soil Type: Keith loam 0-1% slope; Keith loam 1-3% slope; Keith loam 3-6% slopes
Planting Date: 6/13-14/22
Harvest Date: 10/11/22
Seeding Rate: 90,000
Row Spacing (in): 15
Hybrid: Panhandle Pride great northern
Reps: 4
Previous Crop: Corn
Tillage: Disked and rolled before planting
Herbicides: ***Pre:*** 30 oz/ac Prowl® H2O, 15 oz/ac Outlook®, and 32 oz/ac Roundup® on 6/7/22 ***Post:*** 4 oz/ac Raptor®, 30 oz/ac Basagran®, and 15 oz/ac Select® on 7/12/22; 3 oz/ac Sharpen®, 2 oz/ac Valor®, 2 pt/ac Gramoxone®, and 10 oz/ac crop oil applied for desiccation on 9/21/22
Seed Treatment: Apron XL®, Maxim®, Rancona®, Vibrance®, and Cruiser®
Foliar Insecticides: None
Foliar Fungicides: 28 oz/ac Praiz®, 1 lb/ac Nu-Cop® HB, 1 qt/100 gal InterLock®, and 1 pt/100 gal Preference® on 8/12/22
Fertilizer: 30 lb N/ac, 3 lb P/ac, and 1 lb Z/ac applied 6/9/22
Irrigation: Pivot, Total: 8-10"
Rainfall (in):



Baseline Soil Samples, 0-8" (October 2021):

pH	OM LOI %	Nitrate – N ppm N	Bicarb- P ppm	Sulfate-S ppm S	-------Melich III------- K	Ca	Mg	Na	CEC me/100g	Zn	Fe (DTPA ppm)	Mn	Cu
7.7	1.5	11.4	9	11	469	2000	313	88	14.2	0.7	3.8	1.3	0.3

Introduction: Pod Ceal® by Miller® is a product applied on dry edible beans to reduce moisture intrusion into the pod. The product is a formulation of cyclohexane polymer concentrate, which forms an elastic, semi-permeable membrane on the pods. The intent is to prevent pods from popping open during natural wetting and drying prior to harvest, and reduce harvest loss due to shelling. This producer was interested in evaluating Pod Ceal® on great northern beans to determine the impact on yield and harvest loss. Pod Ceal® was applied on 9-21-22 by ground application (90-ft boom) at a rate of 1 pt/ac, and was compared to an untreated check. Both treatments received a Gramoxone® desiccation application on 9-21-22. The field was harvested with a Case IH 7088 combine with a MacDon® 30-foot FlexDraper® head. The temperature at harvest was 75°F with 19% relative humidity.

Samples from each plot were analyzed for bean quality parameters. Harvest loss estimates were determined by taking counts in one-square-foot frames randomly chosen in the harvested area, but equally representing the left, center, and right side of the header area behind the combine.

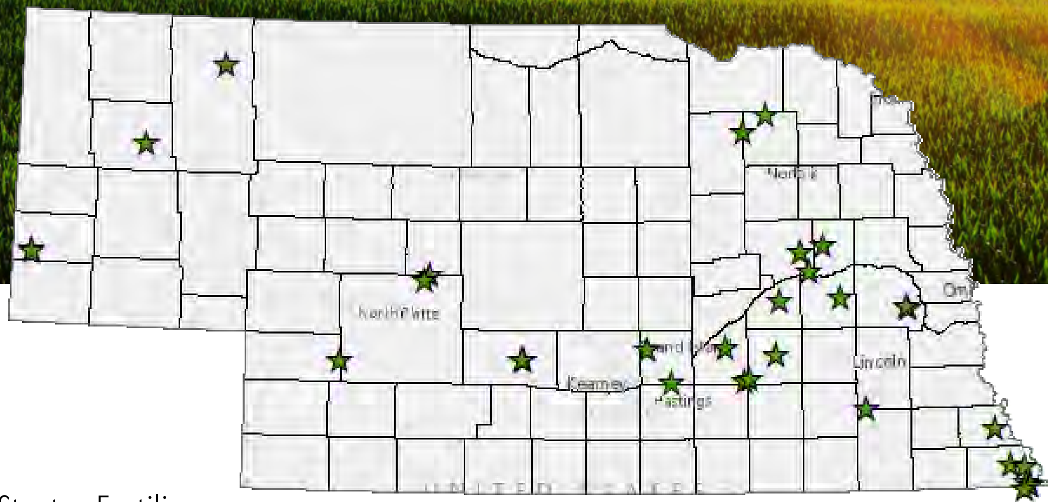
Results:

	Harvest Loss (bu/ac)	Split (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	7.1 A*	0.6 A	13.4 A	35 A	836 A
Pod Ceal®	6.1 A	0.4 B	13.8 A	33 B	770 B
P-Value	0.230	0.077	0.197	0.098	0.063

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 14% moisture.
‡Marginal net return based on $40/cwt ($24/bu at 60lb/bu) and $11.82/ac for Pod Ceal®.

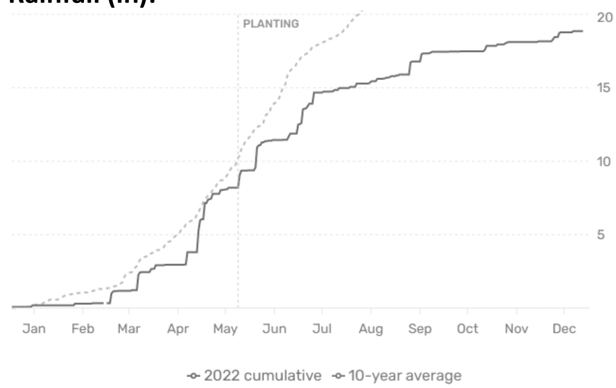
Summary:
- There was no difference in harvest loss between the Pod Ceal® treated beans and the untreated beans.
- Beans treated with Pod Ceal® had a reduction in percent splits.
- Yield was reduced by 2 bu/ac where Pod Ceal® was applied.
- Marginal net return was $66/ac lower for the Pod Ceal® treatment compared to the untreated check.

Fertility & Soil Management



Comparing Soybean Starter Fertilizers

Study ID: 0996037202201
County: Colfax
Soil Type: Alcester silty clay loam 2-6% slopes; Crofton silt loam 2-6% slopes, eroded; Nora-Crofton complex 6-17% slopes, eroded
Planting Date: 5/23/22
Harvest Date: 10/8/22
Seeding Rate: 125,000
Row Spacing (in): 30
Hybrid: Pioneer® P28A51X
Reps: 5
Previous Crop: Corn
Tillage: No-till
Herbicides: ***Pre:*** 22 oz/ac XtendiMax®, 32 oz/ac glyphosate, 40 oz/ac Satellite® HydroCap, and 2.75 oz/ac Valor® SX on 5/7/22 ***Post:*** 32 oz/ac glyphosate and 64 oz/ac Warrant® on 6/23/22
Seed Treatment: LumiGEN™
Foliar Insecticides: None
Foliar Fungicides: 7 oz/ac RustEase® on 8/10/22
Fertilizer: An average of 120 lb/ac MAP, 18.4 lb/ac sulfur 85%, and 5.7 lb/ac zinc 10% was applied by variable-rate on 3/4/22
Irrigation: None
Rainfall (in):



Soil Tests, 0-8" (January 29, 2021):

					-------Melich III-------				
	pH	**OM LOI %**	**Melich-III P ppm**	**Sulfate-S ppm S**	**K**	**Ca**	**Mg**	**Na**	**CEC me/100g**
Sample 1	6.9	3.7	5	11.6	244	4907	372	14	28.3
Sample 2	6.7	3.1	15	9.7	328	3225	504	9	21.2
Sample 3	7.0	3.0	5	8.0	259	3246	771	22	23.4
Sample 4	7.2	2.0	5	6.0	263	5327	404	13	30.7

Introduction: This study evaluated the impact of several starter fertilizer products and placements on soybean yield. The treatments are as follows:

1) The 2x2x2 treatment consisted of 5 gal/ac 10-34-0 and 5 gal/ac ammonium thiosulfate (ATS) and was applied using a 360 Yield Center® 360 Bandit™.
2) The in-furrow treatment was applied using Keeton® seed firmers with the splitter to keep the fertilizer off of the seed. In addition to the 2.5 gal/ac of 7-22-5 low salt fertilizer in-furrow, 2.5 gal/ac water was added to increase the total applied volume to 5 gal/ac for a more uniform application and to dilute the salt.
3) The third treatment combined the 2x2x2 and in-furrow treatments.
4) The final treatment was a no starter fertilizer check.

A rye cover crop was drilled in December, 2021, at 75 lb/ac and was approximately 8-10" tall at termination. A hail event on June 4, 2022, thinned the stand to about 65,000 plants/ac. On June 12, 90,000 seed/ac was planted into the standing crop. An extended dry spell after the June 12 planting limited germination. Drought conditions were present for most of the growing season.

Results:

	Harvest Stand Count (plants/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	88,600 A*	21 AB	290 A
5 gal/ac 10-34-0 + 5 gal/ac ATS 2x2x2	82,200 A	21 AB	254 B
2.5 gal/ac 7-22-5 In-Furrow	92,000 A	22 A	288 A
2x2x2 and In-Furrow	90,000 A	21 B	236 C
P-Value	0.140	0.067	<0.0001

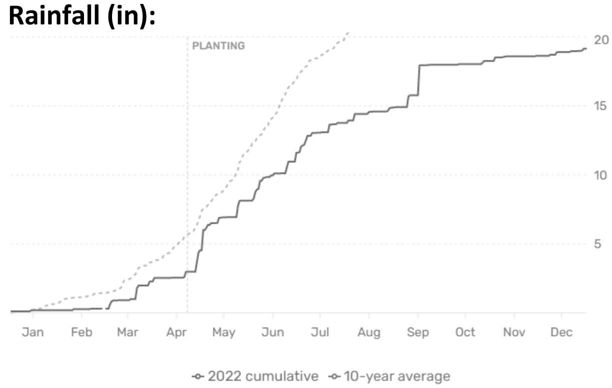
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $13.97/bu soybean, $39.26/ac for the 2x2x2 fertilizer, and $13.75/ac for the in-furrow fertilizer.

Summary:

- There were no differences in harvest stand counts among the treatments.
- Yield was significantly higher for the in-furrow treatment compared to the in-furrow and 2x2x2 treatments; however, average yields across all treatments only varied by 1 bu/ac. Challenging growing conditions, including hail and drought, limited the yield potential.
- The check and in-furrow treatments had the greatest marginal net return. Due to increased input costs, the treatment with both in-furrow and 2x2x2 had the lowest net return.

Impact of CultivAce FREE pHOS 24 and CVA® Starter Fertilizers on Soybeans

Study ID: 0085141202201
County: Platte
Soil Type: Wann loam occasionally flooded; Gibbon silt loam 0-2% slopes, occasionally flooded
Planting Date: 4/22/22
Harvest Date: 9/28/22
Seeding Rate: 125,000
Row Spacing (in): 30
Hybrid: Golden Harvest® GH2922E3
Reps: 4
Previous Crop: Corn
Tillage: Ridge-till, Buffalo stalk chopper 4/15/22, ditcher-till 7/2/22
Herbicides: ***Pre:*** 32 oz/ac Enlist®, 7 oz/ac Authority® Supreme, and 20 oz/ac Roundup PowerMAX® 3 on 4/29/22 ***Post:*** 40 oz/ac CVA® Elite PHP and 32 oz/ac Symbol® Release Plus 6/3/22
Seed Treatment: CruiserMaxx® Advanced, Vibrance®, Optimize®, and Saltro®
Foliar Fungicides: 4 oz/ac Priaxor® and 4 oz/ac Propicon 3.6EC on 7/13/22
Fertilizer: 200 lb/ac 11-52-0 on 12/21/21; 100 lb/ac 0-0-60 on 4/5/22
Irrigation: Gravity, Total: 10"
Rainfall (in):



Soil Tests, 0-8" (November 2021):

pH	CEC	1:1 S Salts	OM	Nitrate-N	K	S	Zn	Fe	Mn	Cu	Ca	Mg	Na	H	K	Ca	Mg	Na	Bray P1	Bray P2
	meq/100g	mmho/cm	%	ppm	---------------------------ppm------------------------									--------------%-----------					-----ppm-----	
6.9	9.6	0.3	1.6	9	235	122	3.5	28	9	0.5	1573	122	20	0	6.3	82.2	10.6	0.9	20	44

Introduction: The purpose of this study was to compare 3 gal/ac CultivAce FREE pHOS 24 starter fertilizer (8-24-0-0.25 Zn) applied in-furrow to the grower's traditional in-furrow starter fertilizer, from Central Valley Ag® (CVA), 8-20-3-6 S-0.4 Zn dribbled on top at a rate of 75 lb/ac. The study also included an untreated check, which had no starter fertilizer. The FREE pHOS 24 starter fertilizer provided 7.7 lb P_2O_5/ac, and the CVA® starter fertilizer provided 15 lb P_2O_5/ac.

Petiole samples were collected at pod filling and evaluated for N%, P%, and Zn (ppm). Stand counts, yield, and net return were evaluated. The east side of the field was not well irrigated, and was dry during some portions of the year; however, all treatments were equally impacted.

Results:

	Early Season Stand Count (plants/ac)	Foliar Nitrogen (%)	Foliar Phosphorus (%)	Foliar Zinc (ppm)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	77,461 A*	5.31 A	0.31 A	47.00 A	10.3 A	85 A	1,182 A
FREE pHOS 24 starter	59,826 B	5.47 A	0.32 A	48.75 A	10.2 A	82 A	1,111 A
CVA starter	79,289 A	5.21 A	0.31 A	47.25 A	10.2 A	81 A	1,103 A
P-Value	0.031	0.738	0.978	0.910	0.678	0.409	0.105

*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 $13.97/bu soybean, $37.50/ac for the FREE pHOS 24 starter, and $31.49/ac for the CVA starter.

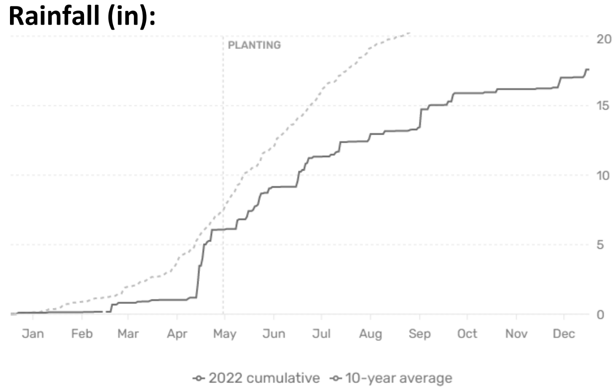
Summary:

- Early season stand counts showed the FREE pHOS 24 starter had approximately 18,500 fewer plants/ac than the check and CVA® starter.
- There was no difference in grain moisture, yield, or net return among the three treatments. No yield response to phosphorus in the starter fertilizer was likely given the entire field received 200 lb/ac of 11-52-0.
- Foliar N, P, and Zn were not significantly different among the treatments.

Y-DROP® Application of Nitrogen in Soybeans at R2

Study ID: 1329113202201
County: Logan
Soil Type: Holdrege silt loam 3-7% slopes, eroded; Hersh fine sandy loam 6-11% slopes; Hersh fine sandy loam 3-6% slopes; Holdrege silt loam 1-3% slope; Uly silt loam 3-6% slopes, eroded
Planting Date: 5/14/22
Harvest Date: 10/1/22
Seeding Rate: 118,000
Row Spacing (in): 30
Hybrid: Pioneer® P25A54X
Reps: 3
Previous Crop: Corn
Tillage: Strip-till

Irrigation: Pivot
Rainfall (in):



Introduction: Some studies have shown that in high yielding soybeans, N-fixation may not meet the entire plant N need. Therefore, this producer was interested in evaluating the impact of N fertilizer on soybeans. The producer tested two N rates, 60 lb N/ac and 85 lb N/ac, and compared these to an untreated check. Nitrogen was applied at R2 as 32% UAN using a 360 Y-DROP® applicator.

Results:

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
0 lb N/ac	6.5 A*	73 A	1,013 A
60 lb N/ac	6.4 A	77 A	1,006 A
85 lb N/ac	6.1 A	73 A	919 A
P-Value	0.592	0.617	0.377

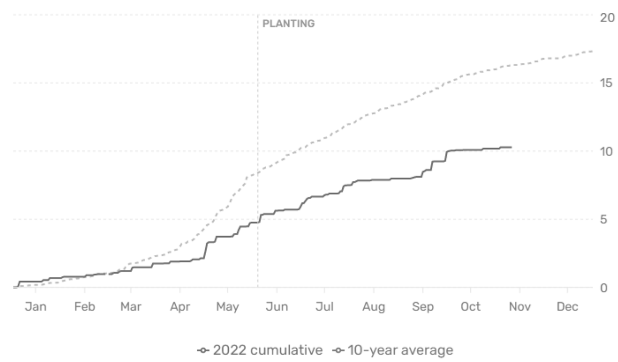
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $13.97/bu soybeans and $1.10/lb N.

Summary:

- The addition of N fertilizer did not result in a yield increase compared to the untreated check.
- There was no difference in marginal net return. Marginal net return calculations only included the cost of N fertilizer and not the cost of application.

Evaluating Nitrogen Rates and Strip-till for Pinto Beans

Study ID: 1401007202202
County: Banner
Soil Type: Satanta-Altvan complex 3-6% slopes; Duroc loam 1-3% slope
Planting Date: 6/2-3/22
Harvest Date: 9/27-28/22
Seeding Rate: 90,000
Row Spacing (in): 30
Hybrid: Radiant slow-darkening pinto
Reps: 4
Previous Crop: Corn
Tillage: Strip-till, no-till
Herbicides: ***Pre:*** 15 oz/ac Prowl® H2O, ammonium sulfate, crop oil concentrate, 7 oz/ac Outlook®, 1 oz/ac Vida®, and 15 oz/ac Envy™ Six Max on 6/4/22 ***Post:*** 3 oz/ac Outlook®, 7 oz/ac PHT® Persist® Ultra, 3.14 oz/ac Assure® II, 9.41 oz/ac Varisto®, and 3.14 oz/ac Basagran® ***Desiccation:*** Gramoxone® on 9/19/22
Seed Treatment: Apron® XL, Maxim®, Rancona®, Vibrance®
Foliar Insecticides: None
Foliar Fungicides: 0.78 oz/ac Priaxor® Xemium® on 6/28/22
Fertilizer: 20 lb N/ac applied via fertigation; other fertilizer varied by rates being tested in the study
Irrigation: Pivot, Total: 10"
Rainfall (in):



Baseline Soil Samples, 0-8" (May 2022):

	pH	OM LOI %	Melich-lll P ppm	Nitrate – N ppm N	Sulfate-S ppm S	-------Melich lll------- K	Ca	Mg	Na	CEC me/100g
NE-1	7.1	2.9	40	7	9.8	458	2178	242	23	14.2

Introduction: Pinto bean growers have questions about the optimal level of nitrogen (N) fertilizer. Historically, most producers have used N fertilizer in their pinto bean production, but recent data has shown less N may be needed to achieve competitive and profitable yields.

The goal of this study was to evaluate the impact of three nitrogen rates applied with strip-till on pinto bean production. Additionally, the producer was interested in the impact of the strip-till operation, so a fourth treatment was added to evaluate no-till.

The fertilizer applied with strip-till was a liquid blend of 32-0-0, 10-34-0, and 9-0-0-26. A sample of the fertilizer blend was sent to Ward Laboratories, and analysis showed a composition of 28% N, 4% P_2O_5, and 1% S. The fertilizer was evaluated at rates of 0 gal/ac, 12 gal/ac (grower's normal management), and 24 gal/ac. The 12 gal/ac treatment received 36 lb N/ac, 2.3 lb P/ac, and 1.3 lb S/ac, whereas the 24 gal/ac treatment received 72 lb N/ac, 4.6 lb P/ac, and 2.6 lb S/ac. Additionally, the entire field received 20 lb N/ac through the pivot.

A rye cover crop was broadcast planted at 100 lb/ac on October 10, 2021, and the strip-till application occurred in the green cover crop on May 27. The fields were planted on June 2 and 3, 2022, and the cover crop was terminated with a June 4 herbicide application. The cover crop was grazed and was 2" tall at the time of termination.

Data Collection:

Satellite imagery was obtained through Skysat, a high-resolution constellation of 21 satellites operated by Planet®, and the normalized difference vegetation index (NDVI) was evaluated for each treatment. Early season stand counts were taken on July 6, 2022. 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. Yield was obtained using the combine yield monitor and was post-processed to remove erroneous data points.

Results:

	Early Season Stand Count (plants/ac)	Pods > 2" Above Ground (%)	Harvest Loss (bu/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
0 gal/ac, no-till	36,201 B*	68 A	1.6 B	11.8 A	21 A	475 A
0 gal/ac	51,988 A	65 A	2.3 AB	10.8 B	27 A	595 A
12 gal/ac	52,206 A	66 A	2.6 A	10.3 B	23 A	459 A
24 gal/ac	47,143 A	65 A	1.8 AB	11.0 AB	26 A	479 A
P-Value	0.001	0.120	0.087	0.017	0.112	0.129

*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 14% moisture.
‡Marginal net return based on $38/cwt ($22.80/bu) pinto beans, $3.85/gal of fertilizer, $19/ac for strip-till with no fertilizer application (from 2022 UNL custom rates), and $25/ac for strip-till with fertilizer application (from 2022 UNL custom rates).

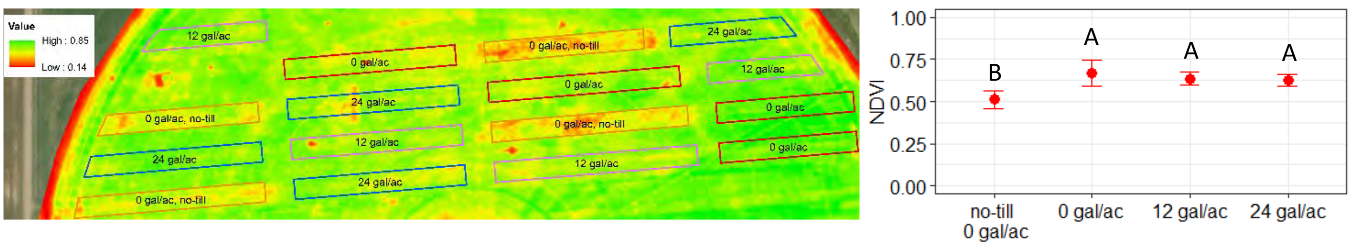


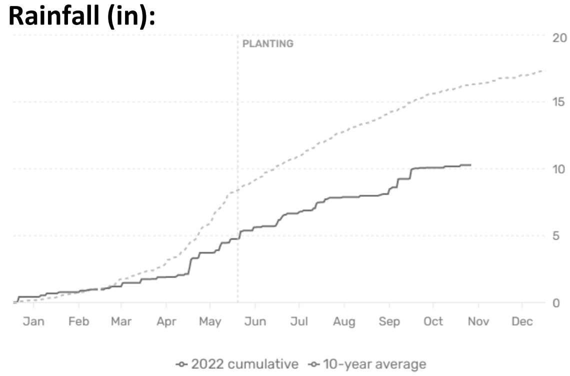
Figure 1. Normalized difference vegetation index (NDVI) from August 8, 2022. Left: treatments are outlined and labeled overlaid on NDVI image. Right: NDVI mean and standard deviation are shown for each treatment. Values with the same letter are not significantly different at a 90% confidence level.

Summary:

- Early season stand counts showed lower plant populations in the no-till treatment compared to the three strip-till treatments. Populations were lower than desired due to a deep planting depth (2.5 inches) and heavy residue, especially in the no-till treatment.
- Imagery from August 9 showed statistically lower NDVI values for the no-till treatment compared to the other three treatments indicating lower biomass. NDVI values were similar for the three strip-till treatments (Fig. 1).
- The 12 gal/ac treatment had the greatest harvest loss, whereas the no-till treatment had the least harvest loss. All harvest losses were within an acceptable range. The pod height did not significantly differ between the treatments; however, numerically, the no-till treatment had a greater percentage of pods above 2", which may be partly responsible for the reduced harvest losses for this treatment.
- Grain yield and marginal net return were not significantly different among the three treatments.

Evaluating Nitrogen Rates and Strip-till for Pinto Beans

Study ID: 1401007202201
County: Banner
Soil Type: Altvan-Eckley complex 3-9% slopes; Satanta fine sandy loam 1-3% slope; Satanta-Altvan complex 3-6% slopes; Duroc loam 1-3% slope
Planting Date: 6/2-3/22
Harvest Date: 9/27-28/22
Seeding Rate: 90,000
Row Spacing (in): 30
Hybrid: Radiant slow-darkening pinto
Reps: 4
Previous Crop: Corn
Tillage: Strip-till, no-till
Herbicides: ***Pre:*** 15 oz/ac Prowl® H2O, 7 oz/ac Outlook®, 1 oz/ac Vida®, and 15 oz/ac Envy™ Six Max with ammonium sulfate and crop oil concentrate on 6/4/22 ***Post:*** 3 oz/ac Outlook®, 7 oz/ac PHT® Persist® Ultra, 3.14 oz/ac Assure® II, 9.41 oz/ac Varisto®, and 3.14 oz/ac Basagran® 5L
Desiccation: Gramoxone® 9/19/22
Seed Treatment: Apron® XL, Maxim®, Rancona®, Vibrance®
Foliar Insecticides: None
Foliar Fungicides: 0.78 oz/ac Priaxor® Xemium® on 6/28/22
Fertilizer: 20 lb N/ac applied via fertigation; other fertilizer varied by rates being tested in the study
Irrigation: Pivot, Total: 10"
Rainfall (in):



Baseline Soil Samples, 0-8" (May 2022):

	pH	OM LOI %	Melich-III P ppm	Nitrate – N ppm N	Sulfate-S ppm S	-------Melich III------- K	Ca	Mg	Na	CEC me/100g
NE-1	6.8	2.0	34	6.3	8.0	285	1191	221	16	8.6
NE-2	6.9	2.2	42	13.4	14.6	315	1315	202	16	9.1

Introduction: Pinto bean growers have questions about the optimal level of nitrogen (N) fertilizer. Historically, most producers have used N fertilizer in their pinto bean production, but recent data has shown less N may be needed to achieve competitive and profitable yields.

The goal of this study was to evaluate the impact of three nitrogen rates applied with strip-till on pinto bean production. Additionally, the producer was interested in the impact of the strip-till operation, so a fourth treatment was added to evaluate no-till.

The fertilizer applied with strip-till was a liquid blend of 32-0-0, 10-34-0, and 9-0-0-26. A sample of the fertilizer blend was sent to Ward Laboratories, and analysis showed a composition of 28% N, 4% P_2O_5, and 1% S. The fertilizer was evaluated at rates of 0 gal/ac, 12 gal/ac (grower's normal management), and 24 gal/ac. The 12 gal/ac treatment received 36 lb N/ac, 2.3 lb P/ac, and 1.3 lb S/ac, whereas the 24 gal/ac treatment received 72 lb N/ac, 4.6 lb P/ac, and 2.6 lb S/ac. Additionally, the entire field received 20 lb N/ac through the pivot.

A rye cover crop was broadcast planted at 100 lb/ac on October 10, 2021, and the strip-till application occurred in the green cover crop on May 19 on one field and May 28 on the other field. The fields were planted on June 2 and 3, 2022, and the cover crop was terminated on June 5, 2022. The cover crop was 12-24" tall at the time of termination.

Data Collection: Satellite imagery was obtained through Skysat, a high-resolution constellation of 21 satellites operated by Planet®, and the normalized difference vegetation index (NDVI) was evaluated for each treatment. Early season stand counts were taken on July 6, 2022. 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. Yield was obtained using the combine yield monitor, and was post-processed to remove erroneous data points.

Results:

	Early Season Stand Count (plants/ac)	Pods > 2" Above Ground (%)	Harvest Loss (bu/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
0 gal/ac, no-till	45,020 B*	68 A	0.9 A	10.9 A	21 B	468 BC
0 gal/ac	54,982 A	69 A	1.6 A	9.9 A	24 A	534 A
12 gal/ac	48,558 AB	66 A	1.2 A	10.2 A	25 A	498 AB
24 gal/ac	48,123 AB	66 A	1.6 A	10.4 A	24 A	434 C
P-Value	0.040	0.139	0.091	0.145	0.003	0.005

*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 14% moisture.
‡Marginal net return based on $38/cwt ($22.80/bu) pinto beans, $3.85/gal of fertilizer, $19/ac for strip-till with no fertilizer application (from 2022 UNL custom rates), and $25/ac for strip-till with fertilizer application (from 2022 UNL custom rates).

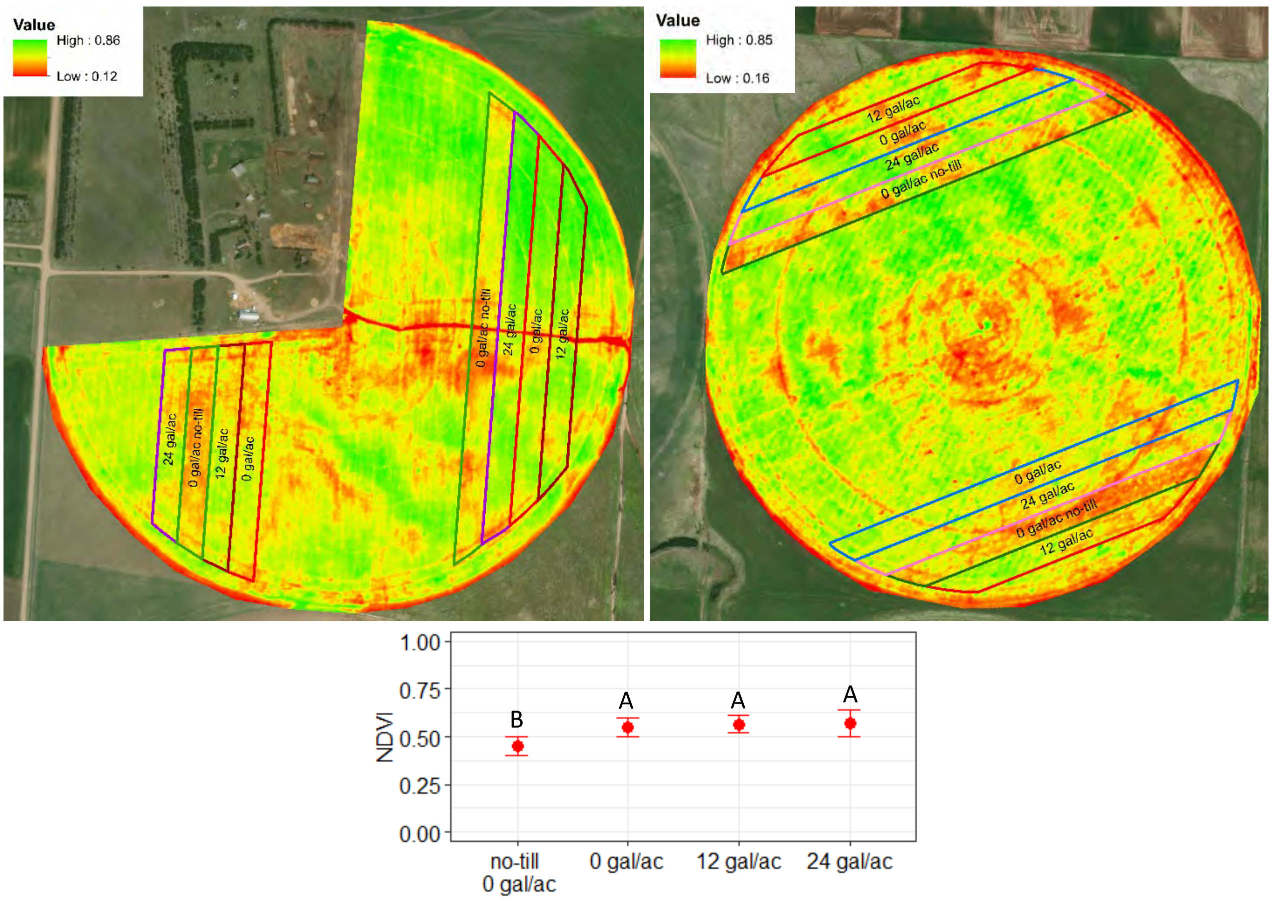


Figure 1. Normalized difference vegetation index (NDVI) from August 8, 2022. Top: treatments are outlined and labeled overlaid on NDVI image. Bottom: NDVI mean and standard deviation are shown for each treatment. Values with the same letter are not significantly different at a 90% confidence level.

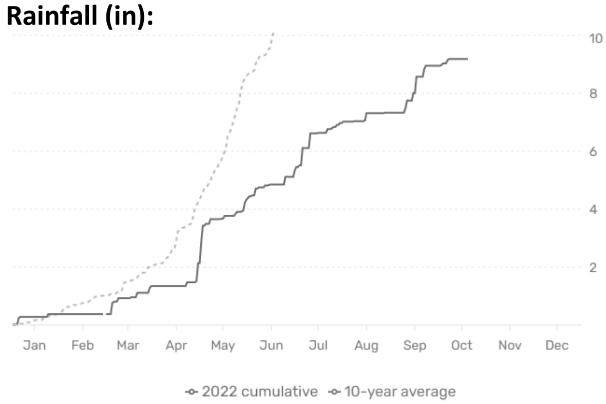
Summary:

- Early season stand counts showed the 0 gal/ac no-till treatment had significantly lower stand than the 0 gal/ac strip-till treatment. Populations were lower than desired due to deep planting depth (2.5 inches) and heavy residue, especially in the no-till treatment.
- Satellite imagery obtained on August 9 showed differences in the NDVI. The no-till treatment had lower NDVI values than the strip-till treatments, and was visually apparent in the imagery. NDVI values were similar for the three strip-till treatments (Fig. 1).
- The no-till treatment had 3-4 bu/ac lower yield compared to the strip-till treatments. There were no yield differences among the different fertilizer rates applied with strip-till. This resulted in the greatest net return for the 0 gal/ac strip-till treatment. Heavy weed pressure in replications one and two negatively impacted yield.

Sensor-Based Nitrogen Management on Winter Wheat

Study ID: 0736111202201
County: Lincoln
Soil Type: Keith silt loam 1-3% slope; Keith silt loam 3-6% slopes, eroded; Kuma silt loam 0-1% slope; Ulysses-Sulco silt loam 6-9% slopes, eroded
Planting Date: 10/19/21
Harvest Date: 7/14/22
Row Spacing (in): 7.5
Hybrid: AgriPro® AP Bigfoot and ApriPro® SY Wolverine
Reps: 4
Previous Crop: Soybean
Tillage: Unknown

Irrigation: Pivot
Rainfall (in):



Baseline Soil Samples, 0-6" (4/13/2022):

	pH	BpH	OM LOI %	Melich-lll P ppm	Nitrate – N ppm	Bray P1 ppm	Sulfate-S ppm	-------Melich lll------- K	Ca	Mg	Na	CEC me/100g	Sand (%)	Silt (%)	Clay (%)
North	6.1	6.7	3.3	62	11.1	47	10	516	1594	246	29	13.4	45	39	16
South	7.1	6.9	2.2	19	6.1	14	9	350	1378	213	33	9.7	59	31	10

Introduction: This study evaluated a sensor-based N management strategy for winter wheat compared to the grower's traditional N management. The experiment was arranged in a randomized complete block design with four replications of two treatments, with each treatment segment being 45 degrees (Figure 1, left). The field had two varieties, one on the north half of the pivot and one on the south half. The entire field received 97 lb N/ac through the following applications:

- 8 gal/ac 10-34-0 (9 lb N/ac) on October 19, 2021, with drilling
- 18 gal/ac 30-0-0-3 (58.5 lb N/ac) on March 18, 2022, stream applied
- 9 gal/ac 30-0-0 (29 lb N/ac) on May 24, 2022, through fertigation with 1 gal/ac chloride

Treatments: The sensor-based N management strategy was compared to the grower's N management in the final fertigation.

- *Grower's N management:* Fertigation of 30 lb N/ac on June 8, 2022.
- *Sensor-based N management:* At Feekes growth stage 3, two small high N rate blocks were established in the field by hand-applying a high rate of fertilizer, one in each variety. Following N rate block establishment, Planet® SkySat (50 cm resolution) satellite imagery (Figure 1, right) and multispectral drone imagery were collected, and the normalized difference vegetation index (NDVI) was calculated. In-field measurements were taken with a handheld Trimble® GreenSeeker® in the high-N plots, and selected locations in the bulk of the field to calibrate the imagery. The imagery and Trimble® GreenSeeker® measurements were processed in the Ninja Ag platform using the Oklahoma State University algorithm and Kansas State University algorithm. On average, these algorithms recommended 15 lb N/ac. On June 8, 2022, 15 lb N/ac was applied through fertigation.

Results:

	Total N rate (lb/ac)	Yield (bu/ac)†	Nitrogen Efficiency (lb N/bu grain)	Partial Profit‡ ($/ac)
Grower N Management	127	73 A*	1.74 A	630 A
Sensor-based N Management	112	72 A	1.57 A	629 A
P-Value	-	0.849	0.179	0.992

*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 13.5% moisture.
‡Marginal net return based on $9.58/bu wheat and $0.56/lb N fertilizer.

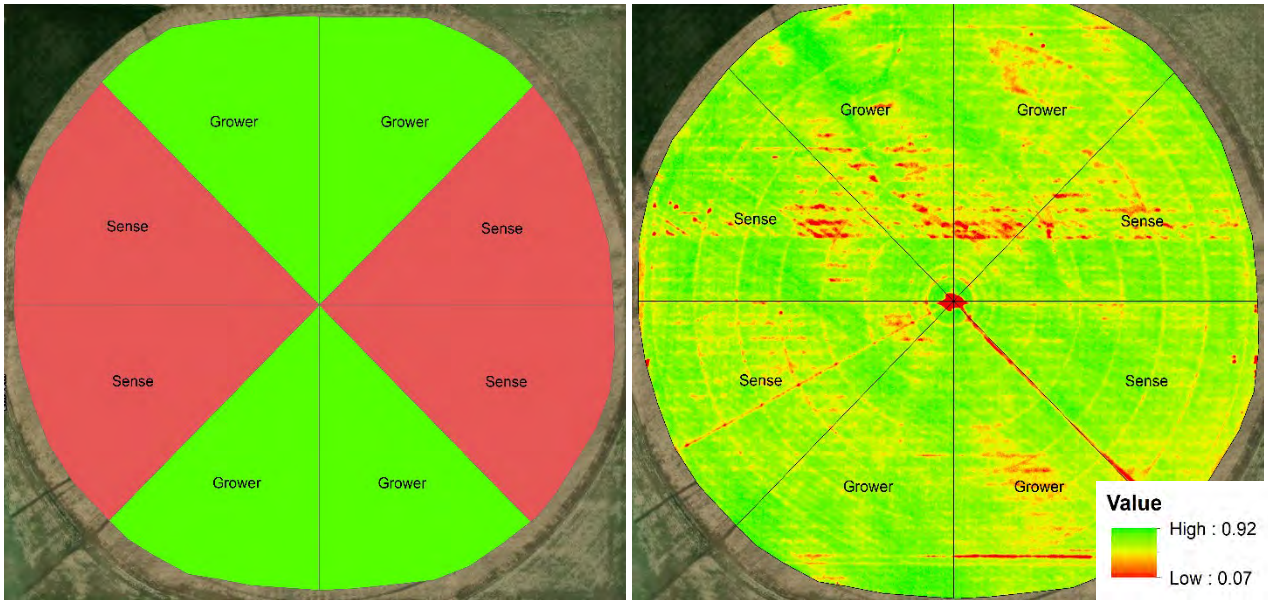


Figure 1. Treatment layout comparing grower's N management (Grower) to sensor-based N management (SENSE) in 45-degree segments (left). Normalized difference vegetation index (NDVI) from Planet® SkySat satellite imagery on May 27, 2022 (right).

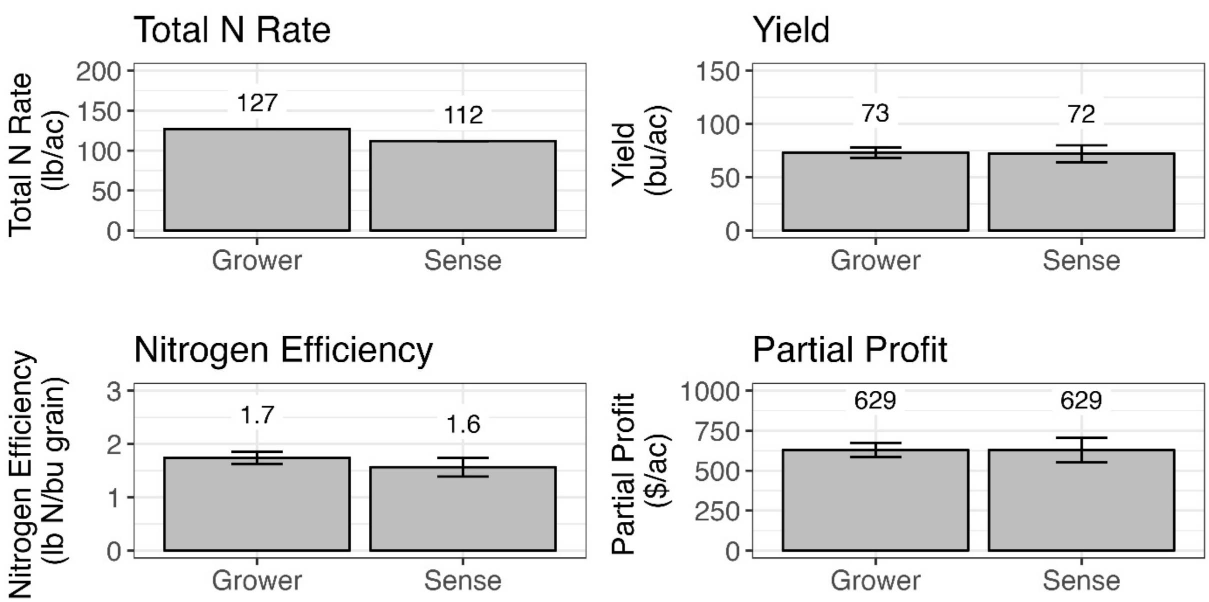


Figure 2. Total N rate, yield, nitrogen efficiency, and partial profit for the grower's N management and sensor-based N management. Vertical bars represent the standard deviation of the mean. Averages reported are means of all observations and will not be identical to results in table on previous page, which are summarized first by replication.

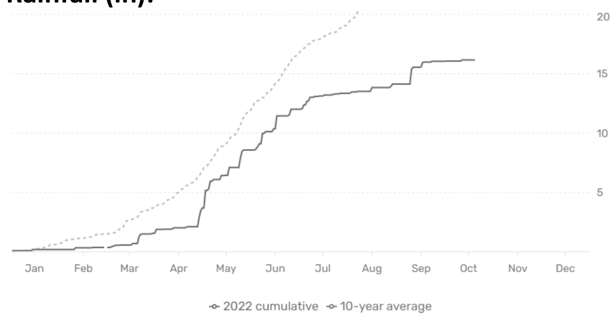
Summary:

- The sensor-based approach resulted in a reduction in N fertilizer (15 lb N/ac) with no yield loss.
- Nitrogen use efficiency and partial profit were not significantly different between the two treatments.
- Utilizing the sensor-based management earlier in the season could result in greater N fertilizer savings.

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

Sensor-based Nitrogen Management on Winter Wheat

Study ID: 1245023202201
County: Butler
Soil Type: Pohocco silty clay loam 6-11% slopes; Pohocco silty clay loam 11-17% slopes; Yutan silty clay loam 2-6% slopes
Planting Date: 10/18/21
Harvest Date: 7/15/22
Seeding Rate:
Row Spacing (in): 7.5
Hybrid: WestBred® WB4401
Reps: 3
Previous Crop: Soybean
Tillage: No-till
Herbicides: None
Seed Treatment: CruiserMaxx® and Vibrance®
Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: None
Rainfall (in):



Soil Tests. Soil test conducted at three locations within the field on April 13, 2022 (Figure 1, left).

ID	Depth (inches)	pH 1:1	BpH	OM LOI%	Nitrate -N N ppm	Melich-III P ppm	---------- Melich III ---------- K ppm	Ca ppm	Mg ppm	Na ppm	S ppm	CEC me/100g	Sand %	Silt %	Clay %	% Base Saturation K	Mg	Ca	Na	H
0	6	6.0	6.59	2.3	2.7	21	197	2624	669	11	9	22.6	28	53	18	2.2	24.7	58.1	0.2	15
1	6	7.2	6.93	3.3	8.9	21	270	2427	443	6	6	16.5	24	61	14	4.2	22.4	73.5	0.2	0
2	6	5.2	6.33	3.4	12.2	17	156	1621	352	7	10	17.5	30	51	18	2.3	16.8	46.3	0.2	34.3

Introduction: This study evaluated a sensor-based N management strategy for winter wheat compared to the grower's traditional N management. The experiment was arranged in a randomized complete block design with three replications of two treatments; sensor-based N management and grower's N management (Figure 1, left). The entire field received a pre-plant application of 180 lb/ac of 11-52-0, contributing 19 lb N/ac.

Treatments: The sensor-based N management strategy was compared to the grower's N management.

- *Grower's N management:* 120 lb N/ac as 32% UAN was applied with TeeJet's StreamJet nozzles at green-up on April 17, 2022, for a total of 139 lb N/ac.
- *Sensor-based N management:* A flat rate of 27 lb N/ac was applied on April 17. Satellite imagery was captured using Planet® SkySat on May 12, 2022 and May 22, 2022. The normalized difference vegetation index (NDVI) was calculated from the imagery (Figure 2). On May 21, 2022, in-field measurements were taken with a handheld Trimble® GreenSeeker® in selected locations in the bulk of the field to calibrate the imagery. The imagery and GreenSeeker® measurements were processed in the Ninja Ag platform using the University of Nebraska-Lincoln algorithm. On average, 60 lb N/ac was recommended. The variable-rate application averaging 60 lb N/ac was applied on June 6, 2022. The total N application averaged 106 lb N/ac.
- *N rate ramps:* At the April 17 application date, a set of four N rates ranging from 0 to 106 lb N/ac was applied, for total rates ranging from 19 to 125 lb N/ac (Figure 1, left). This N rate ramp was used to determine the observed economic optimum nitrogen rate (EONR).

As-applied fertilizer maps were used to evaluate the accuracy of fertilizer application, and only areas with high accuracy were included in the analysis. Hand samples were collected at harvest to determine grain protein.

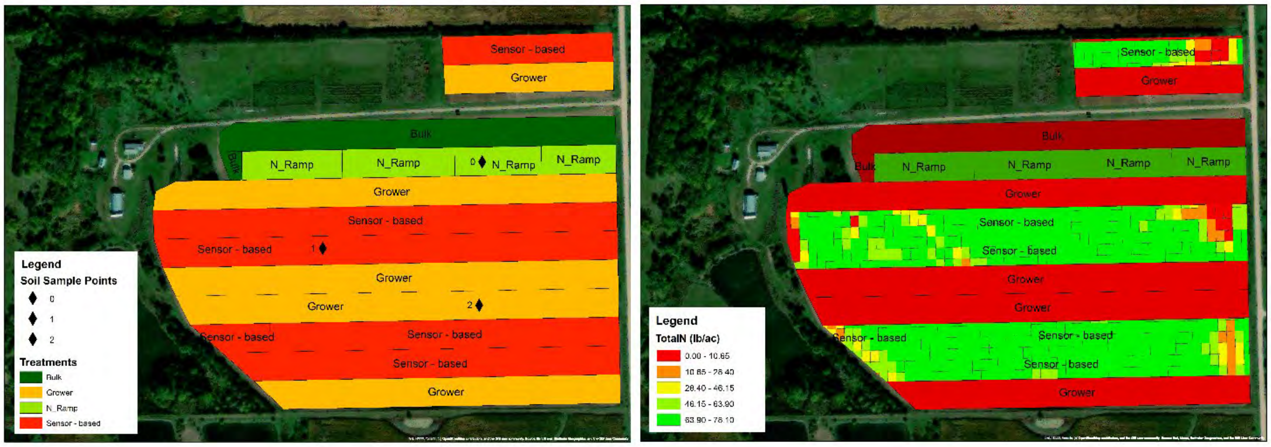


Figure 1. Treatment layout with grower, sensor-based, and nitrogen rate blocks (N_Ramp) with increasing N rates. Soil sampling points from April 13, 2022, are indicated (left). Sensor-based, variable-rate nitrogen recommended by Ninja Ag prescription and applied on June 6, 2022.

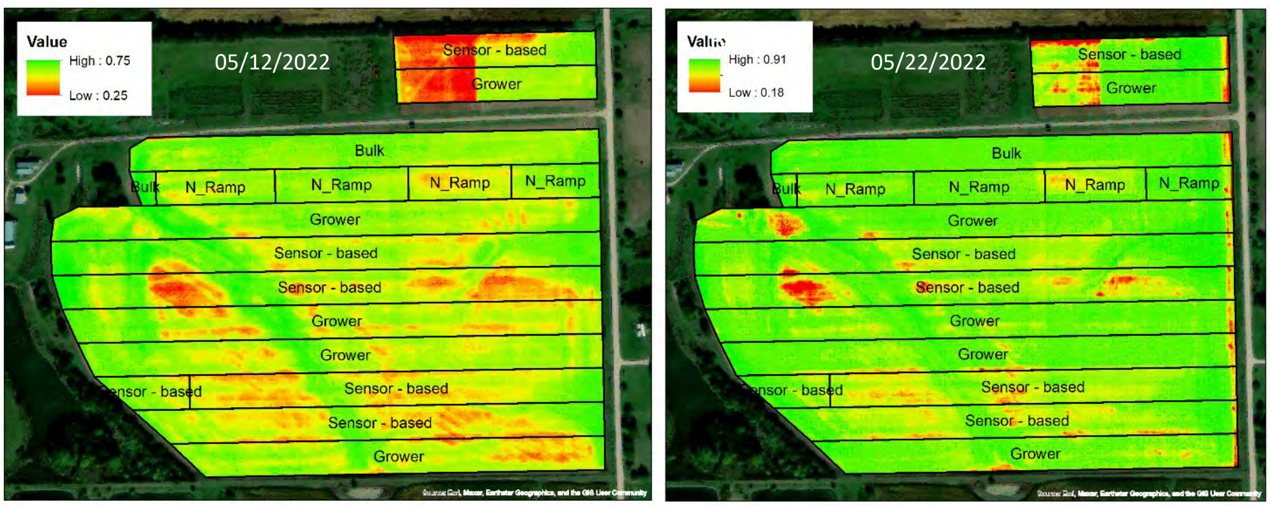


Figure 2. Normalized difference vegetation index (NDVI) values captured on May 12 (left), and May 22 (right) using Planet® SkySat satellite imagery (50 cm resolution).

Results:

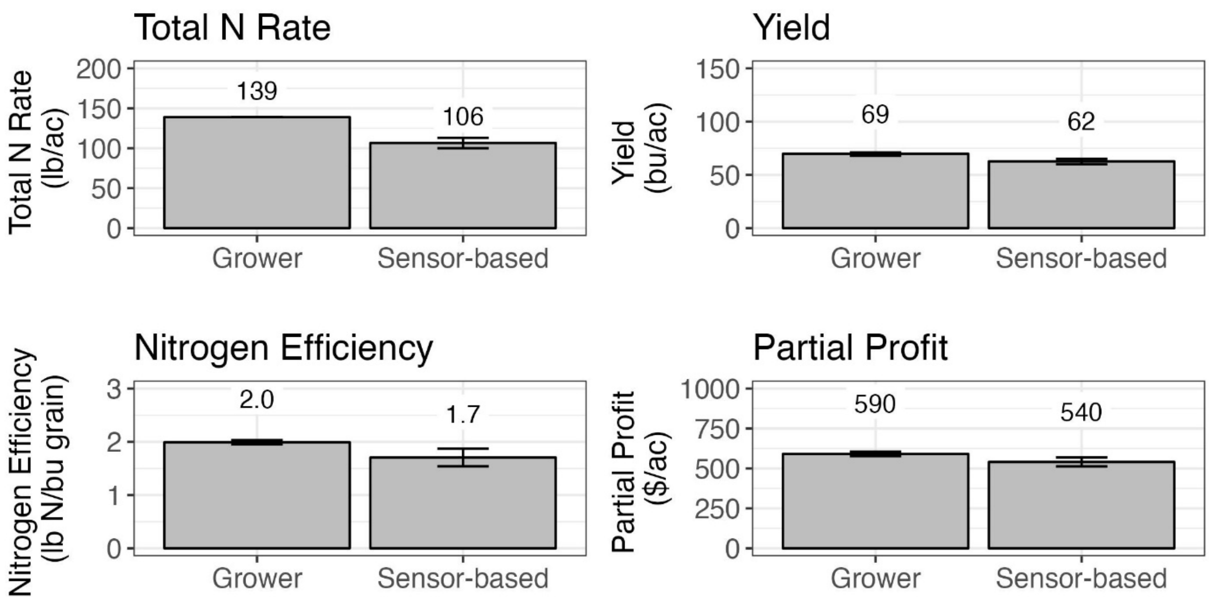


Figure 3. Total N rate, yield, nitrogen efficiency, and partial profit for the grower's N management and sensor-based N management. Vertical bars represent the standard deviation of the mean. Averages reported are means of all observations, and will not be identical to results in table below, which are summarized first by replication.

	Total N rate (lb/ac)	Yield (bu/ac)†	Nitrogen Efficiency (lb N/bu grain)	Protein (%)	Partial Profit‡ ($/ac)
Grower N Management	139 A*	70 A	1.99 A	11.1 A	591 A
Sensor-based N Management	106 B	63 B	1.7 B	10.7 B	541 B
P-Value	0.013	0.008	0.060	<0.01	0.026

*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from weight wagon. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $9.58/bu wheat and $0.56/lb N.

Summary:

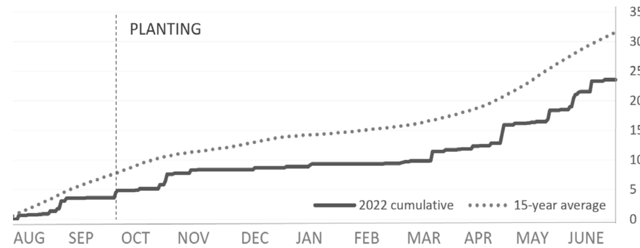
- The average stand count in the field was 880,000 plants/ac on April 25, 2022.
- The sensor-based approach averaged 33 lb N/ac lower than the grower's traditional management.
- Yield was 7 bu/ac lower for the sensor-based treatment. The yield reduction may be due to the late timing of the application.
- The lower N rates resulted in greater N efficiency for the sensor-based treatment.
- Profit was $50/ac lower for the sensor-based treatment compared to the grower's management as the yield reduction was not offset by the fertilizer savings.
- This field and area were abnormally dry, according to the U.S. Drought Monitor (https://droughtmonitor.unl.edu/) during grain fill in June, which may have limited yield potential and N uptake. Additionally, there was minimal snow cover during the vernalization period.

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

Sensor-Based Nitrogen Management on Winter Wheat

Study ID: 0656127202201
County: Nemaha
Soil Type: Judson silt loam 2-6% slopes; Pohocco silty clay loam 6-11% slopes; Pohocco silty clay loam 2-6% slopes
Planting Date: 9/30/21 and 10/13/21
Harvest Date: 7/5/22
Seeding Rate: 1.25 million
Row Spacing (in): 7.5
Hybrid: AG Icon, from AGSECO
Reps: 5
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Post:*** Dicamba applied in November

Seed Treatment: Sativa™ IM RTU
Foliar Insecticides: None
Foliar Fungicides: AzoxyProp Xtra
Irrigation: None
Rainfall (in):



Soil Tests. Soil test conducted at four locations within the field on April 27, 2022 (Figure 1, left).

ID	Depth (inches)	pH 1:1	BpH	OM LOI%	Nitrate -N N ppm	Melich-III P ppm	---------- Melich III ---------- K ppm	Ca ppm	Mg ppm	Na ppm	S ppm	CEC me/100g	Sand %	Silt %	Clay %	% Base Saturation K	Mg	Ca	Na	H
0	6	6.2	6.66	3.7	3.9	10	175	3308	369	12	9	22.8	18	61	20	2	13.5	72.5	0.2	11.8
1	6	6.1	6.7	3.5	2.9	10	108	2302	288	10	10	16.5	26	55	18	1.7	14.5	69.8	0.3	13.9
2	6	5.8	6.67	3.6	4.2	8	120	1683	283	10	10	13.7	22	59	18	2.2	17.2	61.4	0.3	19
3	6	5.8	6.63	3.5	4.4	11	81	2039	259	11	9	15.6	24	55	20	1.3	13.8	65.4	0.3	19.2

Introduction: This study evaluated a sensor-based N management strategy for winter wheat compared to the grower's traditional N management. The experiment was arranged in a randomized complete block design with five replications of two treatments (Figure 1, left). The entire field received 30 lb N/ac in the fall as urea and 30 lb N/ac as UAN 32% with fungicide in April.

Treatments: The sensor-based N management strategy was compared to the grower's N management.

- *Grower's N management:* 20 lb N/ac was applied on May 31, 2022, for a total of 80 lb N/ac.
- *Sensor-based N management:* A senseFly eBee ag drone with a 4-band multispectral camera (Parrot Sequoia+) was used to capture imagery of the field on May 3, 2022. The normalized difference vegetation index (NDVI) was calculated from the imagery (Figure 2). On the same date, in-field measurements were taken with a handheld Trimble® GreenSeeker® in selected locations in the bulk of the field to calibrate the imagery. The imagery and GreenSeeker® measurements were processed in the Ninja Ag platform using the University of Nebraska-Lincoln winter wheat algorithm. On average, 19 lb N/ac was recommended. A variable-rate application averaging 19 lb N/ac was made on May 31, 2022, for a total of 79 lb N/ac.
- *N rate ramps:* At the May 31 application date, two sets of high and low N rates were established using a variable-rate prescription (Figure 1, right). The low N rate had no additional N applied for a total N rate of 60 lb N/, whereas the high N rate had 67 lb N/ac applied for a total N rate of 127 lb N/ac. N rate ramps were used to determine the yield response at low and high N rates.

As-applied fertilizer maps were used to evaluate the accuracy of fertilizer application, and only areas with high accuracy were included in the analysis. Hand samples were collected at harvest to determine grain protein.

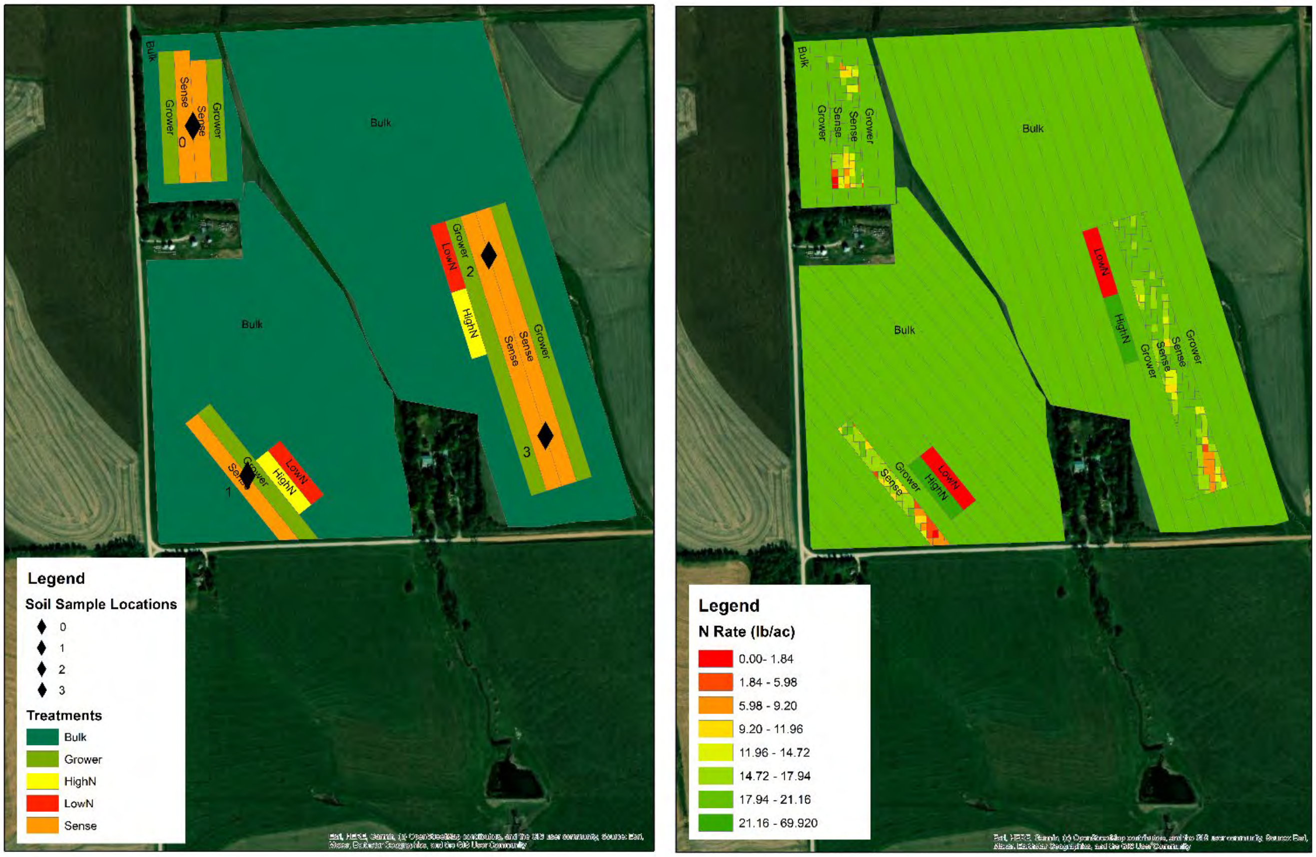


Figure 1. Treatment layout and soil sampling points with grower, sensor-based, low, and high nitrogen blocks (60 and 127 lb N/ac) (left). Nitrogen application prescription for sensor-based management, grower's management, high N blocks, and low N blocks applied on May 31, 2022 (right).

Results:

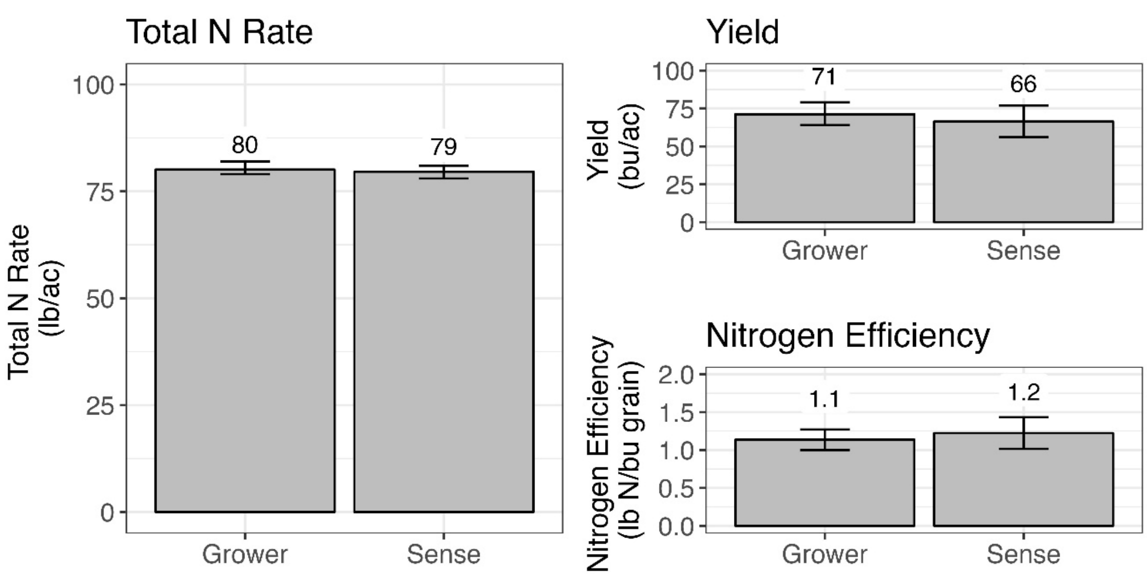


Figure 2. Total N rate, yield, nitrogen efficiency, and partial profit for the grower's N management and sensor-based N management. Vertical bars represent the standard deviation of the mean. Averages reported are means of all observations and will not be identical to results in table below, which are summarized first by replication.

High and low N blocks were only replicated two times; therefore, they are not included in the statistics, but means are provided in the table below for reference.

	Total N rate (lb/ac)	Yield (bu/ac)†	Nitrogen Efficiency (lb N/bu grain)	Protein (%)	Partial Profit‡ ($/ac)
Grower N Management	80 A*	71 A	1.14 B	13.6	637 A
Sensor-based N Management	79 A	65 B	1.22 A	13.6	581 B
High N	127	72	1.75	-	619
Low N	60	71	0.85	-	646
P-Value	0.465	0.055	0.058	-	0.055

*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 13.5% moisture.
‡Marginal net return based on $9.58/bu wheat and $0.56/lb N.

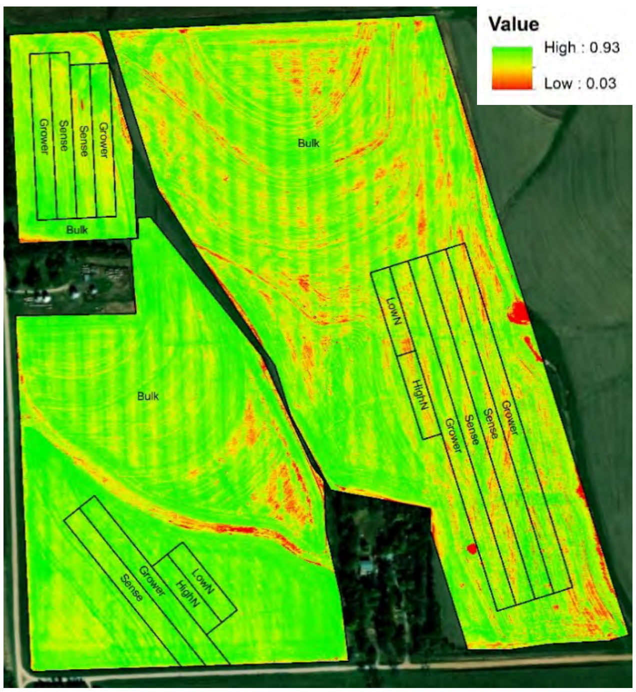


Figure 2. Normalized difference vegetation index (NDVI) values captured with a senseFly eBee ag drone and 4-band multispectral camera (Parrot Sequoia+) on May 3, 2022.

Summary:

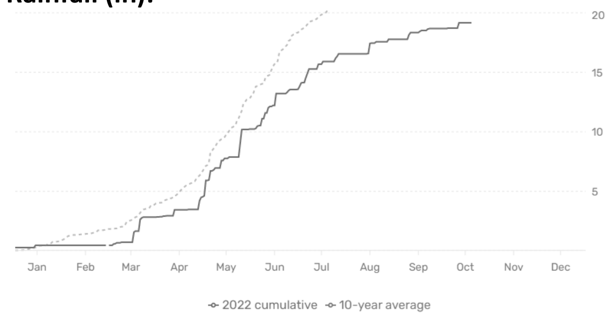
- The variable-rate-sensor-based management applied on average the same amount of fertilizer as the grower's traditional management. A delay from the time of obtaining sensor and imagery data (May 3) and applying the prescription (May 31) may have reduced the reliability of the prescription.
- The grower's traditional management yielded 6 bu/ac more than the sensor-based approach, was $56/ac more profitable, and had greater nitrogen use efficiency.
- There was no difference in grain protein between the treatments.
- This field and area were moderately dry, according to the U.S. Drought Monitor (https://droughtmonitor.unl.edu/) during grain fill in June, which may have limited yield potential and N uptake.
- This field was damaged by hail two times in June 2022, and had a yield loss of 8% across the entire field according to the insurance.

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

Sensor-Based Nitrogen Management on Winter Wheat

Study ID: 1268067202201
County: Gage
Soil Type: Malmo complex; Nodaway silt loam channeled, occasionally flooded; Pawnee complex 6-11% slopes; Wymore silty clay loam 0-2% slope; Wymore silty clay loam 2-6% slopes
Planting Date: 10/14/21
Harvest Date: 7/15/22
Row Spacing (in): 7.5
Hybrid: WestBred® WB4699
Reps: 8
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Post:*** 0.8 oz/ac Affinity®

Seed Treatment: Vibrance® Extreme
Foliar Insecticides: None
Foliar Fungicides: Miravis® Ace
Irrigation: Pivot
Rainfall (in):



Soil Tests. Soil test conducted at three locations within the field on April 27, 2022 (Figure 1, left).

							---------- Melich III ----------														
ID	Depth (inches)	pH 1:1	BpH	OM LOI%	Nitrate -N N ppm	Melich-III P ppm	K ppm	Ca ppm	Mg ppm	Na ppm	S ppm	CEC me/100g	Sand %	Silt %	Clay %	% Base Saturation K	Mg	Ca	Na	H
0	6	6.8	6.85	2.7	3.9	11	216	3674	856	195	10	27.7	30	43	26	2	25.8	66.3	3.1	2.9
1	6	6.5	6.74	2.8	1.4	8	118	3463	608	110	8	25.1	34	35	30	1.2	20.2	69	1.9	7.6
2	12	6.1	-	3.5	2	8	143	2853	549	28	9	22.5	38	46	16	1.6	20.3	63.4	0.5	14.2

Introduction: This study evaluated a sensor-based N management strategy for winter wheat compared to the grower's traditional N management. The experiment was arranged in a randomized complete block design with eight replications of two treatments (Figure 1, left). The entire field received a broadcast application of MAP, AMS, and potash in the fall resulting in 22.8 lb of N/acre.

Treatments: The sensor-based N management strategy was compared to the grower's N management.

- *Grower's N management:* 80 lb N/ac was applied as 32% UAN at green-up on April 15, 2022, for a total N rate of 103 lb N/ac.
- *Sensor-based N management:* A satellite image was captured using Planet® SkySat on May 11, 2022. The normalized difference vegetation index (NDVI) was calculated from the imagery (Figure 2). On the same date, in-field measurements were taken with a handheld Trimble® GreenSeeker® in selected locations in the bulk of the field to calibrate the imagery. The imagery and GreenSeeker® measurements were processed in the Ninja Ag platform using the University of Nebraska-Lincoln winter wheat algorithm. On average, 63 lb N/ac was recommended. The variable-rate application averaging 63 lb N/ac was applied on May 21, 2022, at jointing (Figure 1, right) for a total of 86 lb N/ac. The field received approximately 1" of rain on May 24.
- *N rate ramps:* At the April 15 application date, two sets of four N rates were applied with total N ranging from 0 to 120 lb N/ac, for total rates ranging from 23 to 143 lb N/ac (Figure 1, left). These N rate ramps were used to determine the observed economic optimum nitrogen rate (EONR data not shown).

As-applied fertilizer maps were used to evaluate the accuracy of fertilizer application, and only areas with high accuracy were included in the analysis. Hand samples were collected at harvest to determine grain protein.

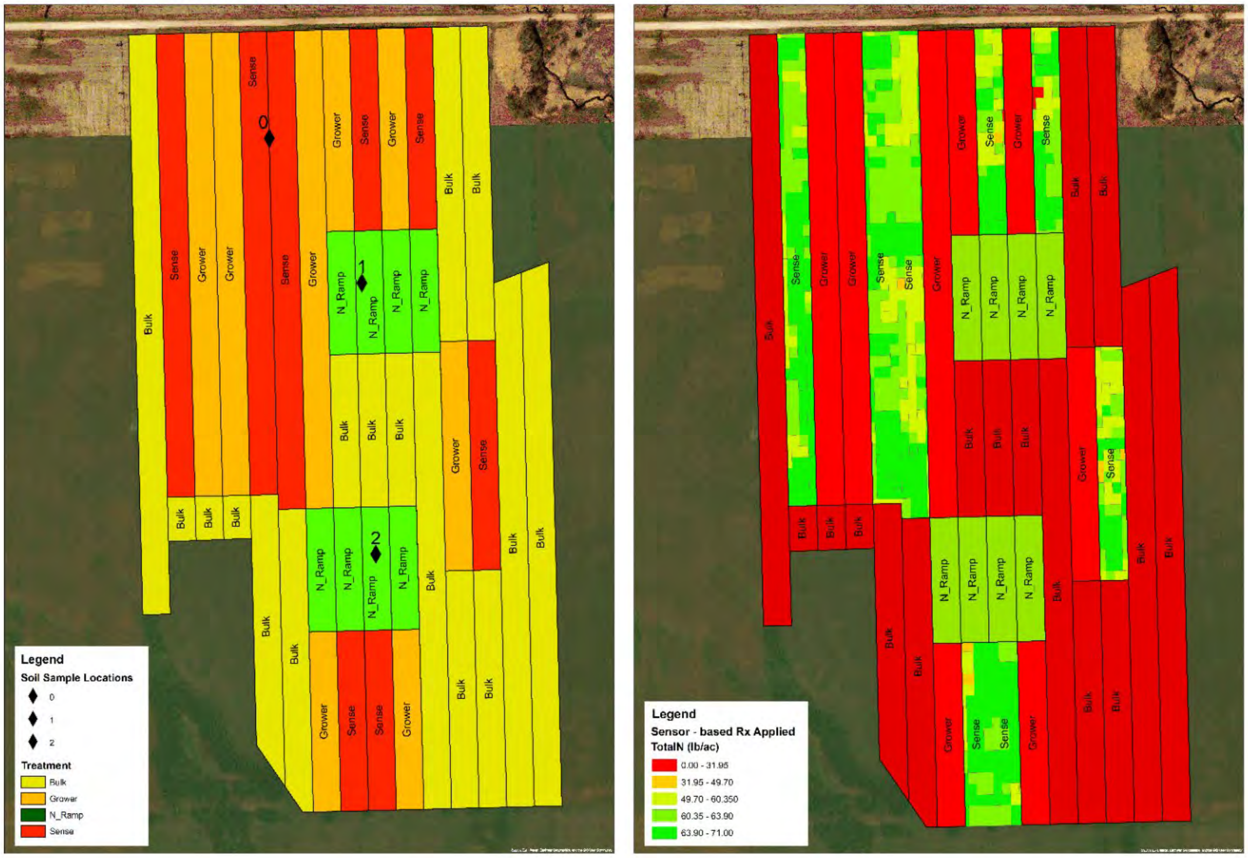


Figure 1. Treatment layout with grower, sensor-based, and nitrogen rate blocks (N_Ramp) with increasing N rates. Soil sampling points are indicated (left). Nitrogen application prescription for sensor-based management applied on May 21, 2022 (left).

Results:

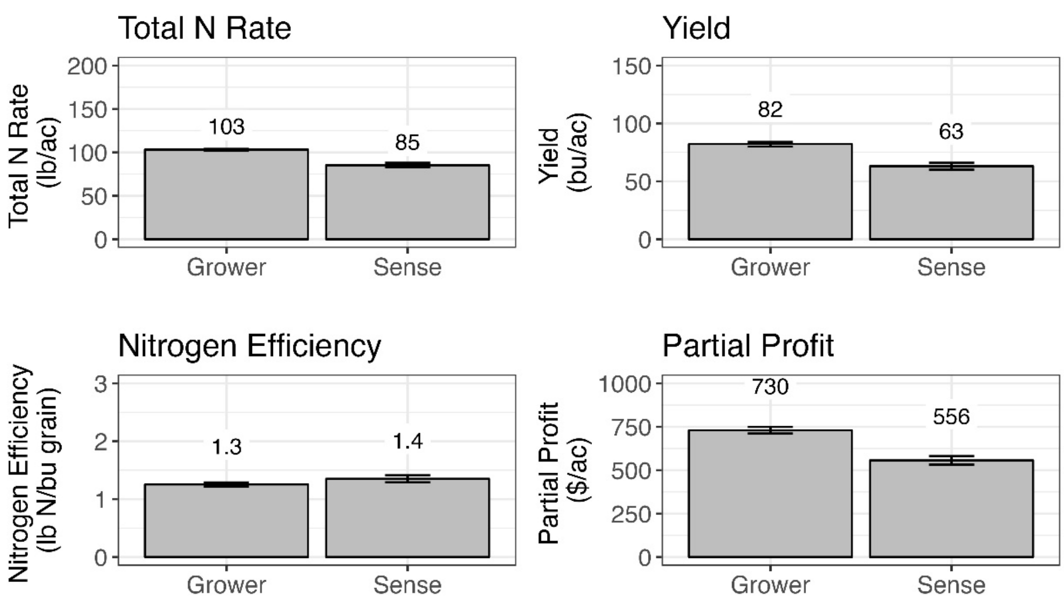


Figure 2. Total N rate, yield, nitrogen efficiency, and partial profit for the grower's N management and sensor-based N management. Vertical bars represent the standard deviation of the mean. Averages reported are means of all observations and will not be identical to results in table below, which are summarized first by replication.

	Total N rate (lb/ac)	Yield (bu/ac)†	Protein (%)	Nitrogen Efficiency (lb N/bu grain)	Partial Profit‡ ($/ac)
Grower N Management	103 A*	82 A	11.4	1.25 B	731 A
Sensor-based N Management	85 B	63 B	11.1	1.35 A	557 B
P-Value	<0.0001	<0.0001	-	0.002	<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 13.5% moisture.
‡Marginal net return based on $9.58/bu wheat and $0.56/lb N.

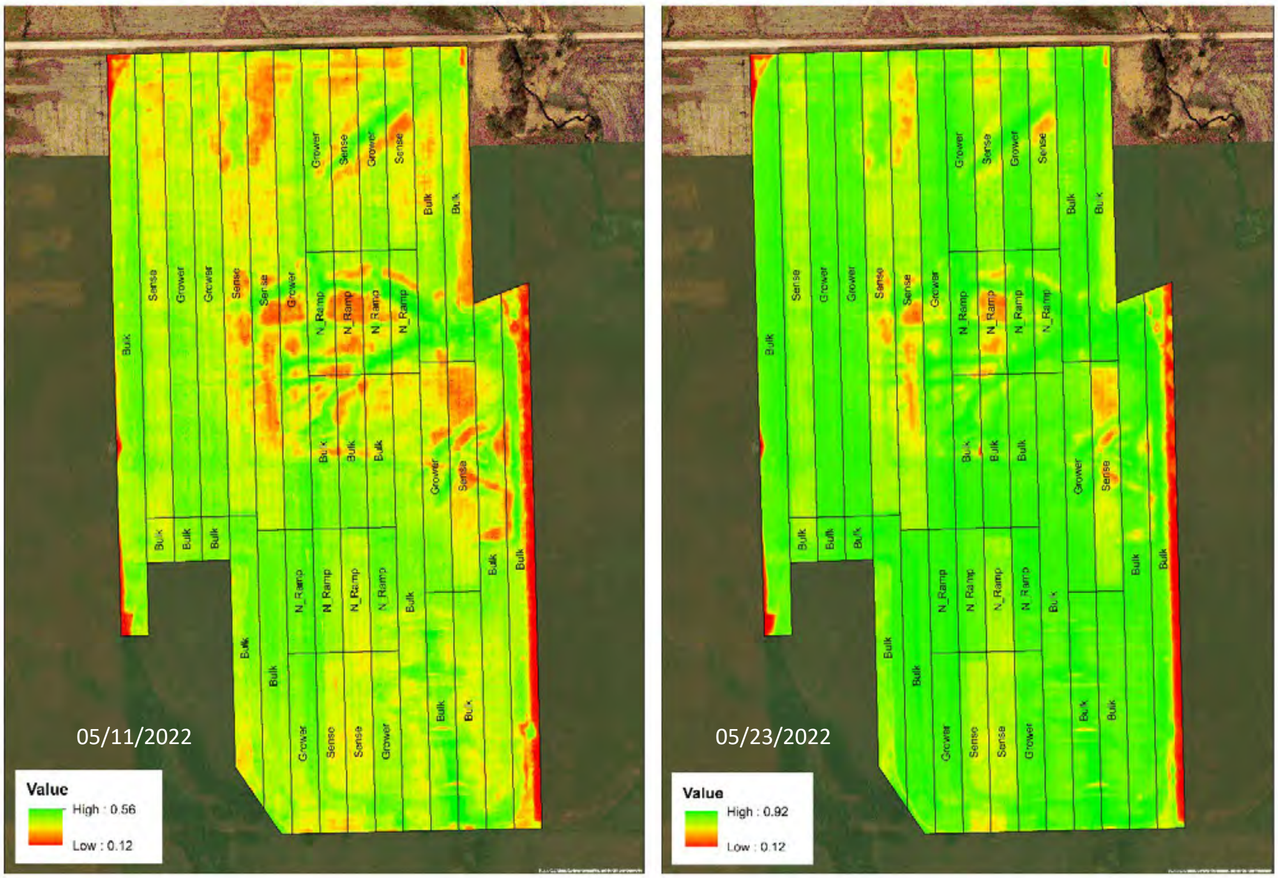


Figure 2. Normalized difference vegetation index (NDVI) values captured on May 11 (left), and May 23 (right) using Planet® SkySat satellite imagery (50 cm resolution).

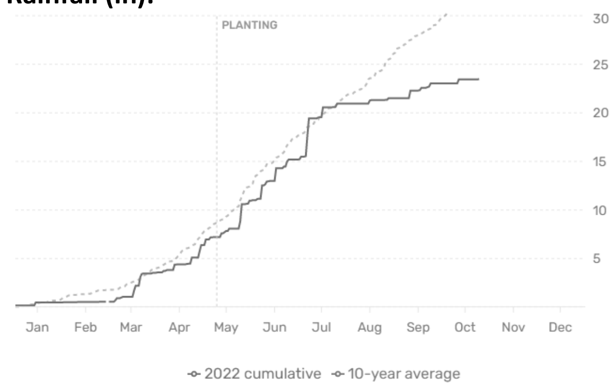
Summary:

- The sensor-based approach applied 19 lb N/ac less than the grower's N management and delayed N application by over a month compared to the grower.
- Yield was 19 bu/ac lower for the sensor-based treatment, and resulted in $174/ac lower profit. Delayed N application for the sensor-based treatment may have resulted in unrecoverable N stress.
- Nitrogen efficiency was greater for the sensor-based treatment.

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

Impact of Dry Starter Fertilizer at Planting of Corn

Study ID: 1292147202201
County: Richardson
Soil Type: Monona silt loam 1-6%
Planting Date: 5/9/22
Harvest Date: 10/3/22
Seeding Rate: 30,950
Row Spacing (in): 30
Hybrid: Pioneer® P1185AM®
Reps: 4
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Burndown:*** 0.316 oz/ac Autumn™ Super, 1 pt/ac 2,4-D LV4, and 1 pt/ac Roundup PowerMAX® 3 with 0.43 pt/ac COC applied in December 2021 ***Post:*** 1 qt/ac atrazine 4L, 3 oz/ac mesotrione, 1 pt/ac Medal®, 22 oz/ac GlyStar® 5 Extra, 1.14 oz/ac Diablo®, and 0.53 oz/ac Interactive® on 5/20/22
Seed Treatment: Standard
Foliar Insecticides: 4 oz/ac Sniper® applied aerially on 7/27/22
Foliar Fungicides: 6.8 oz/ac Aproach® Prima applied aerially on 7/27/22
Fertilizer: 168 lb N/ac applied as anhydrous ammonia on 4/4/22; blend of 51 lb/ac 0-0-60, 101 lb/ac ammonium sulfate, 0.04 gal/ac Ele-Max® Super Zinc Fl, and 0.016 gal/ac Ele-Max® Boron LC broadcast applied on 2/21/22
Irrigation: None
Rainfall (in):



Soil Tests, June 2022:

Depth	Soil pH 1:1	Soluble Salts 1:1 mmho/cm	OM LOI-%	KCl Nitrate ppm N	Nitrate lb N/ac 0-8"	M-3 P ppm	-Ammonium Acetate- K ppm	Ca ppm	Mg ppm	NA ppm	----------DTPA----------- Zn ppm	Fe ppm	Mn ppm	Cu ppm	Sum of Cations me/100g	% Base ---Saturation--- H	K	Ca	Mg	Na
0-8"	5.8	0.28	3.7	38.4	92	21	99	1846	221	8	1.46	30	16.5	0.62	14.5	21	2	64	13	0

Introduction: The objective of this study was to evaluate the impact of dry starter fertilizer on corn production. The fertilizer was applied in a 2x2 placement at planting. The product was a blend of 70% 11-52-0 and 30% 0-0-60 impregnated with 0.031 gal/ac Ele-Max® Super Zinc Fl and applied at a rate of 74 lb/ac. Total nutrient contribution was 5.7 lb N/ac, 26.9 lb P_2O_5/ac, and 13.3 lb K/ac. Early season stand counts were conducted on June 22, 2022. At harvest, yield was measured with a weigh wagon and grain moisture and test weight were measured.

Results:

	Early Season Stand Count (plants/ac)	Moisture (%)	Test Weight (lb/bu)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	32,000 A*	14.0 A	62 A	277 B	1,819 A
Starter	31,833 A	14.0 A	61 A	283 A	1,822 A
P-Value	0.868	0.878	0.574	0.027	0.742

*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 $6.57/bu corn and $34.54/ac for starter fertilizer.

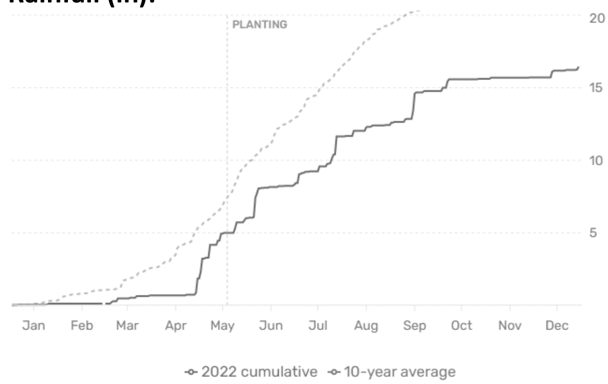
Summary:

- Stand counts, test weight, and grain moisture were not different between the starter treatment and untreated check.
- Overall, yields were excellent, averaging 280 bu/ac for the plot. The use of starter fertilizer resulted in a yield increase of 6 bu/ac compared to the untreated check.
- The increased yield for the starter fertilizer treatment covered the additional input costs, but did not result in a statistically significant profit increase compared to the check.

ReaX™ Mn in Starter Fertilizer on Corn

Study ID: 0709047202202
County: Dawson
Soil Type: Hord silt loam 0-1% slope; Cozad silt loam 0-1% slope; Cozad silt loam 1-3% slope
Planting Date: 5/18/22
Harvest Date: 11/2/22
Seeding Rate: 34,000
Row Spacing (in): 30
Hybrid: Channel® 214-22STX
Reps: 7
Previous Crop: Corn
Tillage: Strip-till, ridge-till
Herbicides: ***Pre:*** 3 oz/ac mesotrione, 2 qt/ac Fearless Xtra® 5.6L, 5 oz/ac Verdict®, and 5 oz/ac Absil™ on 5/18/22 ***Post:*** 1.5 qt/ac Fearless Xtra® 5.6L, 4 oz/ac Yukon®, and 0.2 gal/ac Padlock® Plus on 6/14/22

Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: Gravity, Total: 24"
Rainfall (in):



Introduction: The purpose of this study was to evaluate the impact of ReaX™ Mn in starter fertilizer. ReaX™ Mn provides 4% manganese (Mn) in a powered formula. Soil tests indicated Mn levels ranged from 7.4 to 13.6 ppm. The producer's goal was to increase Mn levels to 20 ppm. This is the third and final year of this study. Treatment strips were maintained in the same location over the three-year study to document yield, and soil test changes with use of ReaX™ Mn over time.

The two treatments were applied with starter at planting on May 18, 2022:

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. The treatments included a strip-till application of 10 gal/ac 32% UAN, 5 gal/ac 12-0-0-26S, 10 gal/ac 10-34-0, and 2 gal/ac Altura™ on May 13, 2022; 10 gal/ac 32% UAN applied with burndown on May 18, 2022; and 37 gal/ac 32% UAN with 5 gal/ac 12-0-0-26S sidedressed on June 28, 2022.

Results:

Table 1. Soil tests before and after application of ReaX™ Mn.

	Soil pH	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
						Before application – April 2020								
Check	6.1	3.0	29	16	3	393	1997	397	56	15	2.0	30.7	17.0	0.6
ReaX™ Mn	6.1	3.2	31	20	4	424	1519	339	61	12	1.7	30.8	13.9	0.6
						After year 1 – March 2021								
Check	5.9	3.0	108	23	21	495	1696	306	77	15	2.1	30.0	22.4	0.7
ReaX™ Mn	5.8	3.3	103	20	26	468	1602	294	77	16	2.1	34.4	22.6	0.9

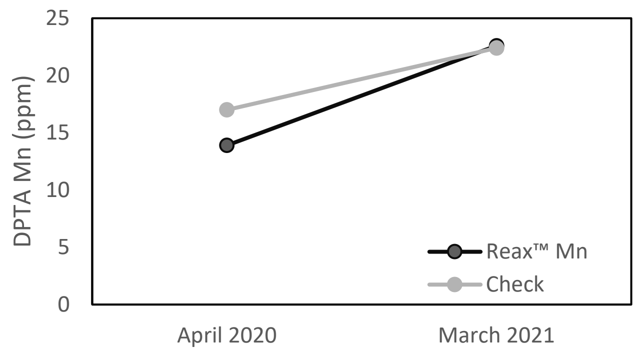


Figure 1. Soil test Mn from before the study and after year one.

Table 2. Stand counts, yield, and profit for the ReaX™ Mn treatment and check.

	Early Season Stand Count (plants/ac)	**Harvest Stand Count (plants/ac)**	**Moisture (%)**	**Yield (bu/ac)†**	**Marginal Net Return‡ ($/ac)**
Check	32,524 A*	30,476 B	13.8 A	224 A	1,438 A
ReaX Mn	32,952 A	31,000 A	13.7 A	223 A	1,423 A
P-Value	0.314	0.052	0.518	0.954	0.284

*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 $6.57/bu corn, $30.12/ac for the check treatment, and $44.52/ac for the ReaX™ Mn treatment.

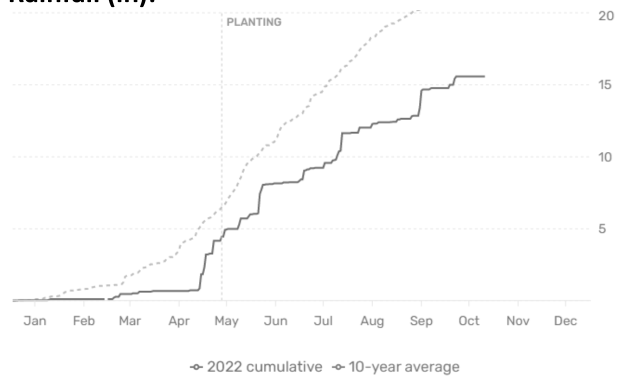
Summary:

- There were no differences in early season stand counts between the two treatments evaluated. At harvest stand, the ReaX™ Mn treatment had significantly higher counts (500 plants/ac more).
- In all three years of the study, there were no differences in grain yield or marginal net return between the treatments evaluated which is consistent with UNL recommendations.

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

Study ID: 0709047202201
County: Dawson
Soil Type: Hord silt loam 0-1% slope; Cozad silt loam 1-3% slope; Cozad silt loam 0-1% slope
Planting Date: 5/18/22
Harvest Date: 11/2/22
Seeding Rate: 34,000
Row Spacing (in): 30
Hybrid: Channel® 214-22STX
Reps: 7
Previous Crop: Corn
Tillage: Strip-till, ridge-till
Herbicides: ***Pre:*** 3 oz/ac mesotrione, 2 qt/ac Fearless Xtra® 5.6L, 5 oz/ac Verdict®, and 5 oz/ac Absil™ on 5/18/22 ***Post:*** 1.5 qt/ac Fearless Xtra® 5.6L, 4 oz/ac Yukon®, and 0.2 gal/ac Padlock® Plus on 6/14/22

Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: Gravity, Total: 24"
Rainfall (in):



Introduction: This is the third and final year of this study evaluating the impact of Altura™ fertilizer versus 10-34-0 fertilizer. The treatment strips were maintained in the same place each year, and soil tests are collected annually to detect changes in soil fertility over time. Altura™ is a 7-21-0-0.2 Zn fertilizer with 6% organic material derived from leonardite, 1% gluconic acid, and 0.2% zinc.

The two treatments were applied with strip-till on May 13, 2022:

Check: 15 gal/ac 32% UAN, 5 gal/ac 12-0-0-26S, and 15 gal/ac 10-34-0 (10-34-0 provided 17 lb N/ac and 59 lb P/ac).

Altura™: 15 gal/ac 32% UAN, 5 gal/ac 12-0-0-26S, and 5 gal/ac Altura™ (Altura™ provided 4 lb N/ac and 11 lb P/ac).

Additional fertilizer on the field was the same for both treatments. The treatments included an in-furrow starter fertilizer application of 1 gal/ac Altura™, 1 gal/ac ReaX™ K, and 0.125 gal/ac ReaX™ Zinc on May 18, 2022; 10 gal/ac 32% UAN applied with burndown on May 18, 2022; and 37 gal/ac 32% UAN with 5 gal/ac 12-0-0-26S sidedressed on June 28, 2022.

Results:

Table 1. Soil tests before and after application of Altura™.

	Soil pH	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
							Before application – April 2020							
Check	6.7	2.8	26	21	3	353	1879	341	60	13	1.4	17.8	6.3	0.6
Altura™	6.6	2.7	26	19	4	385	2865	436	61	19	1.7	24.2	8.4	0.7
							After year 1 – March 2021							
Check	6.4	3.1	98	23	19	448	2300	424	82	17	2.8	18.5	9.1	0.8
Altura™	6.7	2.7	156	20	26	432	2701	390	72	18	2.1	20.0	11.4	0.9

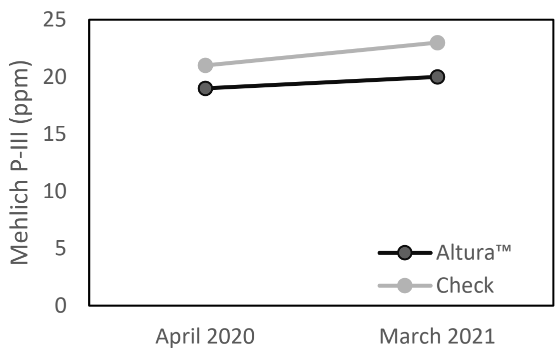


Figure 1. Soil test P from before the study and after year one of Altura™ application.

Table 2. Stand counts, yield, and profit for the Altura™ treatment and check.

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check (10-34-0)	32,095 A*	29,714 A	13.3 A	227 A	1,417 A
Altura™	32,524 A	30,476 A	13.4 A	213 B	1,355 B
P-Value	0.321	0.130	0.394	0.001	0.005

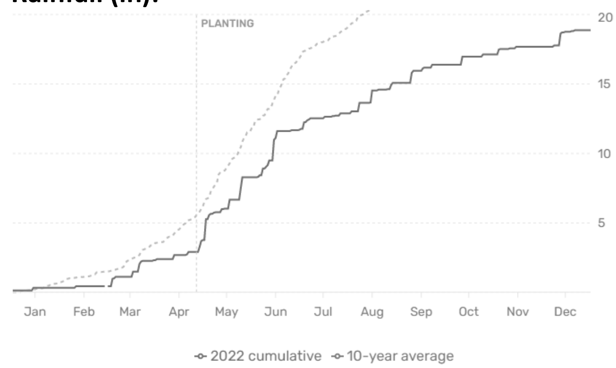
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $6.57/bu corn, $70.80/ac for 10-34-0, and $46.25/ac for Altura™.

Summary:

- There were no differences in early season or harvest stand counts.
- In year one of the study, there were no significant yield or net return differences. In year two, the check yield was 10 bu/ac greater than the Altura™ yield, resulting in a profit increase of $55/ac for the check treatment compared to the Altura™. In year three, corn yield was 13 bu/ac greater for the check treatment compared to the Altura™, resulting in a profit increase of $62/ac for the check treatment compared to the Altura™.
- Soil tests do not show an increase in soil P with an additional 5 gal/ac Altura™ in the strip-till application.

Evaluating Sidedress UAN on Irrigated Corn

Study ID: 1266155202201
County: Saunders
Soil Type: Filbert silt loam 0-1% slope; Tomek silt loam 0-2% slope; Yutan silty clay loam terrace, 2-6% slopes, eroded
Planting Date: 4/26/22
Harvest Date: 9/12/22
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P1185AM®
Reps: 6
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** 17.3 oz/ac Verdict®, 7.7 oz.ac DiFlexx®, 11.6 oz/ac Roundup PowerMAX® 3, 15.4 oz/ac atrazine 4L, 1.4 lb/ac AMS, and 18.7 oz/ac MSO ***Post:*** 2.9 oz/ac Laudis®, 19.5 oz/ac Roundup PowerMAX® 3, 15.6 oz/ac atrazine 4L, 9.5 oz/ac Superb® HC, and 1.4 lb/ac AMS
Irrigation: Pivot
Rainfall (in):



Introduction: The objective of this study was to evaluate the need for in-season N fertilizer application following a manure application. The entire field received a beef manure injection of 10,389 gallons per acre. The manure sample analysis results showed 13.9 lbs of ammonium N and 7.2 lbs of organic N per 1000 gallons. Assuming a first year availability of 95% for ammonium N and 35% for organic N the total available to this crop was 163 lb N/ac. In order to evaluate the impact of in-season N fertilizer application, strips with 30 lb N/ac were sidedressed with 32% UAN using coulters on June 21, 2022. The study compared the manure only treatment to the manure plus UAN.

In addition, multispectral drone imagery was collected throughout the season to determine if additional N was required through fertigation. The NDRE from the imagery was used to calculate nitrogen sufficiency of the non-sidedressed area by using the strips with the additional 30 lb N/ac as a reference. The method was similar to previous studies using sensor-based fertigation. At no point during the season did the sufficiency cross the threshold to trigger a fertigation application.

Results:

	Moisture (%)	Yield (bu/ac)†	Nitrogen Efficiency (lb N/bu grain)	Marginal Net Return‡ ($/ac)
Manure	30.9 A*	275 A	0.59 B	1,809 A
Manure + UAN	31.2 A	288 A	0.67 A	1,870 A
P-Value	0.294	0.121	0.003	0.238

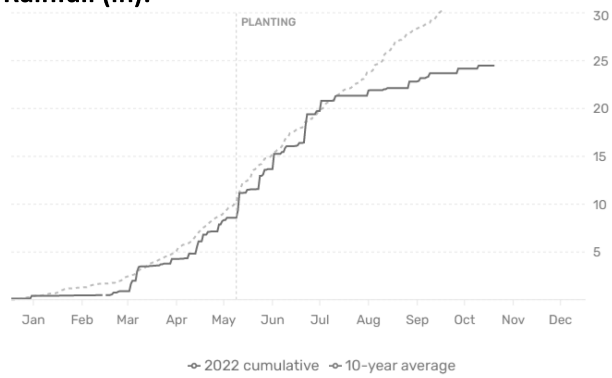
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $6.57/bu corn and $0.80/lb of N.

Summary: The addition of 30 lb N/ac as sidedress did not result in an increase in yield or profit. The manure only treatment had a greater N efficiency, with 0.6 lb N/bu of grain.

Evaluating Nitrogen Fertilizer Rates on Non-Irrigated Corn

Study ID: 0701147202301
County: Richardson
Soil Type: Marshall silty clay loam 2-6% slopes
Planting Date: 5/23/22
Harvest Date: 10/25/22
Seeding Rate: 27,500
Row Spacing (in): 30
Hybrid: DEKALB® DKC68-48
Reps: 5
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** atrazine, Dual Magnum®, Roundup®, and 2,4-D ***Post:*** mesotrione and Roundup® applied in June
Seed Treatment: None

Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: None
Rainfall (in):



Soil Tests, 0-8" (August 2022):

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	OM LOI-%	KCl Nitrate ppm N	Nitrate lb N/ac 0-8 in	M-3 P ppm	-Ammonium Acetate- K ppm	Ca ppm	Mg ppm	NA ppm	---------DTPA---------- Zn ppm	Fe ppm	Mn ppm	Cu ppm	Sum of Cations me/100g	% Base ---Saturation--- H	K	Ca	Mg	Na
7.3	0.19	3.4	18.8	45	38	600	3558	408	78	3.20	32.5	7.4	1.00	23.1	0	7	77	15	1

Introduction: The objective of this study was to evaluate the impact of nitrogen (N) fertilizer rate on corn yield and net return. Fertilizer was applied with the planter. The fertilizer blend was 19% 10-34-0, 77% UAN 32%, and 4% Thio-Sul®. The grower's standard rate was 48 gal/ac. This study evaluated rates of 42 gal/ac, 52 gal/ac, and 62 gal/ac, which contributed the following nutrients:

42 gal/ac: 126 lb N/ac, 4.8 lb S/ac, and 31 lb P_2O_5/ac

52 gal/ac: 156 lb N/ac, 6.0 lb S/ac, and 39 lb P_2O_5/ac

62 gal/ac: 186 lb N/ac, 7.2 lb S/ac, and 46 lb P_2O_5/ac

Stand counts were collected in the spring, and yield, grain moisture, and net return were evaluated at harvest.

Results:

	Early Season Stand Count (plants/ac)	Moisture (%)	Test Weight (lb/bu)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
42 gal/ac	27,733 A*	13.8 B	60 A	224 B	1,318 B
52 gal/ac	28,200 A	14.1 AB	60 A	235 A	1,354 A
62 gal/ac	28,200 A	14.4 A	60 A	232 A	1,297 B
P-Value	0.647	0.013	0.272	0.0004	0.002

*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 $6.57/bu corn and $3.64/gal of fertilizer ($1.2/lb N).

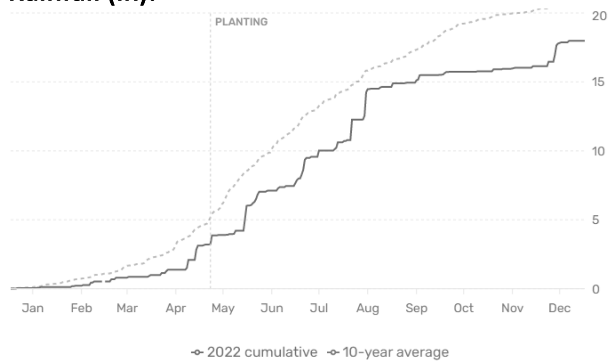
Summary:

- There were no differences in stand counts or test weight among the treatments.
- Grain moisture of the 62 gal/ac treatment was 0.5% wetter than the 42 gal/ac treatment.
- The 52 gal/ac treatment resulted in a yield increase of 11 bu/ac compared to the 42 gal/ac treatment. There was no additional yield increase for the 62 gal/ac treatment.
- This resulted in the greatest net return for the 52 gal/ac treatment ($36/ac better than the 42 gal/ac treatment and $56/ac better than the 62 gal/ac treatment).

Evaluating Nitrogen Fertilizer Rates on Irrigated Corn

Study ID: 0881161202201
County: Sheridan
Soil Type: Dunday loamy fine sand 3-9% slopes; Tuthill fine sandy loam 0-3% slope; Tuthill fine sandy loam 3-6% slopes
Planting Date: 5/7/22
Harvest Date: 10/30/22
Seeding Rate: 35,000
Row Spacing (in): 30
Hybrid: Pioneer® P9840Q®
Reps: 7
Previous Crop: Corn
Tillage: Vertical-till and strip-till
Herbicides: ***Pre:*** 1 oz/ac Sharpen® and 32 oz/ac Roundup® on 5/9/22 ***Post:*** 32 oz/ac Roundup®, 6 oz/ac Status® and 1.5 oz/ac Zidua® SC on 6/18/22

Irrigation: Pivot, Total: 18-20"
Rainfall (in):



Baseline Soil Samples, 0-12": February 2022

	pH	CEC meq/100g	OM LOI %	Nitrate – N ppm N	Bray P1 P ppm	Sulfate-S ppm S	-----Ammonium Acetate----- K	Ca	Mg	Na	Zn	Fe (DTPA ppm)	Mn	Cu
Sample	7.4	9.8	0.9	5	13	5	194	1663	108	20	0.8	34	9	0.4

Introduction: The entire field received 76 lb/ac potash dry spread, 13 gal/ac 17.6-17.4-0-3.4 S (25 lb N/ac) applied 2x2, and 4 gal/ac 8.8-17.5-4.4-0.8 S-0.37 Zn (3 lb N/ac) applied in-furrow at planting, 23.5 gal/ac 26-0-0-2.5 S (67 lb N/ac) topdressed on June 18, 2022, and 21.2 gal/ac 25.4-0-0-8.4 S (60 lb N/ac) applied by injections on 7/1/22-7/30/22. Total N contribution was 155 lb N/ac.

A variable-rate nitrogen prescription was developed to apply blocks of nitrogen rates approximately 400' long by 120' wide (Figure 1). The nitrogen prescription was implemented with the strip-till application on April 22, 2022. The blend used contained 24.6% N, 7.8% P, and 2.3% S. Three rates were evaluated:

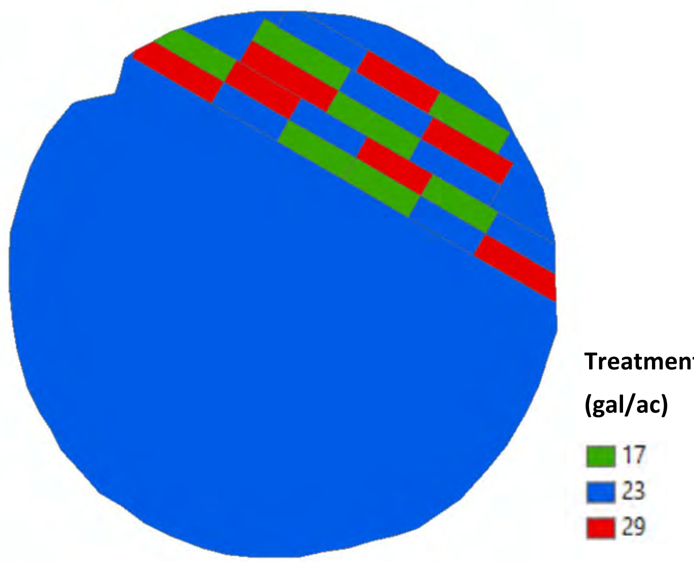


Figure 1. Nitrogen treatment map showing N rates applied with strip-till application.

17 gal/ac: contributing 47 lb N/ac, 15 lb P/ac, and 4 lb S/ac (total N is 202 lb/ac)

23 gal/ac: contributing 63 lb N/ac, 21 lb P/ac, and 6 lb S/ac (total N is 218 lb/ac)

29 gal/ac: contributing 80 lb N/ac, 26 lb P/ac, and 8 lb S/ac (total N is 235 lb/ac)

Yield monitor data were collected at the end of the growing season and post-processed to remove errors. Additionally, yield data points that correspond to areas where the fertilizer application rate was more than 10% above or below the target rate were eliminated.

Results:

	Total N (lb/ac)	Moisture (%)	Yield (bu/ac)†	Nitrogen Efficiency (lb N/bu grain)	Marginal Net Return‡ ($/ac)
17 gal/ac	202	13.3 A*	226 A	0.90 B	1,424 A
23 gal/ac	218	13.1 A	212 A	1.04 A	1,315 A
29 gal/ac	235	13.4 A	223 A	1.06 A	1,363 A
P-Value	-	0.603	0.239	0.004	0.147

*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 $6.57/bu corn and $3.84/gal of fertilizer applied at strip-till.

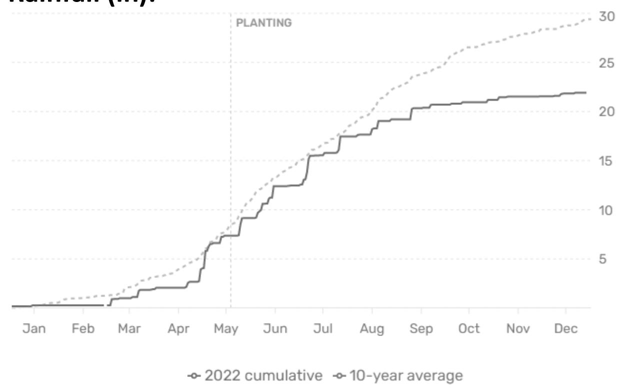
Summary:

- There were no differences in grain moisture, yield, or net return among the three fertilizer rates evaluated, indicating that the lowest rate (17 gal/ac) was sufficient for optimum yields. The actual optimum rate may have been lower.
- Nitrogen use efficiency was greater for the 17 gal/ac fertilizer treatment compared to the 23 and 29 gal/ac treatments.

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

Evaluating Nitrogen Rate and Timing on Irrigated Corn

Study ID: 1111185202202
County: York
Soil Type: Butler silt loam 0-1% slope; Hastings silty clay loam 3-7% slopes, eroded; Hord silt loam 1-3% slope; Hord silt loam 0-1% slope
Planting Date: 5/18/22
Harvest Date: 10/20/22
Seeding Rate: 29,000
Row Spacing (in): 36
Hybrid: Pioneer® P1563
Reps: 3
Previous Crop: Corn
Tillage: Stumping on 4/28/22
Herbicides: ***Pre:*** 2 qt/ac Lexar® EZ, 22 oz/ac Roundup®, 12 oz/ac generic dicamba, and AGpHRx™ on 5/20/22 ***Post:*** 1 qt/ac Resicore®, 1 qt/ac atrazine, 22 oz/ac Roundup®, generic dicamba, and AGpHRx™ on 6/21/22
Seed Treatment: Maxim® Quattro, Lumiflex™, Lumiante™, L-20012R, and Lumivia™ 250.
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: The spring anhydrous was applied in early April; the split applications had anhydrous in the spring, as well as an additional 50 lb N/ac applied as 32% UAN
Note: This field had 35% hail damage on 6/14/2022 when the corn was at V5
Irrigation: Pivot, Total: 8.5"
Rainfall (in):



Introduction: This study evaluated various rates and timings of nitrogen application. The study was repeated on the same strips as the previous study in 2021. The treatments in 2022 were as follows:

Spring 180 lb/ac: 180 lb/ac as spring anhydrous

Spring 230 lb/ac: 230 lb/ac as spring anhydrous

Split 180 lb/ac: 120 lb/ac as spring anhydrous and 60 lb/ac as sidedress with 32% UAN at V8

Split 230 lb/ac: 170 lb/ac as spring anhydrous and 60 lb/ac as sidedress with 32% UAN at V8

Spring anhydrous was applied in late March 2022, and sidedress application occurred on June 23, 2022.

Soil samples were collected prior to the season and at the end of the season. Two soil cores were pulled 10” from the plant, in the anhydrous band, from 3 rows, for a total of 6 cores per sample. Soil samples were collected from one replication only.

Results:

	Stand Count (plants/ac)	Stalk Rot (%)	Green Snap (%)	lb N/ bu grain	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
	----------------	----------------	----------------	*2021*	----------------	----------------	----------------
140 lb N/ac spring	27,333 A*	2.50 A	12 A	0.60 B	15.5 A	235 A	1,178 A
190 lb N/ac spring	29,000 A	2.50 A	2 A	0.81 A	15.5 A	236 A	1,166 A
140 lb N/ac split	28,667 A	1.67 A	3 A	0.59 B	15.5 A	237 A	1,171 A
190 lb N/ac split	27,833 A	3.33 A	4 A	0.81 A	15.5 A	236 A	1,150 A
P-Value	0.464	0.974	0.441	<0.0001	1	0.955	0.305
	----------------	----------------	----------------	*2022*	----------------	----------------	----------------
180 lb N/ac spring	23,833 A*	0.00 A		0.79 B		226 A	1,331 A
230 lb N/ac spring	23,833 A	0.00 A		1.00 A		229 A	1,313 A
180 lb N/ac split	23,500 A	0.83 A		0.79 B		227 A	1,325 A
230 lb N/ac split	23,333 A	0.00 A		1.00 A		230 A	1,304 A
P-Value	0.979	0.455		<0.0001		0.664	0.710

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡2021 marginal net return based on $5.20/bu corn, $0.30/lb N as anhydrous ammonia, $0.40/lb N as UAN, and $8/ac for the side-dress UAN application at V8. 2022 marginal net return based on $6.57/bu corn, $0.85/lb N as anhydrous with application, and $1.10/lb N as 32% UAN with application.

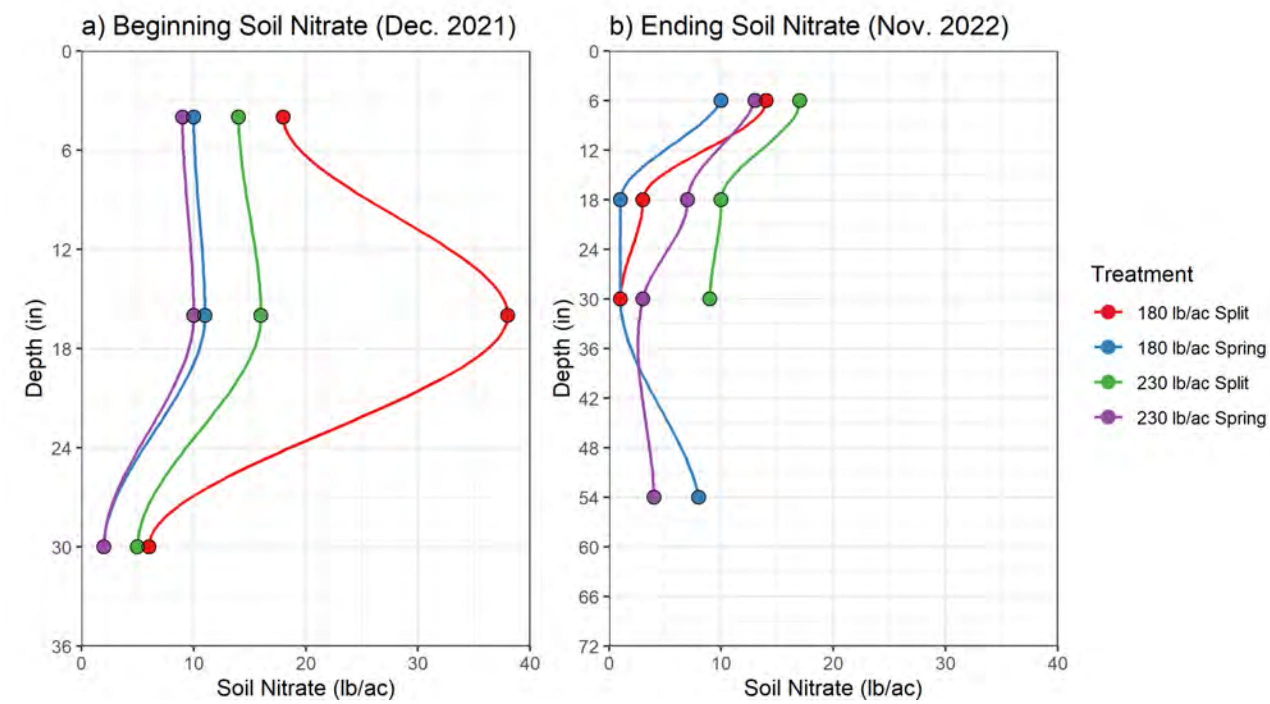


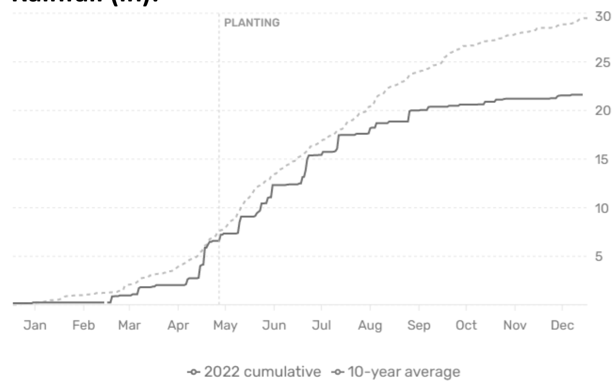
Figure 1. a) Beginning soil nitrate from December 2021, for depths of 0-8", 8-24", and 24-36". Soil samples were collected in one replication only; therefore, statistics can not be calculated. **b)** End-of-season soil nitrate from November 2022, for depths of 0-12", 12-24", 24-36", and 36-72". Soil samples were collected in one replication only; therefore, statistics can not be calculated.

Summary:

- In 2022 there were no differences in stand counts, stalk rot, yield, or net return among the rates evaluated. This is consistent with results from 2021, when rates of 140 lb/ac and 190 lb/ac were evaluated with no differences in stand counts, stalk rot, yield, or net return.
- For most depths, the 230 lb/ac treatment had higher nitrate levels in the end-of-season soil nitrate samples compared to the 180 lb/ac treatments.
- Nitrogen use efficiency was significantly better for the 180 lb/ac treatments compared to the 230 lb/ac treatments, regardless of the application timing.

Determining Economically Optimum Nitrogen Rate on Irrigated Corn

Study ID: 1111185202201
County: Hamilton
Soil Type: Hord silt loam 1-3% slope; Hord silt loam rarely flooded; Hastings silty clay loam 3-7% slopes; Hastings silty clay loam 7-11% slopes
Planting Date: 5/11/22
Harvest Date: 10/17/22
Seeding Rate: 29,000
Row Spacing (in): 36
Hybrid: Pioneer® P1572
Reps: 3
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** 2 qt/ac Lexar® EZ, 22 oz/ac Roundup®, and AGpHRx™ on 5/16/22 ***Post:*** 1 qt/ac Resicore®, 1 qt/ac atrazine, 22 oz/ac Roundup®, and AGpHRx™ on 6/14/22
Seed Treatment: Maxim® Quattro, Lumiflex™, Lumiante™, L-20012R, and Lumivia™ 250
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: Treatments were applied in the form of anhydrous in November 2021; all treatments had 50 lb N/ac applied as 32% UAN at V8
Note: This field had 25% hail damage on 6/14/2022 when the corn was at V6
Irrigation: Pivot, Total: 8.5"
Rainfall (in):



Introduction: The goal of this study was to determine the economic optimum nitrogen (N) rate for corn. Treatments were established as anhydrous ammonia with rates of 0, 50, 100, 150, and 200 lb N/ac in November 2021. All treatments also received a sidedress of 50 lb N/ac as 32% UAN at V8. The sidedress treatment was surface applied and did not get incorporated until a rain 10 days later. Harvest stand counts, yield, net return, and residual nitrate were evaluated.

Results:

Total N Rate (lb/ac)	Harvest Stand Count (plants/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
50 lb N/ac	25,167 A*	211 C	1,329 AB
100 lb N/ac	22,667 A	222 B	1,354 A
150 lb N/ac	22,833 A	231 A	1,375 A
200 lb N/ac	22,167 A	232 A	1,339 AB
250 lb N/ac	24,500 A	230 A	1,288 B
P-Value	0.121	0.0002	0.012

*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 $6.57/bu corn, $0.85/lb N as anhydrous, and $1.10/lb N as 32% UAN.

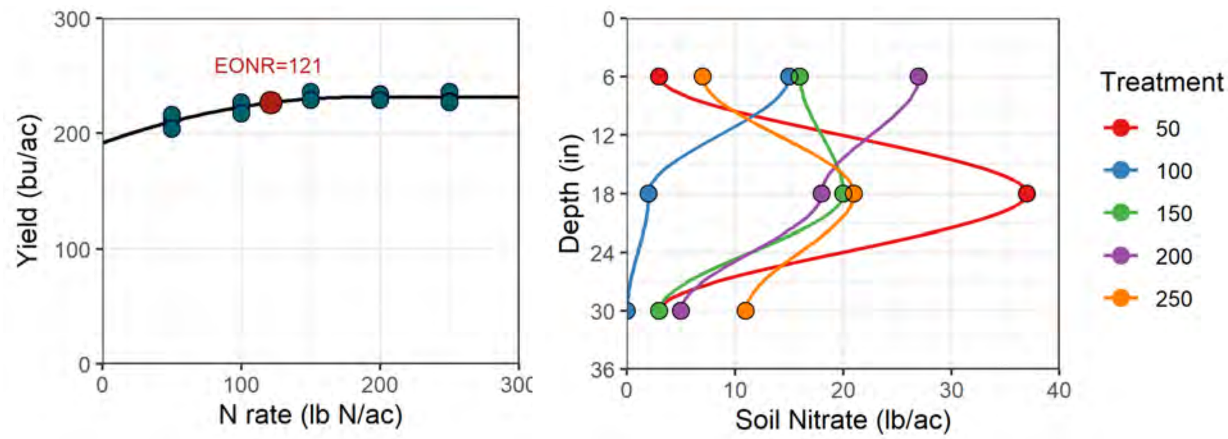


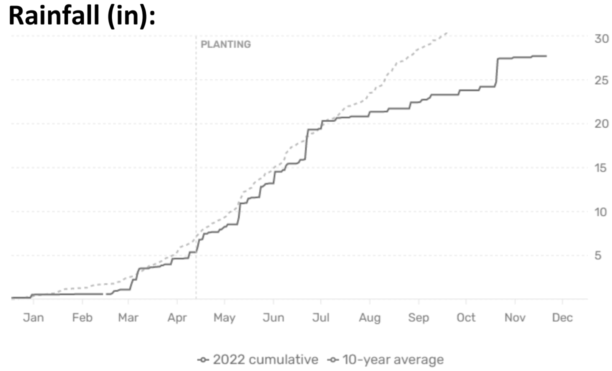
Figure 1. (left) Economic optimum nitrogen rate (lb/ac) at a corn price of \$6.57/bu and nitrogen fertilizer price of \$0.98/lb. **(right)** Residual soil nitrate (lb/ac) for five nitrogen rates at depths of 0-12", 12-24", and 24-36".

Summary:

- There was no difference in harvest stand counts between the N rates evaluated.
- Residual nitrate varied greatly both by depth and by treatment.
- The economic optimum N rate was 121 lb N/ac and resulted in a yield of 226 bu/ac. At this N rate, the nitrogen use efficiency is 0.54 lb N/bu grain.
- As always, individual expenses are unique for each grower and need to be considered. The economic optimum N rate was calculated using the standard grain price of \$6.57/bu and the nitrogen fertilizer prices paid by the farmer (\$0.85/lb N as anhydrous and \$1.10/lb N as UAN 32%). However, the grower noted he has additional grain drying, storage, and hauling expenses that total \$0.35/bu and an additional N expense of \$0.05/lb of N from interest on an operating loan for N fertilizer.

Determining Economically Optimum Nitrogen Rate on Corn

Study ID: 0416147202201
County: Richardson
Soil Type: Kennebec silt loam rarely flooded; Zook silty clay loam occasionally flooded; Judson silt loam 2-6% slopes; Kipson-Benfield silty clay loam 7-17% slopes
Planting Date: 4/27/22
Harvest Date: 10/7-8/22
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P1572
Reps: 4
Previous Crop: Soybean
Tillage: Strip-till
Herbicides: ***Pre:*** 0.825 oz/ac Basis® Blend, 1.4 pt/ac atrazine 4L, 16 oz/ac dicamba ***Post:*** 2.2 qt/ac Keystone® NXT, 24 oz/ac glyphosate, 5.33 oz/ac mesotrione
Foliar Fungicides: 7 oz/ac Veltyma® on 7/13/22
Fertilizer: Anhydrous ammonia on 11/24/21 varied based on treatments tested; 44 lb/ac 11-52-0 contributing 5 lb N/ac; variable-rate gypsum averaging 113 lb/ac; variable-rate 0-0-60 averaging 113 lb/ac
Irrigation: None
Rainfall (in):



Baseline Soil Samples, 0-6" (11/22/21):

	pH	BpH	OM LOI %	Melich III P ppm	Nitrate – N ppm N	Bray P1 ppm	Sulfate-S ppm S	-------Melich III------- K	Ca	Mg	Na	CEC me/100g	Sand (%)	Silt (%)	Clay (%)
Zone 2	6.8	6.9	2.9	41	5.1	31	9	168	1824	165	10	11.3	33	53	14
Zone 5	6.7	6.9	2.4	28	2.8	21	10	98	1895	171	12	11.7	31	55	14
Zone 7	6.8	6.9	4	38	3.8	29	8	170	2330	211	10	14.3	31	55	14
Zone 8	6.1	6.7	3.4	19	4.2	14	13	137	2300	305	12	16.8	33	51	16

Introduction: This study utilized variable-rate nitrogen application technology to evaluate nitrogen rates in contrasting field zones. A variable-rate nitrogen prescription was developed to apply blocks of nitrogen rates approximately 300' long by 30' wide (Figure 1). An anhydrous rate of 0 lb N/ac was established by turning the applicator off for a small area in zones 2 and 5. Nitrogen was applied as anhydrous ammonia on November 21, 2021, at a depth of 7" with strip-till following a previous crop of soybeans. As-applied fertilizer maps were used to evaluate the accuracy of fertilizer application. The field also received a flat rate of 44 lb/ac of 11-52-0 (contributing 5 lb N/ac). Two of the treatments evaluated sidedress applications of 40 lb N/ac as 32% UAN stabilized with N-Fixx® XLR at V10 on June 21, 2022. A rainfall event of 0.25" was received the night of the application.

Multispectral imagery was collected using a DJI™ Inspire 2 drone equipped with a MicaSense® RedEdge-MX™ five-band sensor. The normalized difference red edge (NDRE) index was calculated for each flight date (Figure 2). Yield monitor data were collected at the end of the growing season and post-processed to remove errors. Yields from the small 0 lb N/ac anhydrous rate blocks were determined by hand harvesting. Additionally, yield data points that correspond to areas where the fertilizer application rate was more than 10% above or below the target rate were eliminated. The economic optimum nitrogen rate (EONR) was calculated for each zone using the pre-plant N treatments (Figure 3).

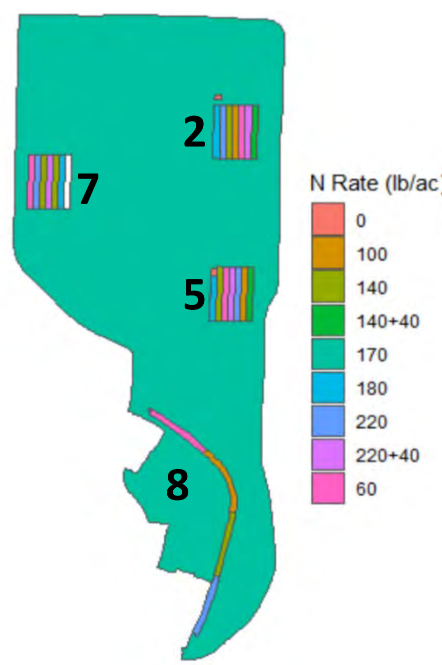


Figure 1. Nitrogen treatment map showing N rates applied with anhydrous ammonia. Treatments with sidedress application of 40 lb N/ac are indicated with "+40". Zones are numbered (2, 5, 7, and 8).

Results:

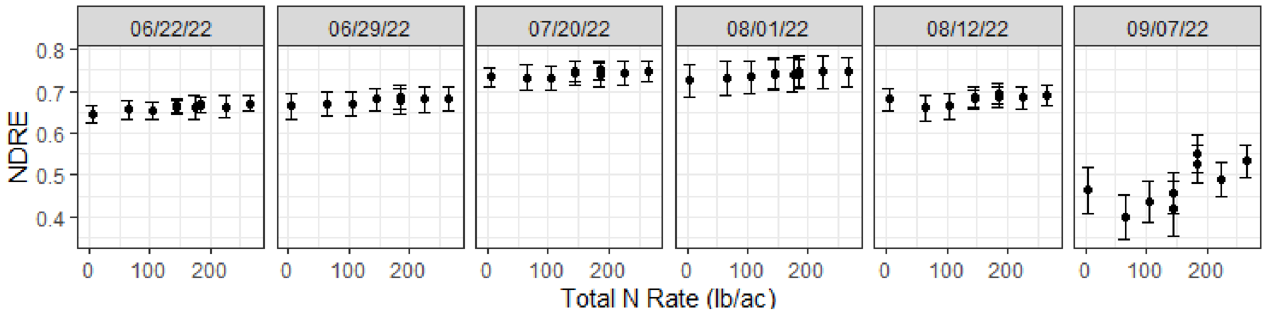


Figure 2. NDRE mean and standard deviation by total N applied for seven imagery dates across all zones.

Because zone 8 only had four of the N rates represented and was in a different landscape position with lower yields, it is not included in the table below.

Nitrogen rate (lb/ac)	Yield (bu/ac)†	lb N/bu grain	Marginal Net Return‡ ($/ac)
5 lb N/ac	244 B	0.02 G	1599 A
65 lb N/ac	260 AB	0.25 F	1678 A
105 lb N/ac	271 A	0.39 E	1732 A
145 lb N/ac	276 A	0.52 D	1750 A
185 lb N/ac	275 A	0.67 C	1720 A
225 lb N/ac	273 A	0.85 B	1695 A
145+40 lb N/ac	274 A	0.67 C	1717 A
225+40 lb N/ac	275 A	0.97 A	1686 A
P-Value	0.01	<0.0001	0.165

*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 $6.57/bu corn and $0.45/lb N.

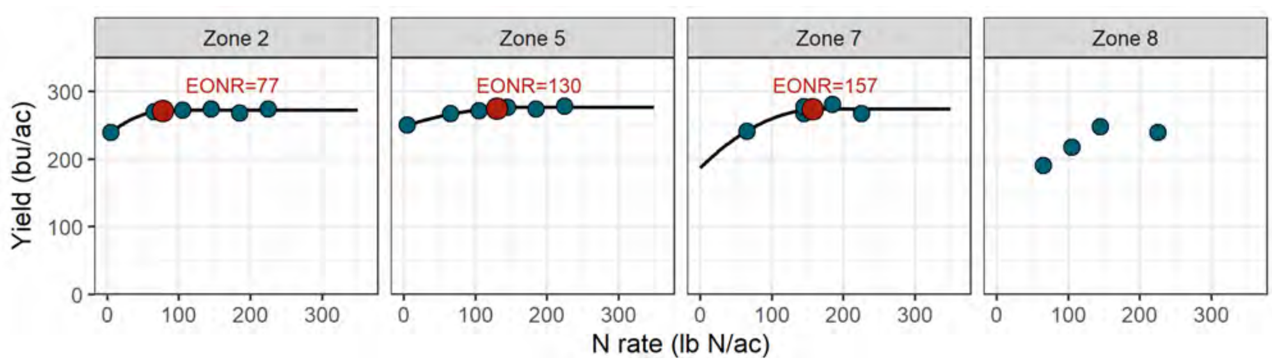


Figure 3. Corn yield by N rate for pre-plant N treatments. Economic optimum N rate is indicated with a red dot. Corn price is $6.57/bu and N fertilizer price is $0.45/lb.

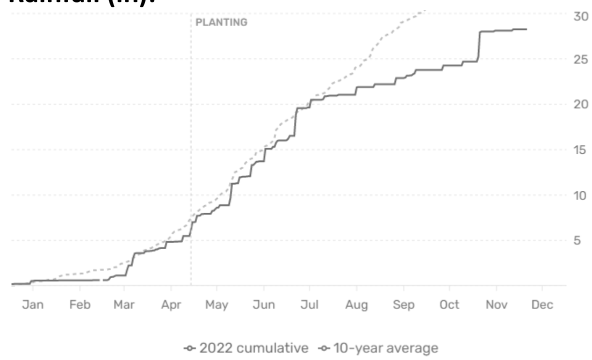
Summary:

- The EONR varied by zone, ranging from 77 lb N/ac to 157 lb N/ac and resulting in a yield of 274 bu/ac. EONR was not able to be calculated for zone 8 due to variation in yield response to N, but lower yields at the 65 lb N/ac rate indicate that this zone has a higher N requirement relative to the other zones.
- NUE at EONR ranged from 0.28 lb N/bu of grain in zone 2 to 0.57 lb N/bu of grain in zone 7.
- The study revealed high inherent N supplying capacity in this field with yields of 240 to 250 bu/ac with only 5 lb N/ac applied.
- Sidedress application did not result in higher yields compared to similar N rates applied entirely in the fall.

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

Determining Economically Optimum Nitrogen Rate on Corn

Study ID: 0416147202202
County: Richardson
Soil Type: Monona silt loam 1-6% slopes; Marshall silty clay loam 2-6% slopes; Judson silt loam 2-6% slopes
Planting Date: 4/27-28/22
Harvest Date: 10/1-3/22
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1572
Reps: 5
Previous Crop: Soybean
Tillage: Strip-till
Herbicides: ***Pre:*** 0.825 oz/ac Basis® Blend, 1.4 pt/ac atrazine 4L, 16 oz/ac dicamba ***Post:*** 2.2 qt/ac Keystone® NXT, 24 oz/ac glyphosate, 5.33 oz/ac mesotrione
Foliar Fungicides: 7 oz/ac Veltyma® on 7/13/22
Fertilizer: Anhydrous ammonia on 11/26/21 and 11/29/21 varied based on treatments tested; 74 lb/ac 11-52-0 contributing 8 lb N/ac; variable-rate gypsum averaging 124 lb/ac; variable-rate 0-0-60 averaging 124 lb/ac
Irrigation: None
Rainfall (in):



Baseline Soil Samples, 0-6" (11/24/2021):

	pH	BpH	OM LOI %	Melich-III P ppm	Nitrate – N ppm N	Bray P1 ppm	Sulfate-S ppm S	-------Melich III------- K	Ca	Mg	Na	CEC me/100g	Sand (%)	Silt (%)	Clay (%)
Zone 2	6.4	6.7	4.1	32	5.3	24	7	308	2607	194	6	17	19	60	20
Zone 5	6.3	6.7	4.2	26	3.4	20	11	217	2813	255	9	18.8	19	60	20
Zone 6	6.6	6.8	4	24	4.7	18	9	218	2739	220	7	17.1	19	62	18
Zone 7	6.2	6.7	4.1	23	3.9	17	11	175	2636	249	11	17.9	17	62	20
Zone 8	6.6	6.8	3.6	20	3.6	15	9	222	2834	263	11	18.1	17	58	24

Introduction: This study utilized variable-rate nitrogen application technology to evaluate nitrogen rates in contrasting field zones. A variable-rate nitrogen prescription was developed to apply blocks of nitrogen rates approximately 300' long by 30' wide (Figure 1). An anhydrous rate of 0 lb N/ac was established by turning the applicator off for a small area in zone 2. Nitrogen was applied as anhydrous ammonia on November 21, 2021, at a depth of 7" with strip-till following a previous crop of soybeans. As-applied fertilizer maps were used to evaluate the accuracy of fertilizer application. The field also received a flat rate of 74 lb/ac of 11-52-0 (contributing 8 lb N/ac). Two of the treatments evaluated sidedress applications of 40 lb N/ac as 32% UAN stabilized with N-Fixx® XLR at V10 on June 21, 2022. A rainfall event of 0.25" was received the night of the application.

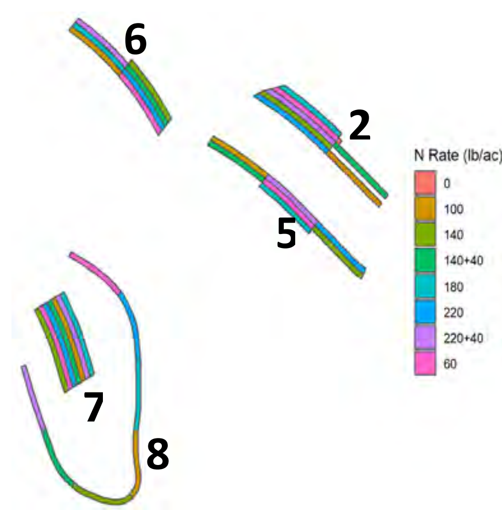


Figure 1. Nitrogen treatment map showing N rates applied with anhydrous ammonia. Treatments with sidedress application of 40 lb N/ac are indicated with "+40". Zones are numbered (2, 5, 6, 7, and 8).

Multispectral imagery was collected using a DJI™ Inspire 2 drone equipped with a MicaSense® RedEdge-MX™ five-band sensor. The normalized difference red edge (NDRE) index was calculated for each flight date (Figure 2).

Yield monitor data were collected at the end of the growing season and post-processed to remove errors. Yields from the small 0 lb N/ac anhydrous rate blocks were determined by hand harvesting. Additionally, yield data points that correspond to areas where the fertilizer application rate was more than 10% above or below the target rate were eliminated. The economic optimum nitrogen rate (EONR) was calculated for each zone using the pre-plant N treatments (Figure 3).

Results:

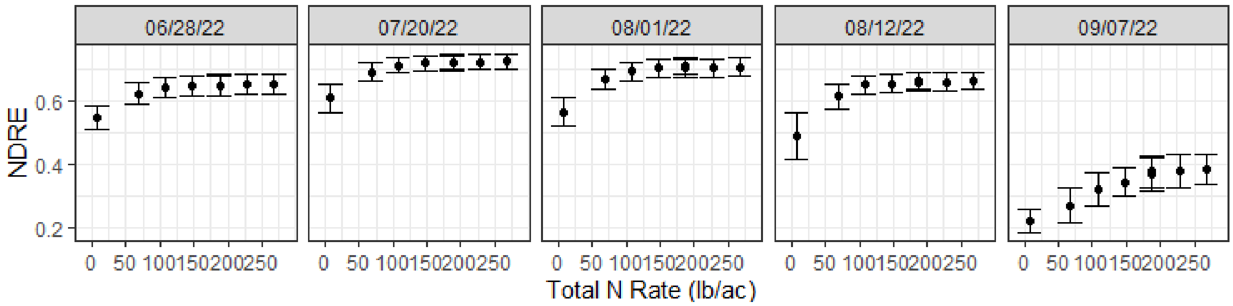


Figure 2. NDRE mean and standard deviation bars by total N applied for four imagery dates across all zones.

	Yield (bu/ac)†	lb N/bu grain	Marginal Net Return‡ ($/ac)
68 lb N/ac	189 D*	0.36 F	1,213 C
108 lb N/ac	227 C	0.48 E	1,442 B
148 lb N/ac	234 BC	0.64 D	1,470 AB
148+40 lb N/ac	245 A	0.77 C	1,525 A
188 lb N/ac	242 AB	0.77 C	1,507 AB
228 lb N/ac	239 AB	0.94 B	1,472 AB
228+40 lb N/ac	247 A	1.08 A	1,504 AB
P-Value	<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 $6.57/bu corn and $0.45/lb N.

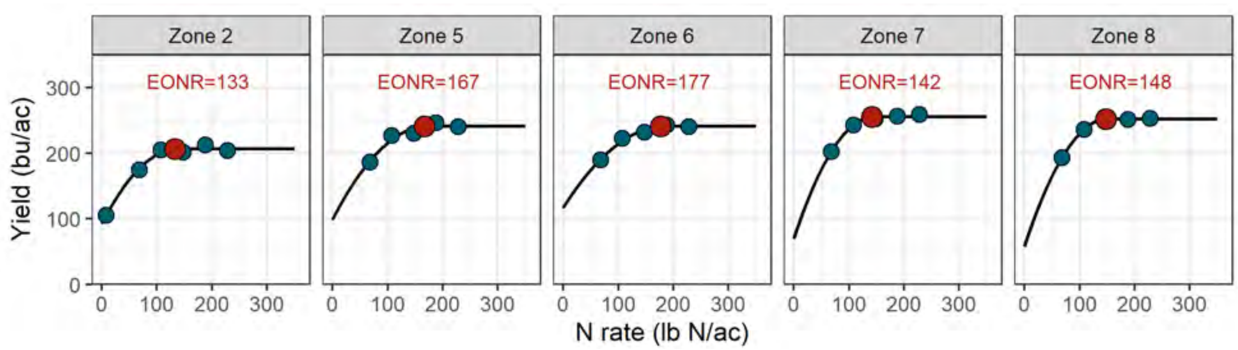


Figure 3. Corn yield by N rate for pre-plant N treatments. Economic optimum N rate is indicated with a red dot. Corn price is $6.57/bu and N fertilizer price is $0.45/lb.

Summary:

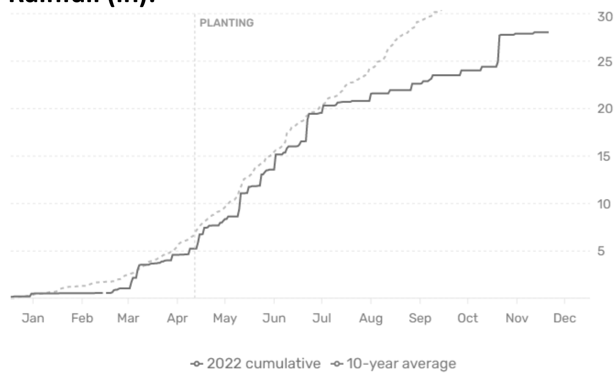
- The EONR varied by zone, ranging from 133 lb N/ac to 177 lb N/ac and resulting in yield at EONR ranging from 207 to 256 bu/ac.
- NUE at EONR ranged from 0.55 lb N/bu of grain in zone 7 to 0.74 lb N/bu of grain in zone 6.
- The small block that had no anhydrous ammonia applied (only 8 lb N/ac from 11-52-0 contribution) yielded 106 bu/ac and had an NUE of 0.08 lb N/bu grain.
- The sidedress treatment 148+40 did not result in higher yields compared to the 188 lb/ac treatment applied entirely in the fall.

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

Determining Economically Optimum Nitrogen Rate on Corn

Study ID: 0510KS013202201
County: Brown, Kansas
Soil Type: Marshall silty clay loam 5-9% slopes; Marshall silt loam 2-5% slopes
Planting Date: 4/26/22
Harvest Date: 10/5/22
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1572
Reps: 4
Previous Crop: Soybean
Tillage: Strip-till
Herbicides: ***Pre:*** 0.825 oz/ac Basis® Blend, 1.4 pt/ac atrazine 4L, 16 oz/ac dicamba ***Post:*** 2.2 qt/ac Keystone® NXT, 24 oz/ac glyphosate, 5.33 oz/ac mesotrione
Foliar Fungicides: 7 oz/ac Veltyma® on 7/13/22

Fertilizer: Anhydrous ammonia on 11/20/21 varied based on treatments tested; 86 lb/ac 11-52-0 contributing 9 lb N/ac; variable-rate gypsum averaging 118 lb/ac; variable-rate 0-0-60 averaging 118 lb/ac
Irrigation: None
Rainfall (in):



Baseline Soil Samples, 0-6" (November 2021):

	pH	BpH	OM LOI %	Melich-III P ppm	Nitrate – N ppm N	Bray P1 ppm	Sulfate-S ppm S	-------Melich III------- K	Ca	Mg	Na	CEC me/100g	Sand (%)	Silt (%)	Clay (%)
Zone 1	6.4	6.7	3.7	22	4.1	17	8	200	2270	221	6	15.1	25	55	20
Zone 2	6.3	6.7	4.6	34	6.2	26	9	306	2517	238	5	17.2	27	47	26
Zone 3	6.6	6.8	3.9	23	3.7	17	9	263	2669	289	5	17.5	33	47	20
Zone 4	7	6.9	3.7	17	4.9	13	8	249	2763	229	6	16.5	19	57	24

Introduction: This study utilized variable-rate nitrogen application technology to evaluate nitrogen rates in contrasting field zones. A variable-rate nitrogen prescription was developed to apply blocks of nitrogen rates approximately 300' long by 30' wide (Figure 1). An anhydrous rate of 0 lb N/ac was established by turning the applicator off for a small area in zone 2 and 4. Nitrogen was applied as anhydrous ammonia on November 20, 2021, at a depth of 7" with strip-till following a previous crop of soybeans. As-applied fertilizer maps were used to evaluate the accuracy of fertilizer application. The field also received a flat rate of 86 lb/ac of 11-52-0 (contributing 9 lb N/ac). Two of the treatments evaluated sidedress applications of 40 lb N/ac as 32% UAN stabilized with N-Fixx® XLR at V10 on June 22, 2022. A rainfall event of 0.3" was received the following day.

Figure 1. Nitrogen treatment map showing N rates applied with anhydrous ammonia. Treatments with sidedress application of 40 lb N/ac are indicated with "+40". Zones are numbered (1, 2, 3, and 4).

Multispectral imagery was collected using a DJI™ Inspire 2 drone equipped with a MicaSense® RedEdge-MX™ five-band sensor. The normalized difference red edge (NDRE) index was calculated for each flight date (Figure 2).

Yield monitor data were collected at the end of the growing season and post-processed to remove errors. Yields from the small 0 lb N/ac anhydrous rate blocks were determined by hand harvesting. Additionally, yield data points that correspond to areas where the fertilizer application rate was more than 10% above or below the target rate were eliminated. The economic optimum nitrogen rate (EONR) was calculated for each zone using the pre-plant N treatments (Figure 3).

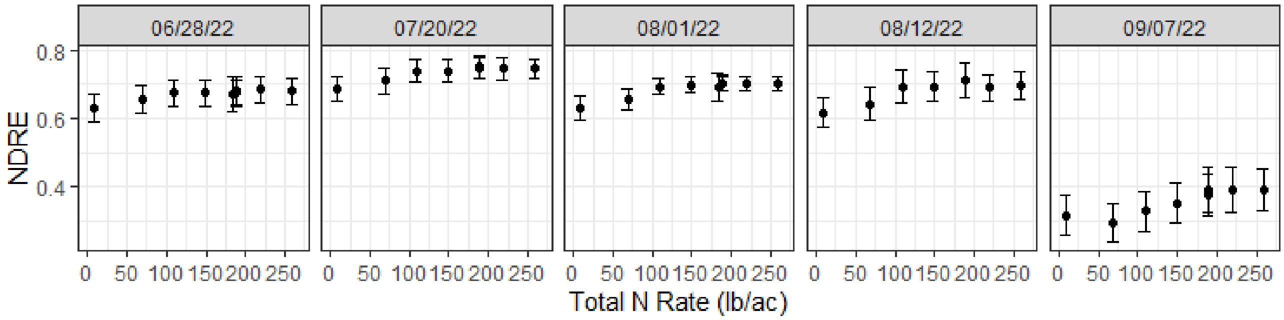


Figure 2. NDRE mean and standard deviation bars by total N applied for five imagery dates.

Results:

	Yield (bu/ac)†	lb N/bu grain	Marginal Net Return‡ ($/ac)
69 lb N/ac	198 B*	0.35 F	1,266 B
109 lb N/ac	228 A	0.48 E	1,449 A
149 lb N/ac	237 A	0.62 D	1,492 A
149+40 lb N/ac	238 A	0.79 C	1,482 A
189 lb N/ac	239 A	0.79 C	1,483 A
219 lb N/ac	241 A	0.89 B	1,488 A
219+40 lb N/ac	242 A	1.06 A	1,474 A
P-Value	<0.0001	<0.0001	0.0003

*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 $6.57/bu corn and $0.45/lb N.

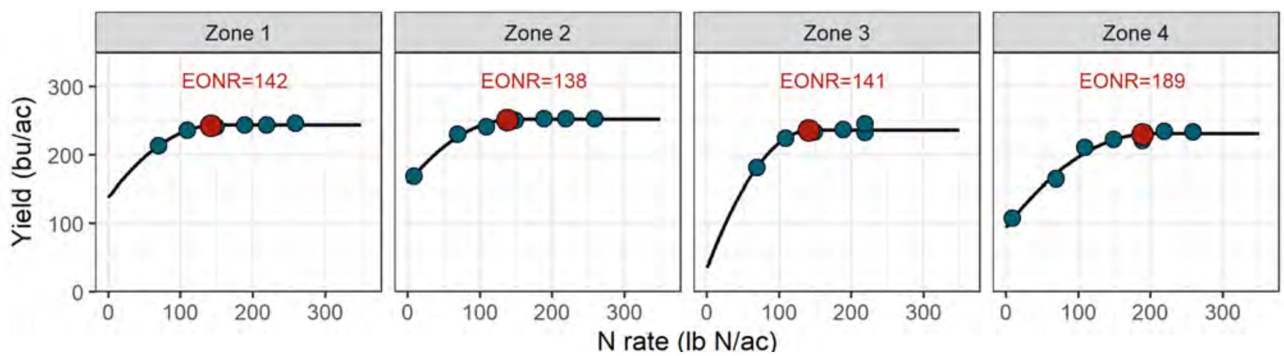


Figure 3. Corn yield by N rate for pre-plant N treatments. Economic optimum N rate is indicated with a red dot. Corn price is $6.57/bu and N fertilizer price is $0.45/lb.

Summary:

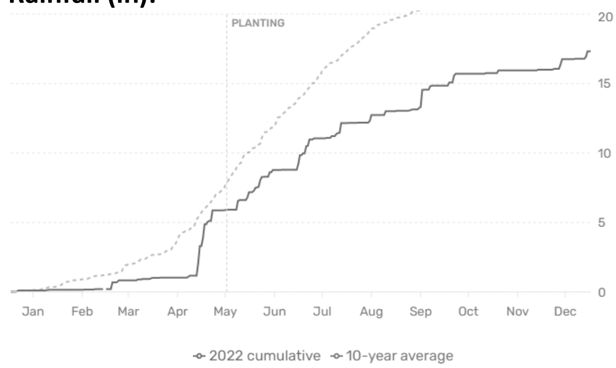
- The EONR varied by zone, ranging from 138 lb N/ac to 189 lb N/ac and resulting in yield at EONR ranging from 230 to 252 bu/ac.
- NUE at EONR ranged from 0.55 lb N/bu of grain in zone 2 to 0.82 lb N/bu of grain in zone 4.
- The small blocks that had no anhydrous ammonia applied (only 9 lb N/ac from 11-52-0 contribution) in zone 2 yielded 169 bu/ac and had an NUE of 0.05 lb N/bu grain. The small blocks in zone 4 yielded 108 bu/ac and had an NUE of 0.08 lb N/bu grain.
- The 149+40 lb N/ac sidedress treatment did not result in higher yields compared to the same rate (189 lb/ac treatment) applied entirely in the fall. Similarly, the 219+40 lb N/ac sidedress treatment did not result in additional yield over the 219 lb N/ac treatment.

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

Evaluating Adapt-N and Sensor-based In-season N Management on Irrigated Corn

Study ID: 1231079202201
County: Lincoln
Soil Type: Hersh fine sandy loam 3-6% slopes; Hersh-Valentine soils 6-11% slopes; Anselmo fine sandy loam 1-3% slope; Hord fine sandy loam 1-3% slope
Planting Date: 5/16/22
Harvest Date: 10/24/22, 10/31/22, 11/1/22
Seeding Rate: 31,500
Row Spacing (in): 30
Hybrid: Pioneer® P0622AM®
Reps: 4
Previous Crop: Corn
Tillage: Unknown
Seed Treatment: AML

Irrigation: Pivot, Total: 14.57"
Rainfall (in):



Baseline Soil Samples, 0-6" (5/17/2022):

	pH	BpH	OM LOI %	Melich-III P ppm	Nitrate – N ppm N	Bray P1 ppm	Sulfate-S ppm S	-------Melich III------- K	Ca	Mg	Na	CEC me/100g	Sand (%)	Silt (%)	Clay (%)
Zone 1	6.3	6.8	0.9	42	6.5	32	12	118	755	110	17	5.7	94	5	1
Zone 2	5.8	6.7	2.2	36	8.8	27	11	348	1348	204	18	11.6	68	21	11
Zone 3	6.1	6.8	1.5	64	7.2	49	9	146	794	108	13	6.2	90	9	1
Zone 4	5.4	6.7	1.4	100	4.4	76	11	148	699	59	14	6.2	84	15	1
Zone 5	5.6	6.8	1.1	140	6.2	106	17	153	640	49	18	5.4	96	3	1

Introduction: Nitrogen fertilizer is a significant input in corn systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. There are a number of digital agriculture tools available to provide site-specific, variable-rate, in-season N recommendations. This study evaluated two tools: 1) a crop canopy sensor-based N recommendation using the Trimble® GreenSeeker®; and 2) a crop model based N tool, Adapt-N by Yara North America Inc. The tools were compared to the grower's traditional N management.

All treatments received the following applications: 1) 1 ton/ac chicken litter (23.3 lb N/ac) applied in fall. 2) 40 lb N/ac as 32% UAN applied with planter on 5/16/22. 3) 20 lb N/ac as 32% UAN fertigated on 6/17/22. 4) 30 lb N/ac as 32% UAN on 6/28/22. 5) 7 lb N/ac thiosulfate fertigated on 7/26/22.

On July 15, 2022, a 32% UAN and molasses blend was applied via Y-drop. The grower's average rate applied 121 lb N/ac, sensor treatment received an average of 42 lb N/ac, and Adapt-N average rate was 63 lb N/ac (Figure 1).

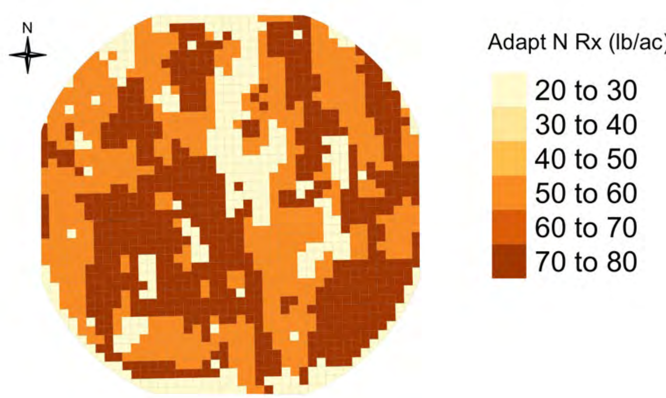


Figure 1. Adapt-N model variable-rate prescription.

Results and Summary:

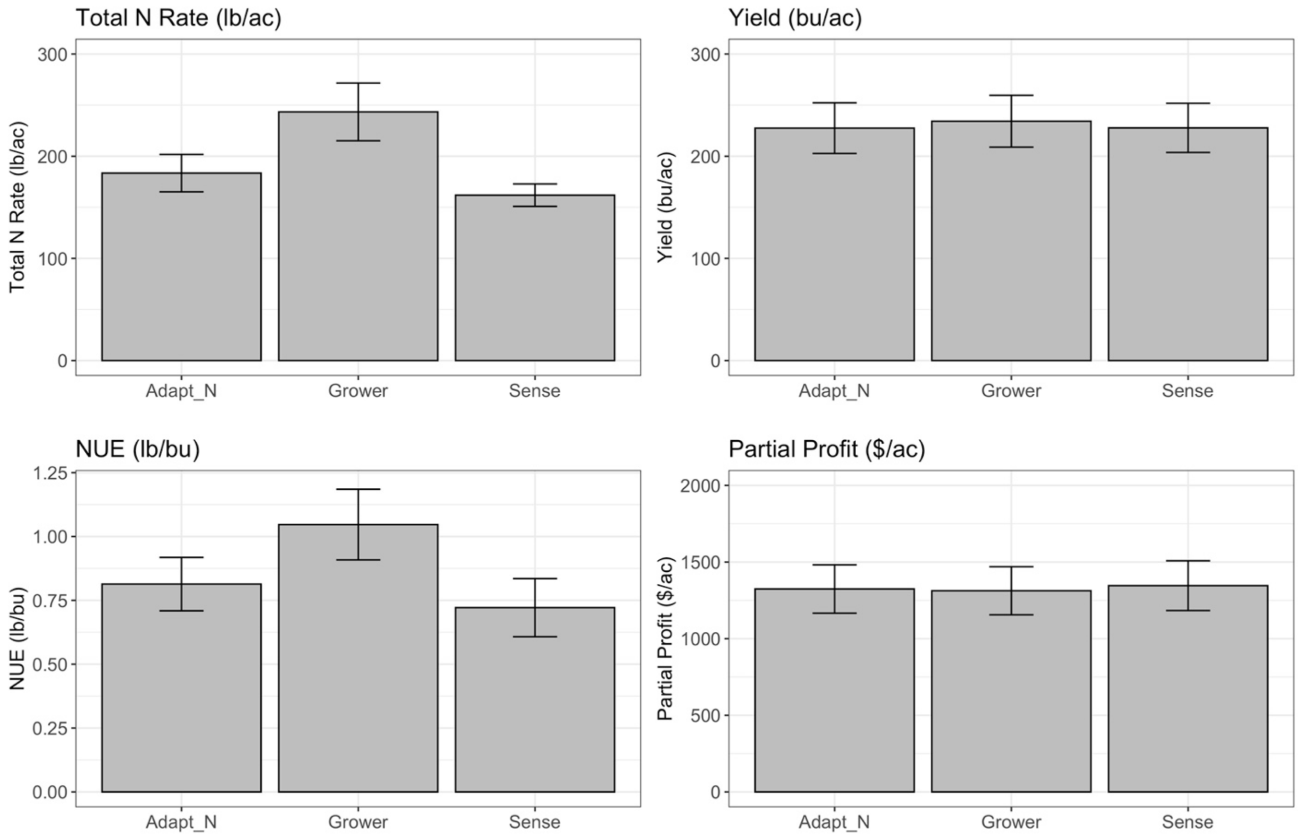


Figure 2. Total N rate, yield, nitrogen use efficiency (NUE), and partial profit for Adapt-N, grower's traditional management, and sensor-based N management.

	Total N rate (lb/ac)	Yield (bu/ac)†	Nitrogen Efficiency (lb N/bu grain)	Partial Profit‡ ($/ac)
Grower N Management	241 A	232 A	1.10 A	1301 B
Sense N Management	162 B	228 A	0.72 C	1349 A
Adapt-N Management	183 C	226 A	0.82 B	1318 AB
P-Value	<0.001	0.12	<0.001	0.04

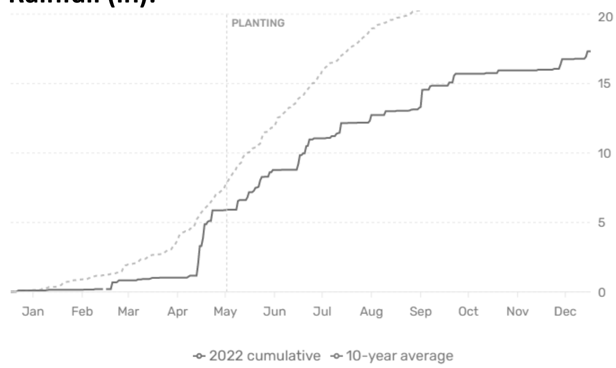
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $6.57/bu corn and $0.93/lb N fertilizer.

- The total N rate for the grower's traditional management was higher than OptRx® sensor-based N management and Adapt-N recommendation (Figure 2). The OptRx® sensor-based N and Adapt-N model used significantly less N (79 and 58 lb N/ac, respectively) than the grower's traditional management.
- Yield was not statistically different between the three treatments evaluated (Figure 2).
- Profitability was $48/ac higher for the OptRx® sensor-based N management compared to the grower's traditional management.
- The Adapt-N and sensor-based N management resulted in improved nitrogen use efficiency compared to the grower's traditional management. Nitrogen use efficiency was good for both sensor- and model-based N management, with all approaches averaging below the traditional 1.2 lb of N per bushel of grain assumed for yield-based N recommendations.

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

Evaluating Adapt-N Nitrogen Management on Irrigated Corn

Study ID: 1408143202301
County: Polk
Soil Type: Hastings silt loam 0-1% slope; Hastings silt loam 1-3% slope
Planting Date: 4/24/22
Harvest Date: 10/10/22
Seeding Rate: 34,000
Row Spacing (in): 30
Hybrid: DEKALB® DKC59-82 (east half) and DEKALB® DKC63-91 (west half)
Reps: 4
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** 24 oz/ac Roundup PowerMAX® 3 (not applied on NE corner) burndown on 4/22/22
Post: 2 oz/ac Balance® Flexx, Redlock AMS, and 2 qt/ac Degree Xtra® on 4/27/22; 22 oz/ac Roundup PowerMAX® 3, 1 pt/ac atrazine 4L, 8 oz/ac DiFlexx®, and 3 oz/ac Callisto® on 6/14/22
Foliar Insecticides: 6 oz/ac Bifenture® applied via helicopter on 7/18/22
Foliar Fungicides: 8 oz/ac Delaro® applied via helicopter on 7/18/22
Irrigation: Pivot, Total: 11.62"
Rainfall (in):



Baseline Soil Samples, 0-6" (May 11, 2022):

	pH	BpH	OM LOI %	Melich-III P ppm	Nitrate – N ppm N	Bray P1 ppm	Sulfate-S ppm S	-------Melich III------- K	Ca	Mg	Na	CEC me/100g	Sand (%)	Silt (%)	Clay (%)
Zone 1	6.4	6.8	3.2	29	7.5	22	13	304	1995	247	20	14.2	34	51	14
Zone 2	6.4	6.8	3	42	7.5	32	12	329	1872	265	27	13.7	34	45	20
Zone 3	6.2	6.7	4.1	88	9.8	67	12	335	2281	287	28	16.8	32	51	16

Introduction: Nitrogen fertilizer is a significant input in corn systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. There are several digital agriculture tools available to provide site-specific, variable-rate, in-season N recommendations. This study utilized Adapt-N from Yara International, a crop model-based N tool for in-season N application and compared it to the grower's typical N management. The whole field received:

1) 2 ton/ac chicken litter (57 lb N/ac) on 12/24/21
2) 30 lb/ac as 32% UAN on 4/22 and Kickoff starter fertilizer (3 lb N/ac) applied at planting on 4/24
3) 1.5 qt/ac Symbol® Release Plus and 5-0-0-2S-0.5B-2Mn-0.05Mo-2Zn on 6/14/22
4) 18 lb/ac as 32% UAN fertigated on 6/27/22
5) 30 lb/ac as 32% UAN fertigated on 7/3/22
6) 40 lb/ac as 32% UAN/thiosulfate fertigated on 7/10/22
7) 42 lb/ac as 32% UAN/thiosulfate fertigated on 7/12/22, and Redstar Elevate+ 30oz/ac applied with fungicide on 7/18.

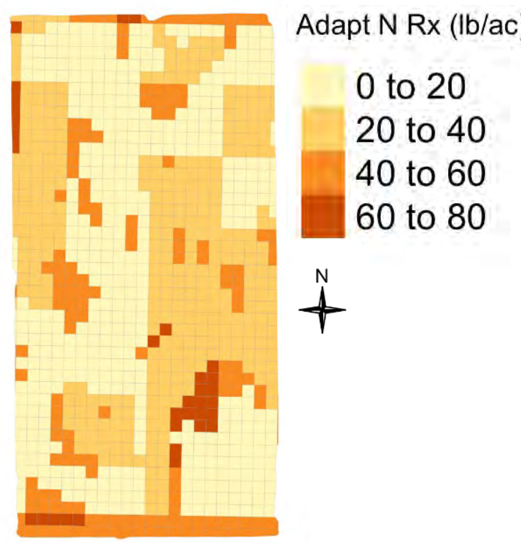


Figure 1. Adapt-N model in-season variable rate prescription.

Urea and monosmmonium phosphate (MAP) were topdressed on June 24. The MAP was flat rate and contributed 5.3 lb N/ac. The urea was variable-rate according to the Adapt-N recommendation and the grower's traditional management. The strips with the grower's traditional management received 40 lb N/ac flat rate. The strips with the Adapt-N management were applied variable-rate (Figure 1) and received 24 lb N/ac on average. An irrigation of 0.23" was applied within 12 hours following the urea application.

Results and Summary:

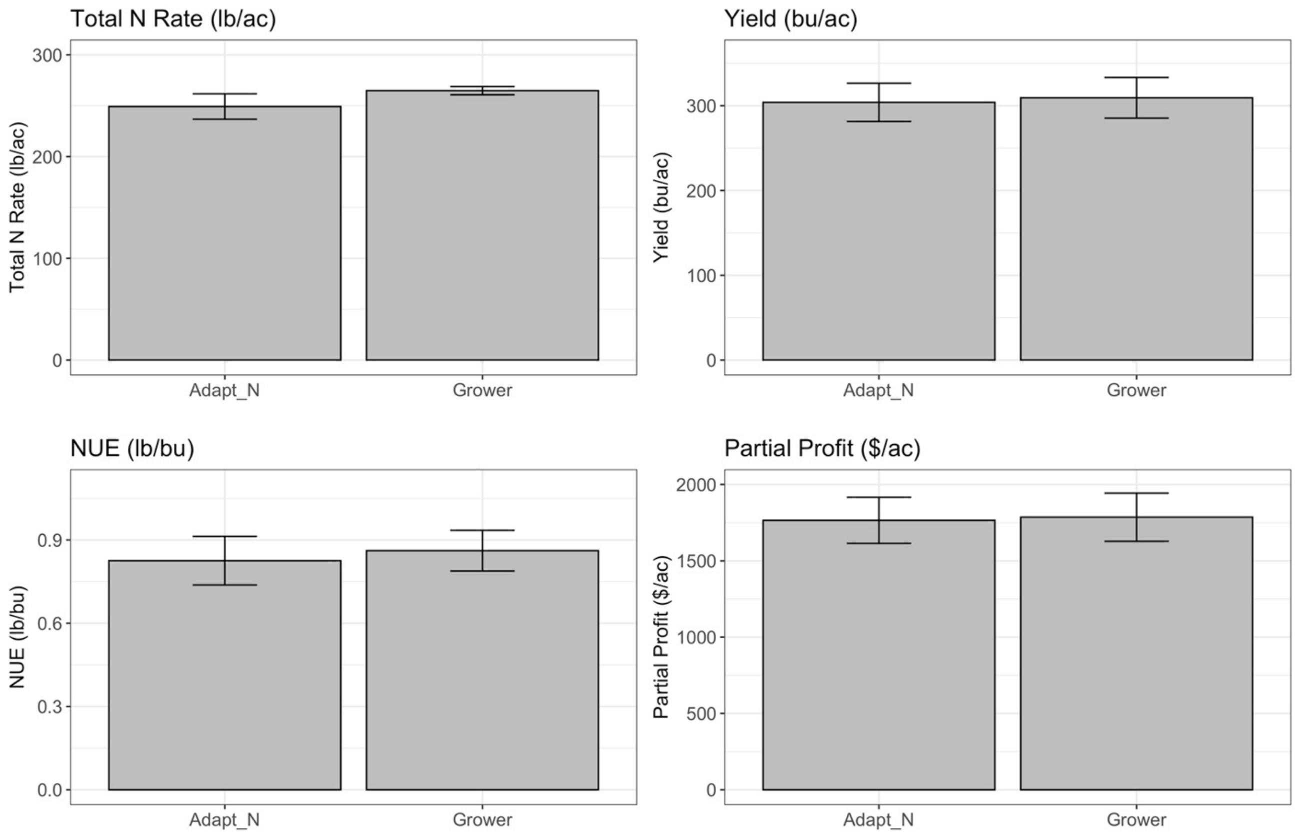


Figure 2. Total N rate, yield, nitrogen use efficiency (NUE), and partial profit for Adapt-N model and the grower's traditional management.

	Total N rate (lb/ac)	**Yield (bu/ac)†**	**Nitrogen Efficiency (lb N/bu grain)**	**Partial Profit‡ ($/ac)**
Grower N Management	265 A	309 A	0.86 A	1786 A
Adapt-N Management	249 B	304 A	0.83 B	1765 A
P-Value	<0.0001	0.439	0.1	0.688

*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 $6.57/bu corn and $0.93/lb N fertilizer.

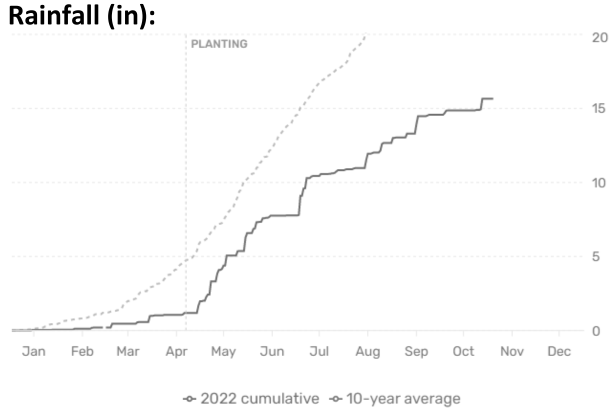
Summary:

- The total N rate for the grower's traditional management was 16 lb/ac higher than the Adapt-N model on average. In addition, the Adapt-N model distributed N applications site-specifically based on historic yield, soil texture, and elevation (Figure 1).
- Yield and profit were very similar between the grower's traditional management and the Adapt-N model on a whole-field basis.
- Nitrogen use efficiency was good for both approaches, below the traditional 1.2 lb of N per bushel of grain assumed for yield-based N recommendations. The Adapt-N model N management had better nitrogen use efficiency than grower's typical N management on a whole-field basis.

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

Evaluating Corteva Agriscience™ Granular Nitrogen Model on Irrigated Corn

Study ID: 1256139202201
County: Pierce
Soil Type: Crofton-Nora silt loam 6-11% slopes; Moody silty clay loam 2-6% slopes; Hord-Hobbs silt loam 0-6% slopes
Planting Date: 4/21/22
Harvest Date: 10/11/22
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P1185AM®
Reps: 17
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** 0.95 oz/ac Reviton® and 1.5 qt/ac Keystone® ***Post:*** 1.25 gal/ac Resicore® and 32 oz/ac Roundup®
Seed Treatment: Standard Pioneer® treatment
Foliar Insecticides: Sniper® applied via irrigation on 7/12/22
Foliar Fungicides: 6.8 oz/ac Aproach® Prima applied via irrigation on 7/12/22
Note: 5-15% wind damage (broken plants) on NE-facing slopes
Irrigation: Pivot
Rainfall (in):



Baseline Soil Samples, 0-6" (5/11/2022):

	pH	BpH	OM LOI %	Melich-III P ppm	Nitrate – N ppm N	Bray P1 ppm	Sulfate-S ppm S	-------Melich III------- K	Ca	Mg	Na	CEC me/100g	Sand (%)	Silt (%)	Clay (%)
Zone 1	6.7	6.9	0.8	64	2.4	49	9	143	978	152	10	6.9	92	5	2
Zone 2	6.3	6.84	2.4	42	7.2	32	8	89	1237	191	11	9	66	27	6
Zone 3	5.8	6.69	2.6	34	10.7	26	15	154	1504	264	20	12.6	48	43	8
Zone 4	8.1	6.93	2.8	22	17.2	17	11	182	4785	313	15	27.1	29	55	16
Zone 5	7.5	6.93	3.5	43	15	33	9	198	2371	324	12	15.1	33	49	18

Introduction: Nitrogen fertilizer is a significant input in corn systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. There are several digital agriculture tools available to provide site-specific, variable-rate, in-season N recommendations. This study evaluated a crop model-based N tool, Granular, a subsidiary of Corteva Agriscience™ company, and compared it to the grower's traditional N management. Nitrogen applications on the field included:

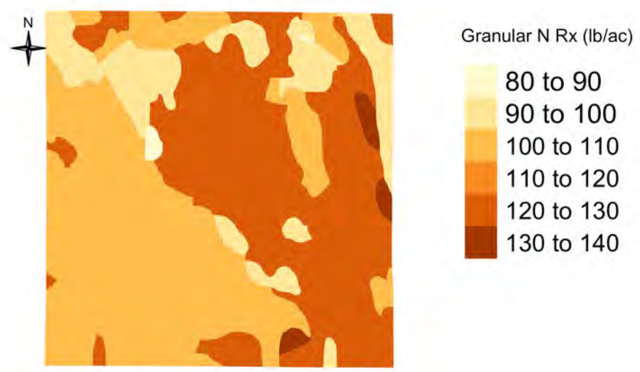


Figure 1. Corteva Agriscience™ Granular model variable rate prescription.

1) 120 lb/ac MAP (13.2 lb N credit) applied in the fall
2) 35 lb N/ac applied as 32% UAN with planter on 5/14/22
3) 20 lb N/ac as 32% UAN and thiosulfate blend fertigated on 6/28/22
4) 20 lb N/ac as 32% UAN fertigated on 7/7/22.

On June 9, 2022, sidedress was applied as a blend of 95% 32% UAN and 5% thiosulfate. For the grower's traditional management, 102 lb N/ac was applied in a flat rate. For the Granular N management, a variable-rate prescription was used (Figure 1), which averaged 114 lb N/ac.

As-applied fertilizer maps were used to evaluate the accuracy of fertilizer application, and yield monitor data were used to analyze differences between treatments.

Results and Summary:

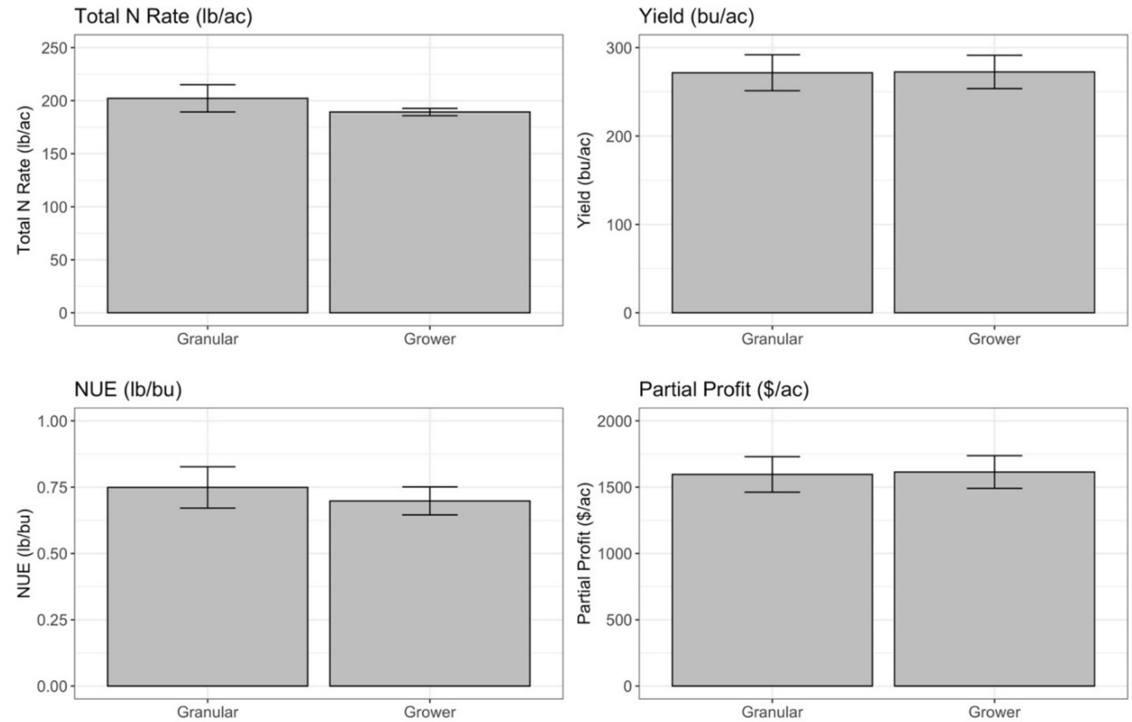


Figure 2. Total N rate, yield, nitrogen use efficiency (NUE), and partial profit for Corteva Agriscience™ Granular model and the grower's traditional management.

	Total N rate (lb/ac)	Yield (bu/ac)†	Nitrogen Efficiency (lb N/bu grain)	Partial Profit‡ ($/ac)
Grower N Management	190 B	272 A	0.70 B	1612 A
Granular N Management	202 A	269 A	0.76 A	1580 B
P-Value	0.001	0.117	0.001	0.018

*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 $6.57/bu corn and $0.93/lb N fertilizer.

- The total N rate for the grower's traditional management was 12 lb/ac lower than the Granular model on average; however, the Granular model distributed N applications site-specifically based on historic yield, soil texture, and elevation (Figure 1).
- Yield was very similar between the grower's traditional management and the Granular model on a whole-field basis.
- Profit was $32/ac greater for the grower's traditional management compared to the Granular model.
- Nitrogen use efficiency was good for both approaches, below the traditional 1.2 lb of N per bushel of grain assumed for yield-based N recommendations. The grower's typical N management had better nitrogen use efficiency than the Granular model.

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

NEBRASKA EXTENSION
FARMBITS PODCAST

GRANULAR GUIDANCE FOR N MANAGEMENT

Bob Gunzenhauser, Corteva

This episode features Bob Gunzenhauser, research scientist at Corteva Agriscience™. Bob describes the Granular model and discusses the future of nitrogen modeling.

SENSOR-BASED NITROGEN FERTIGATION

KEY TAKEAWAYS AND OUTCOMES

- A new technique of using sensors to inform fertigation timing known as **sensor-based fertigation management (SBFM)** has been developed and tested against current grower fertigation practices.
- The SBFM approach resulted in **better nitrogen use efficiency (NUE) in 100% of the test sites** when compared to the growers' approach.
- At current corn and N prices ($6.80/bu & $0.80/lb-N), the recommended **SBFM approaches (RAP and RAP-IR) increased profitability by $23/ac on average compared to grower practices!**

STUDY OVERVIEW

From 2019-2022, growers participating in the Nebraska On-Farm Research Network experimented with using imagery to direct responsive nitrogen (N) application to corn through *fertigation* - application of fertilizer through an irrigation system; the new technique is known as sensor-based fertigation management (SBFM). 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; however, no such technology existed to couple imagery-based decision support tools with fertigation management. There were five sites in 2019, five sites in 2020, four sites in 2021, and four sites in 2022; three of these sites were repeated in multiple years (Figure 1) where current grower fertigation management was compared to the SBFM approach.

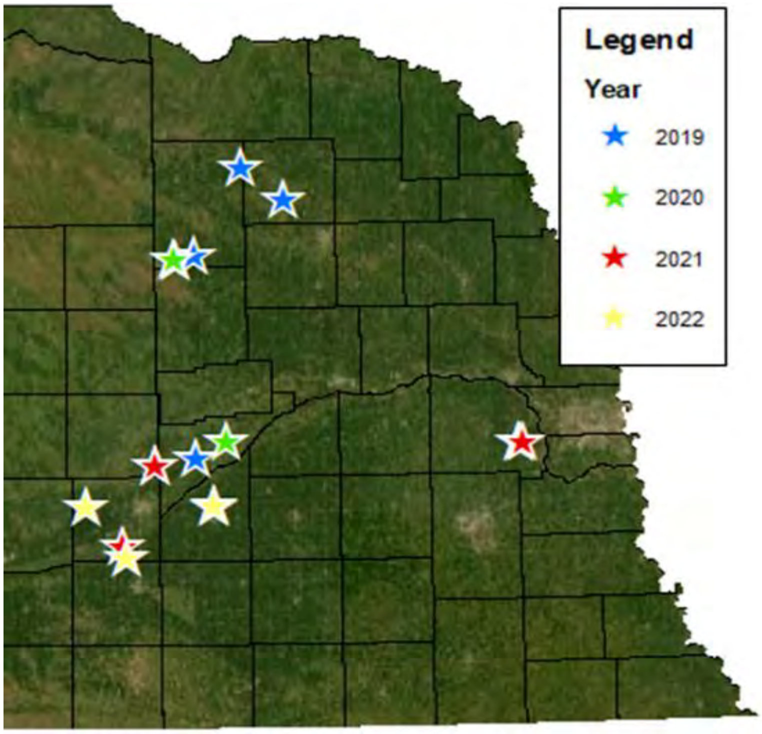


Figure 1: SBFM research site locations. Duplicate and close-proximity site locations are non-distinguishable.

MANAGING VARIABILITY WITH DRONE-BASED SENSORS

Nitrogen needs vary 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 red edge (NDRE) index to be calculated. This vegetation index is correlated with crop biomass and N status, and therefore can inform growers about the crop 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).

Figure 3. Center-pivot system equipped with a variable rate fertilizer injection pump.

STUDY DESIGN

The experiments were arranged in a randomized complete block design with four replications of three treatments. Treatments were applied in 15° sectors on half of a quarter section under pivot irrigation. Figure 4 shows a typical field layout from a study conducted in 2022 where three treatments are grouped into a block for the study design, each block replicated four times. 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-N/ac less than the bulk sector rate and reference plots received at least 30 lb-N/ac more than the bulk sector rate. Indicator blocks were established in each management zone represented in a sector since 2020.

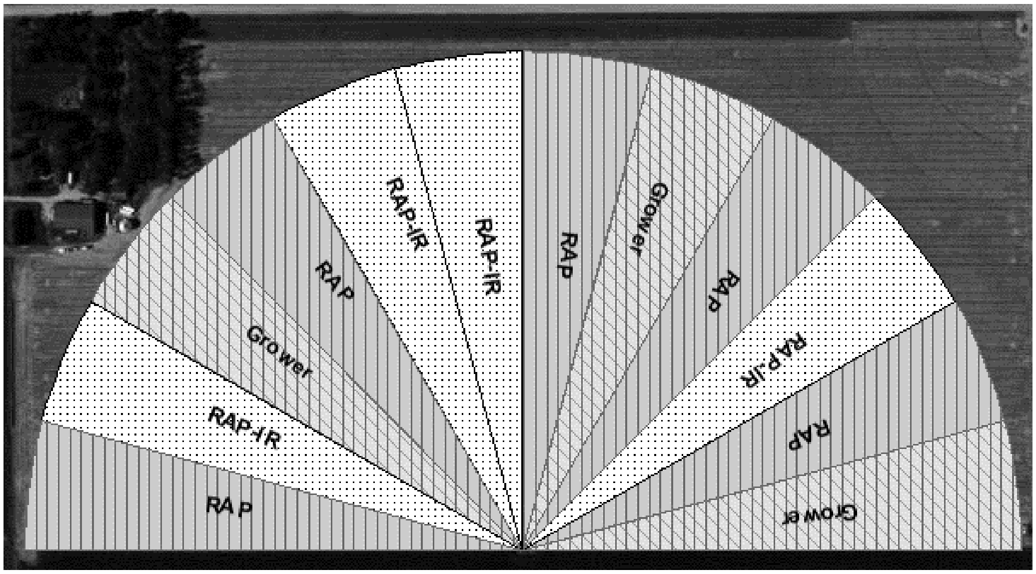


Figure 4. Representative experimental design for 2020 and 2021 with four replications of three treatments (grower's traditional management and the constrained and full-season sensor-based management approaches) arranged in sectors.

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 of a given sector suggested that an N application was needed, fertigation was initiated at a rate of 30 lb-N/ac (or 60 lb-N/ac, depending on the SBFM approach). 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 of 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-rate fertilizer injection pump that injected liquid fertilizer into the irrigation water to fertigate the corn through the center-pivot irrigation system (Figure 3). This allowed each sector to be managed independently for N applications.

Consecutive fertigation applications were not allowed to occur based on imagery captured within 8 days of a previous fertigation application to allow the crop enough time to take up and incorporate applied nitrogen, thereby reducing the risk of excess fertilizer applications. Fertigation applications were allowed to occur up to the R3 growth stage (or R4, depending on the SBFM approach) as observed at the time of image capture. 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. Comprehensively, this method is referred to as sensor-based fertigation management (SBFM). A visual summary of SBFM implementation is presented in Figure 5.

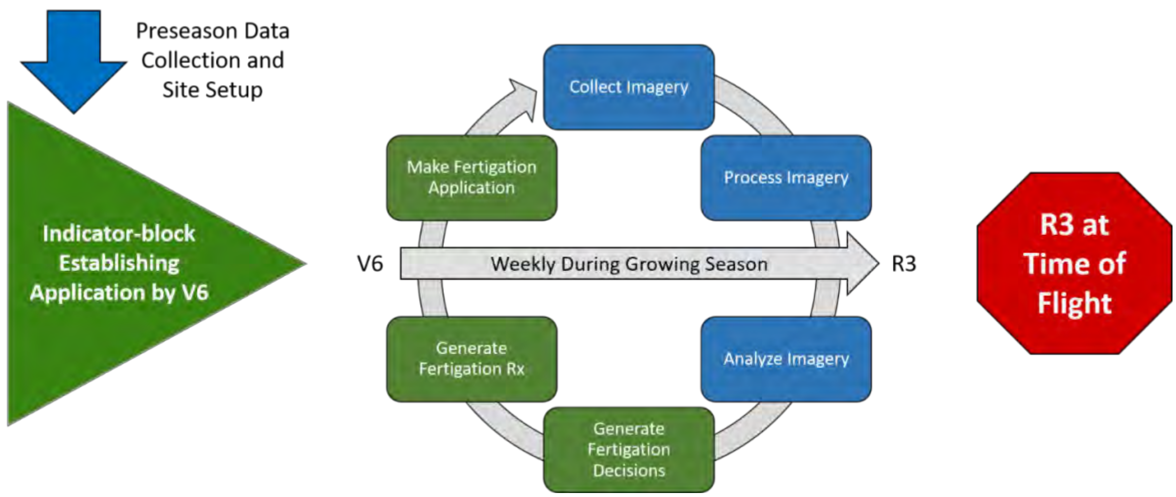


Figure 5. Visual summary of SBFM implementation.

SBFM APPROACHES DEPLOYED AND TESTED

Since 2019, the approaches for SBFM have evolved as new methods for control logic were developed and incorporated into field studies. Initial SBFM approaches limited our control of fertigation events until N applications were within 60 lb-N of the growers' total planned N rate (these were known as 'constrained' approaches). This essentially limited the ability of the SBFM to fully take advantage of the sensor-based approaches the team was promoting. Thus, new SBFM approaches (typically known as 'post-establishment') were created to control of fertigation events beginning at the V6 growth stage.

For the purposes of this summary document, we will focus on the three more recently developed 'post-establishment' treatments: risk-averse post-establishment (RAP), RAP-R4 (fertigation events could be applied up to R4), and RAP-IR (Increased Rate; where 60 lb-N/ac applied between V9-V14). A comprehensive summary of all SBFM approaches is contained in the final report section "Additional SBFM Approach Information." It should be noted that applying N after R3 was not show to be effective at improving NUE or yields, thus RAP and RAP-IR techniques would be suggested approaches. Figure 9 (end of report) illustrates why these more recent approaches were developed and further tested.

DATA ANALYSIS

Yield for the plots were recorded with calibrated yield monitors. Following harvest, yield data was post-processed using the USDA Yield Editor software to remove erroneous data points, then the average yield from each sector was computed. 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 from 2020 through 2022 have been compiled and summarized; SBFM approaches were 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' PFP differences versus MNR differences compared with typical grower management at that site. Values to the right of the y-axis indicate that the SBFM approach was more efficient than typical grower management, whereas values left of the y-axis indicate that SBFM was less efficient than typical grower management. Similarly, points above the x-axis indicate that SBFM was more profitable than typical grower management, whereas points below the x-axis indicate that SBFM was less profitable than typical grower management. SBFM sites both more profitable and more efficient than typical grower management are in the upper right-hand quadrant.

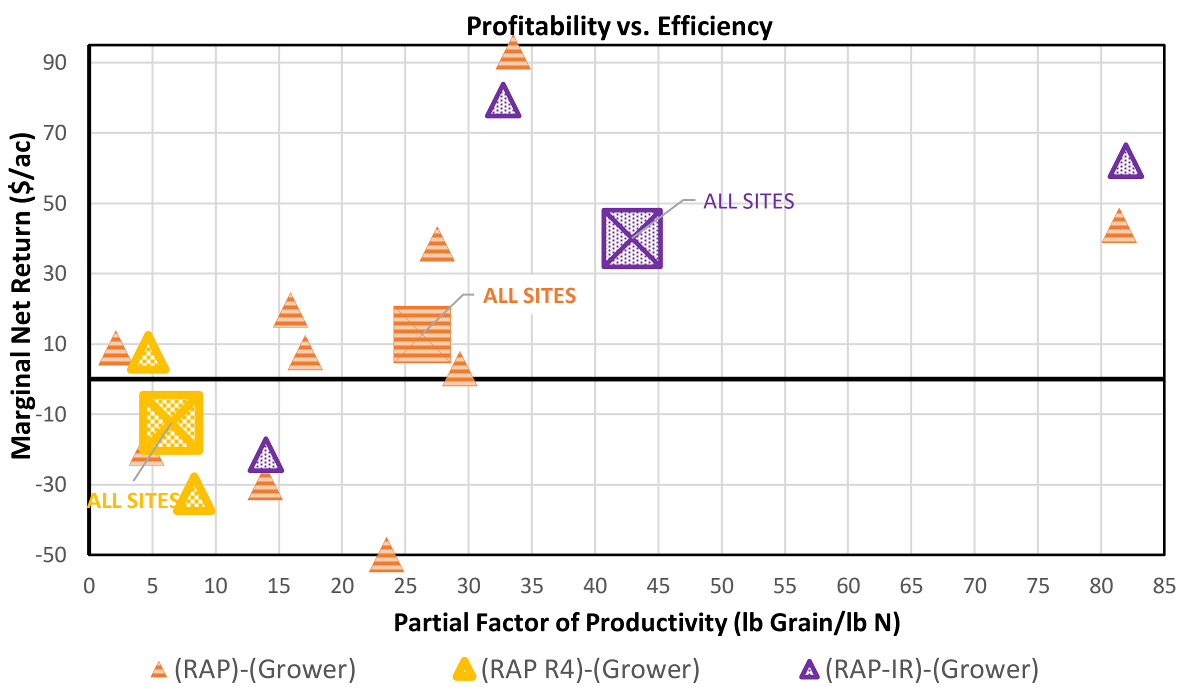


Figure 6. Profitability* (y-axis) versus efficiency (x-axis) differences by site for sensor-based fertigation- management treatments compared with traditional grower management. Large squares indicate treatment averages across three years; only sites with a grower management treatment are included. **Corn prices of ($3.51, $5.20 & $6.80 per bushel) and N prices ($0.41, $0.4 & $0.80 per lb-N) years 2020, 2021 & 2022, respectively)*

This distribution (Figure 6) shows that 100% of the RAP-based SBFM treatment instances across all sites were more efficient than typical N grower management. Most notably, RAP and RAP-IR treatments increased grain produced per lb-N by over 26 lb-grain/lb-N compared to the growers. Average treatment outcome differences versus traditional grower management are directly quantified in Figure 7 with the RAP and RAP-IR approaches showing great potential for increased profitability with increases ranging from $12.68/ac to just over $40/ac.

It should be noted that if the RAP and RAP-IR sites prior to 2022 utilized current (2022-2023) corn and N prices ($6.80/bu and $0.80/lb-N), two-thirds of the sites would be more profitable; with increased profitability averaging just over $23/ac!

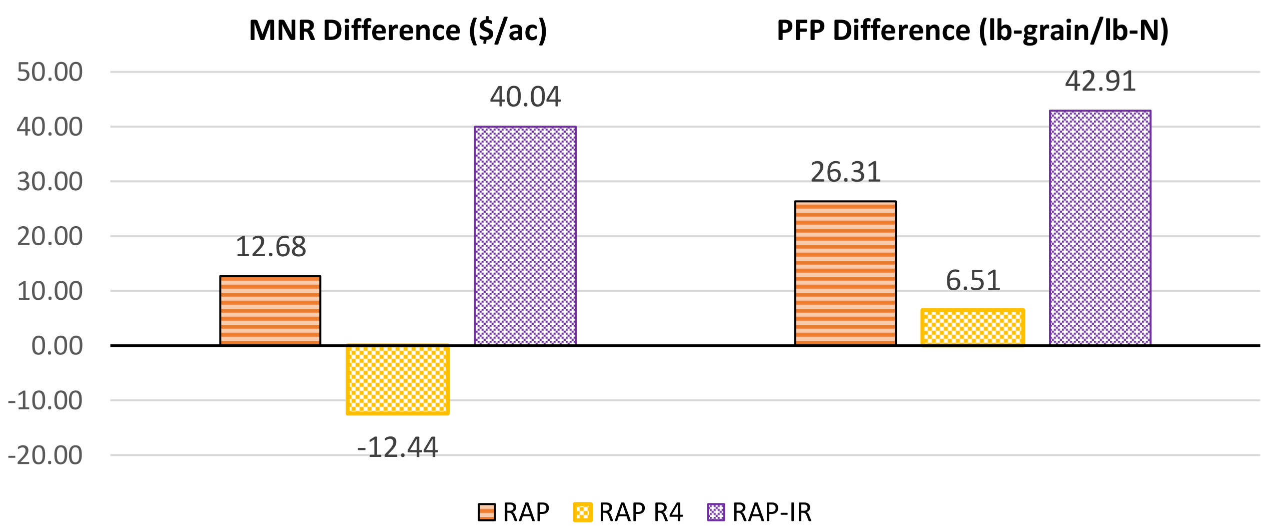


Figure 7. Average profitability* and efficiency differences between SBFM approaches and typical grower management. **Corn prices of ($3.51, $5.20 & $6.80 per bushel) and N prices ($0.41, $0.4 & $0.80 per lb-N) years 2020, 2021 & 2022, respectively)*

CONCLUSIONS

A couple conclusions can be drawn from the comprehensive dataset compiled over the past four years. First, SBFM is likely to substantially improve NUE versus typical grower management. 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 currently following best practices. Second, implementing the RAP approaches appears to offer significant likelihood of improved profitability. Initial results do not indicate any appreciable benefit to extending the application window to the R4 growth stage.

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

CPNRD Central Platte Natural Resources District

NEBRASKA EXTENSION
FARMBITS PODCAST

SENTINEL SOLUTIONS

Jackson Stansell, Founder & CEO

Sentinel Fertigation is a new startup utilizing satellite imagery to help farmers better manage N through fertigation. Jackson Stansell shares about taking his research done at the University of Nebraska-Lincoln and developing a commercial decision-making support software to increase nitrogen use efficiency.

ADDITIONAL SBFM APPROACH

In 2019, treatments investigated were the grower's traditional N management, a constrained risk-averse SBFM approach (RAC), and a constrained risk-tolerant SBFM approach (RTC) as shown in Figure 8. RAC and RTC treatments differed only in the amount of measured 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 the 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. Both RAC and RTC treatments were implemented to make fertigation decisions only once the applied N for the season was within 60 lb-N/ac of the grower's intended total applied N.

Three additional treatments were included in some of the 2021 on-farm research trials: risk-averse constrained R4 (RAC R4), risk-averse post-establishment R4 (RAP R4), and risk-averse post-establishment increased rate (RAP IR). RAC R4 followed the same implementation as the RAC treatment except that the fertigation application window was extended to observation of the R4 growth stage instead of the R3 growth stage at the time of image capture. Similarly, RAP R4 followed the same implementation as the RAP treatment except with an extended fertigation application window to the R4 growth stage at the time of image capture. Finally, RAP IR followed the same implementation as the RAP treatment except that any fertigation application triggered between the V9 and V14 growth stages was made at a rate of 60 lb-N/ac rather than the typical rate of 30 lb-N/ac. In 2022, a continuation of testing took place regarding the RAP IR treatment as well as the RAP treatment specifications are outlined in Table 1 and treatment implementation constraints are depicted in Figure 8.

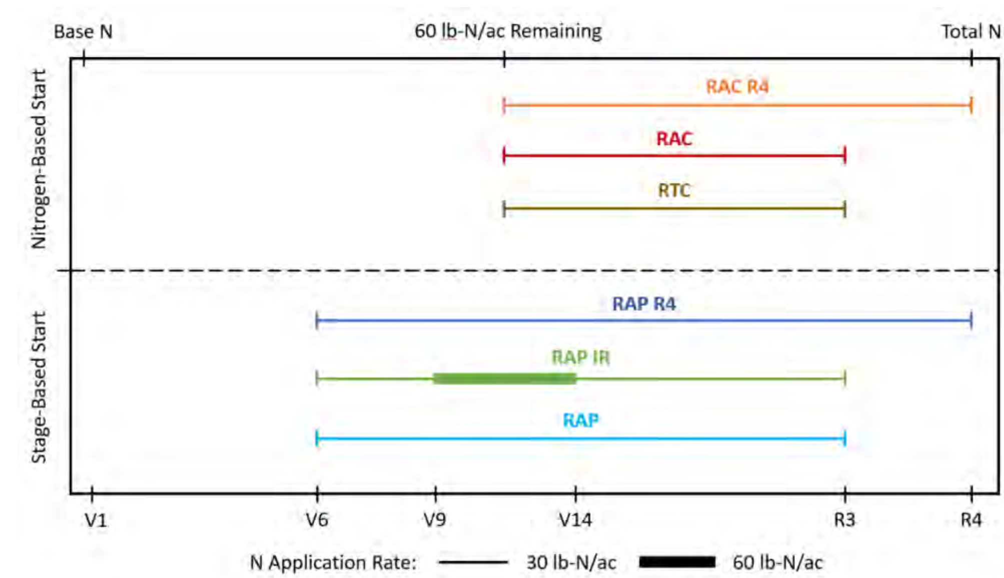


Figure 8. Timeline summary of treatment types indicating at what point in the growing season SBFM began controlling fertigation applications, the application rate of fertigation applications by growth stage, and the growth stage at which no further fertigation applications were made. RTC, RAC, and RAC R4 treatments all assumed control of fertigation applications when there were 60 lb-N/ac remaining relative to the grower's planned total N rate. RAP, RAP IR, and RAP R4 all began as early as the V6 growth stage and controlled all fertigation applications after indicator block establishment. For all treatments, no fertigation applications were allowed once a certain growth stage was observed.

Table 1. Summary table of SBFM treatments investigated between 2019 and 2022. Key attributes of initiation condition, fertigation application rate, and termination condition are provided for each treatment type. Treatments included in 2022 are highlighted in gray.

Treatment	Acronym	Years	Condition to Initiate Fertigation Applications	Fertigation Application Rate	Termination Growth Stage
Risk-Averse Constrained	RAC	2019-2021	Last 60 lb N ac^{-1}	30 lb-N/ac	R3
Risk-Tolerant Constrained	RTC	2019	Last 60 lb N ac^{-1}	30 lb-N/ac	R3
Risk-Averse Post-Establishment	RAP	2020-2022	At V6 (10 days post-est.)	30 lb-N/ac	R3
Risk-Averse Constrained R4	RAC R4	2021	Last 60 lb N ac^{-1}	30 lb-N/ac	R4
Risk-Averse Post-Establishment R4	RAP R4	2021	At V6 (10 days post-est.)	30 lb-N/ac	R4
Risk-Averse Post-Establishment Increased Rate	RAP IR	2021-2022	At V6 (10 days post-est.)	60 lb-N/ac for V9-V14, 30 lb-N/ac otherwise	R3

Figure 9 illustrates the average NUE values per site across all years and fertigation approaches tested where the growers' NUEs averaged 0.92. This helps to understand the trend in SBFM approaches as well, while the 'constrained' approaches did improve NUE compared to the growers', the project team noticed potential improvements, thus the 'post-establishment' approaches were created to manage more during the growing season. Improvements in NUE were significant using these approaches. *NOTE: the data below contains additional RAP and RAP-IR sites from the ENREEC research farm, where no grower comparisons were obtained.*

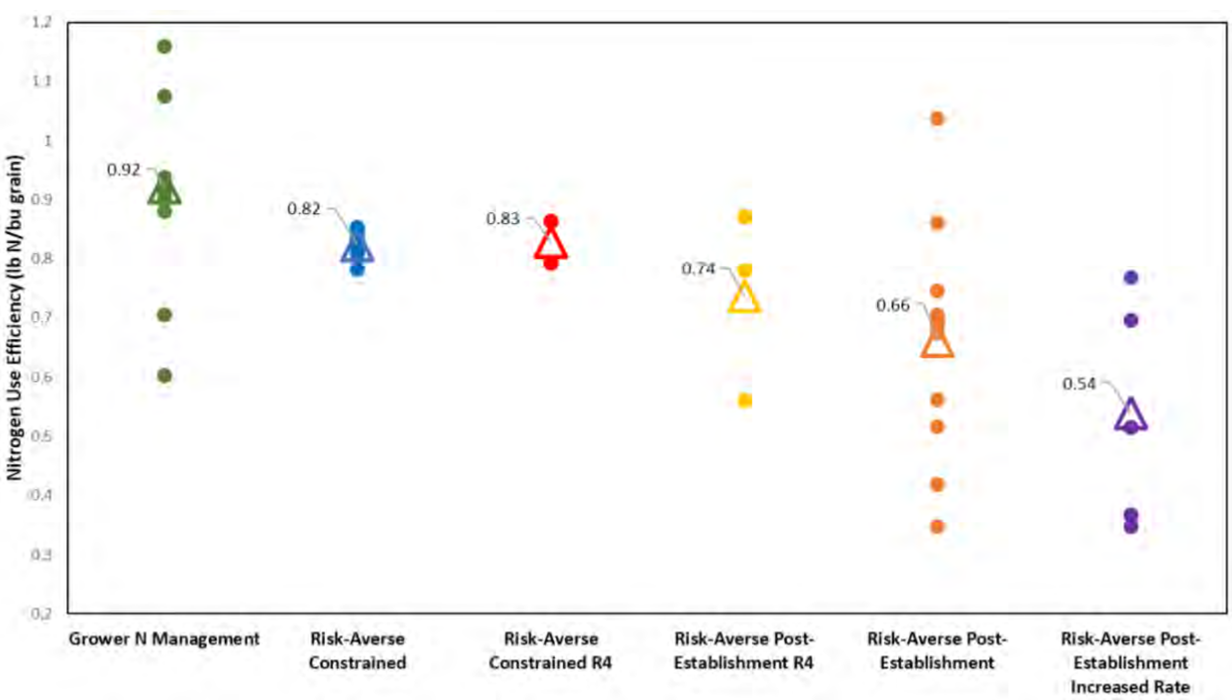
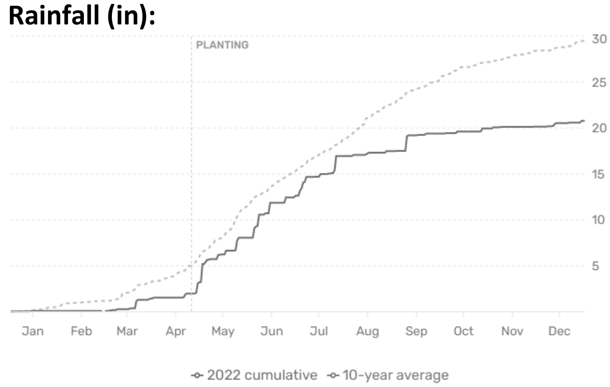


Figure 9. Illustration of NUE estimates (does not include irrigation water N contributions) among fertigation practices tested with average NUE values (shaded triangles) for each.

Sensor-Based Nitrogen Fertigation Management

Study ID: 0817081202301
County: Hamilton
Soil Type: Crete silt loam 0-1% slope; Hastings silt loam 0-1% slope; Hastings silt loam 1-3% slope; Hastings silty clay loam 3-7% slopes, eroded; Fillmore silt loam 0-1% slope
Planting Date: 4/25/22
Harvest Date: 10/14/22
Seeding Rate: 32,400
Row Spacing (in): 30
Hybrid: Pioneer® P1185Q™
Reps: 8
Previous Crop: Corn
Tillage: Ridge-till
Herbicides: ***Pre:*** 1.5 qt/ac Resicore®, 32 z/ac glyphosate, and 1 qt/ac atrazine 4L on 4/27/22
Post: 1.5 qt/ac Resicore®, 32 oz/ac glyphosate, and 1 qt/ac atrazine 4L on 6/10/22
Seed Treatment: LumiGEN™ and Lumisure™ 1250
Foliar Insecticides: 5 oz/ac Hero® applied aerially on 7/18/22
Foliar Fungicides: 7 oz/ac Veltyma® applied aerially on 7/18/22
Note: The field was hail damaged on 6/5 and 6/7 at the V6 growth stage
Irrigation: Pivot, Total: 10.7"
Rainfall (in):



Introduction: Corn nitrogen management may be improved by using sensors or imagery to detect and respond to corn nitrogen needs 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 or 60 lb/ac was triggered. This study compared the grower's standard management with two reactive, sensor-based fertigation approaches as follows:

Grower Management: Cooperating grower made the fertigation management decisions for this treatment throughout the growing season

Risk-Averse Post-Establishment (RAP): Fertigation application decisions were made based on decision logic and analytics applied to aerial imagery from the V6 growth stage to the R3 growth stage.

Risk-Averse Post-Establishment Increased-Rate (RAP-IR): Fertigation application decisions were made based on decision logic and analytics applied to aerial imagery from the V6 growth stage to the R3 growth stage with application rate increased from 30 lb N/ac to 60 lb N/ac for any fertigation applications recommended between V9 and V14.

Application Table: Unless otherwise noted, N was applied using 32% UAN. Gray shaded area to the right of the striped line indicates where sensor-based management dictated N rates. The applied values are averages across all four reps; therefore, if only one out of four replications triggered an application of 30 lb N/ac, a value of 7.5 lb N/ac is reported as the average treatment N application.

	4/5	4/25	4/27	6/24	6/29	7/13	7/20	7/29	Total N Applied
Treatment	----------------	----------------	*lb N/ac applied*	----------------					
Grower	90 [a]	5.8[b]	35.5[c]	-	35.5	35.5	-	17.8	**221**
RAP	90 [a]	5.8[b]	35.5[c]	-	-	-	3.75	15	**150**
RAP-IR	90[a]	5.8[b]	35.5[c]	22.5	7.5	-	7.5	7.5	**177**

[a] Product used was anhydrous ammonia
[b] Product used was 10-34-0 at planting
[c] Product used was 32-0-0 via high clearance applicator

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lb N/ bu grain	Marginal Net Return‡ ($/ac)
Grower	221 A*	14.0 A	238 A	61 B	0.93 B	1,443 A
RAP	150 C	13.9 A	223 B	84 A	0.68 A	1,394 A
RAP-IR	177 B	13.9 A	230 AB	74 A	0.77 A	1,422 A
P-Value	<0.0001	0.861	0.009	0.0007	0.0002	0.262

*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 $6.80/bu corn and $0.80/lb N.

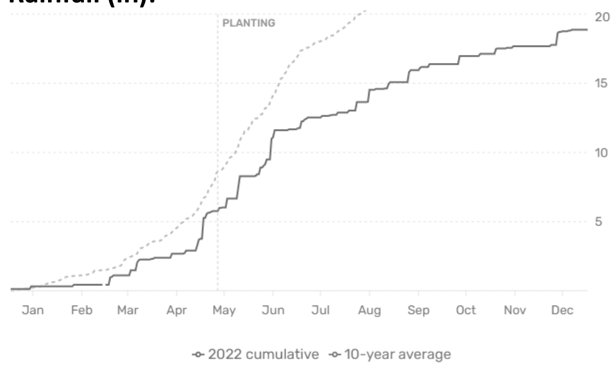
Summary:

- The RAP-IR resulted in a 44 lb/ac decrease in N compared to the grower's management. The RAP treatment resulted in a 71 lb/ac decrease in N compared to the grower's management.
- The RAP approach resulted in a 16 bu/ac decrease in yield compared to the grower's management. The RAP-IR treatment had a yield that was not statistically different from the RAP treatment or the grower's management.
- Nitrogen use efficiency was statistically improved for both sensor-based management treatments compared to the grower's N management.
- Marginal net return was not significantly different among the treatments.
- While the RAP treatment had greater N efficiency, it resulted in a decrease in yield. In comparison, the RAP-IR was able to achieve greater N efficiency while not resulting in a statistical yield reduction compared to the grower's management.

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

Sensor-Based Nitrogen Fertigation Management

Study ID: 1171155202201
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; Fillmore silt loam terrace, occasionally ponded
Planting Date: 5/11/22
Harvest Date: 10/17/22
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: DEKALB® DKC63-91
Reps: 4
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** 15.4 oz/ac atrazine 4L, 7.7 oz/ac DiFlexx®, 17.3 oz/ac Verdict®, 15.4 oz/ac Roundup PowerMAX® 3, 1.4 lb/ac AMS, and 18.7 MSO on 6/7/22 ***Post:*** 3 oz/ac Laudis®, 15.7 oz/ac atrazine 4L, 9.5 oz/ac Superb® HC and 1.4 lb/ac AMS
Seed Treatment: None
Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: Pivot, Total: 13.25"
Rainfall (in):



Introduction: Corn nitrogen management may be improved by using sensors or imagery to detect and respond to corn nitrogen needs 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 or 60 lb/ac was triggered. This study compared the two reactive, sensor-based fertigation approaches as follows:

Risk-Averse Post-Establishment (RAP): Fertigation application decisions were made based on decision logic and analytics applied to aerial imagery from the V6 growth stage to the R3 growth stage.

Risk-Averse Post-Establishment Increased-Rate (RAP-IR): Fertigation application decisions were made based on decision logic and analytics applied to aerial imagery from the V6 growth stage to the R3 growth stage with application rate increased from 30 lb N/ac to 60 lb N/ac for any fertigation applications recommended between V9 and V14.

Application Table: Unless otherwise noted, N was applied using 32% UAN. Gray shaded area to the right of the striped line indicates where sensor-based management dictated N rates. The applied values are averages across all four reps; therefore, if only one out of four replications triggered an application of 30 lb N/ac, a value of 7.5 lb N/ac is reported as the average treatment N application.

	6/2	7/1	7/8	7/12	7/26	Total N Applied
Treatment	--------------------*lb N/ac applied*--------------------					
RAP	33[a]	30	-	22.5	22.5	**108**
RAP-IR	33[a]	45	15	7.5	-	**101**

[a] Product used was 32-0-0 via high-clearance applicator

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lb N/ bu grain	Marginal Net Return‡ ($/ac)
RAP	108 A*	15.0 A	258 B	146 A	0.42 A	1,670 B
RAP-IR	101 A	16.1 A	274 A	155 A	0.37 A	1,784 A
P-Value	0.638	0.155	0.004	0.761	0.426	0.015

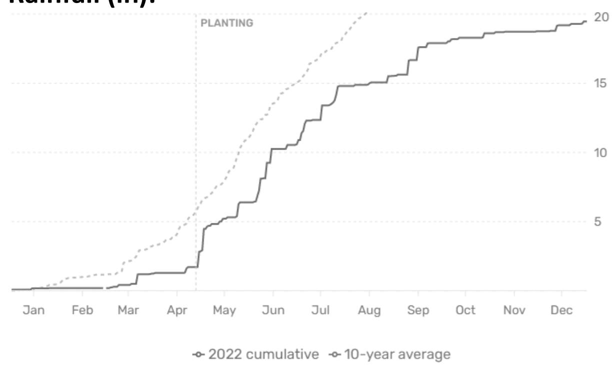
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $6.80/bu corn and $0.80/lb N.

Summary:

- Total N rate applied was very similar (within 7 lb N/ac) between the two sensor-based approaches evaluated. Rates during the V9 to V14 growth stages are doubled for the RAP-IR approach compared to the RAP approach, resulting in the RAP-IR having more N fertilizer applied earlier in the season compared to the RAP treatment.
- The RAP-IR approach resulted in an increase of 16 bu/ac compared to the RAP approach, which may be due to the earlier timing of N fertilizer application.
- There were no differences in nitrogen efficiency between the treatments.
- The RAP-IR treatment resulted in an increase in net return of $114/ac compared to the RAP treatment.

Sensor-Based Nitrogen Fertigation Management

Study ID: 1260079202201
County: Hall
Soil Type: Holder loam 0-3% slope; Holder loam 0-3% slopes, overblown
Planting Date: 4/27/22
Harvest Date: 10/16/22
Seeding Rate: 32,000
Row Spacing (in): 36
Hybrid: Pioneer® P1185AM
Reps: 4
Previous Crop: Corn
Tillage: Conventional + strip-till
Herbicides: ***Post:*** 1.5 qt/ac Resicore®, 1 qt/ac atrazine, 1 qt/ac Roundup®, and 8 oz/ac DiFlexx® on 5/18/22. 1 qt/ac Warrant® Ultra and 22 oz/ac Roundup® on 6/27/22
Seed Treatment: None
Foliar Insecticides: 8 oz/ac Index® during planting on 4/27/22. 6 oz/ac bifenthrin on 7/20/22
Foliar Fungicides: 12 oz/ac Quilt Xcel® on 7/20/22
Note: Hail damage on 6/7 at the V6 growth stage
Irrigation: Pivot, Total: 9.0”
Rainfall (in):



Introduction: Corn nitrogen management may be improved by using sensors or imagery to detect and respond to corn nitrogen needs 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 or 60 lb/ac was triggered. This study compared the grower’s standard management with two reactive, sensor-based fertigation approaches as follows:

Grower Management: Cooperating grower made the fertigation management decisions for this treatment throughout the growing season.

Risk-Averse Post-Establishment (RAP): Fertigation application decisions were made based on decision logic and analytics applied to aerial imagery from the V6 growth stage to the R3 growth stage.

Risk-Averse Post-Establishment Increased-Rate (RAP-IR): Fertigation application decisions were made based on decision logic and analytics applied to aerial imagery from the V6 growth stage to the R3 growth stage with application rate increased from 30 lb N/ac to 60 lb N/ac for any fertigation applications recommended between V9 and V14.

Application Table: Unless otherwise noted, N was applied using 32% UAN. Gray shaded area to the right of the striped line indicates where sensor-based management dictated N rates. The applied values are averages across all four reps; therefore, if only one out of four replications triggered an application of 30 lb N/ac, a value of 7.5 lb N/ac is reported as the average treatment N application across reps.

	4/5	4/9	4/9	4/27	6/24	7/8	7/13	Total N Applied
Treatment	-------------------------------*lb N/ac applied*-------------------------------							
Grower	125 [a]	11.7[b]	35.5[c]	3[d]	35.5	35.5	-	**246**
RAP	90 [a]	11.7[b]	35.5[c]	3[d]	7.5	-		**148**
RAP-IR	90[a]	11.7[b]	35.5[c]	3[d]	-	-	7.5	**148**

[a] Product used was 32-0-0 via coulter rig
[b] Product used was 10-34-0 via dual applicator coulter rig
[c] Product used was 32-0-0 via dual applicator coulter rig
[d] Product used was 9-24-3 via planter

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lb N/ bu grain	Marginal Net Return‡ ($/ac)
Grower	246 A*	17.4 A	212 A	48 B	1.16 A	1,245 B
RAP	148 B	17.3 A	214 A	82 A	0.69 B	1,338 A
RAP-IR	148 B	17.3 A	212 A	81 A	0.70 B	1,325 A
P-Value	<0.0001	0.321	0.623	0.001	0.0001	0.011

*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 $6.80/bu corn and $0.80/lb N.

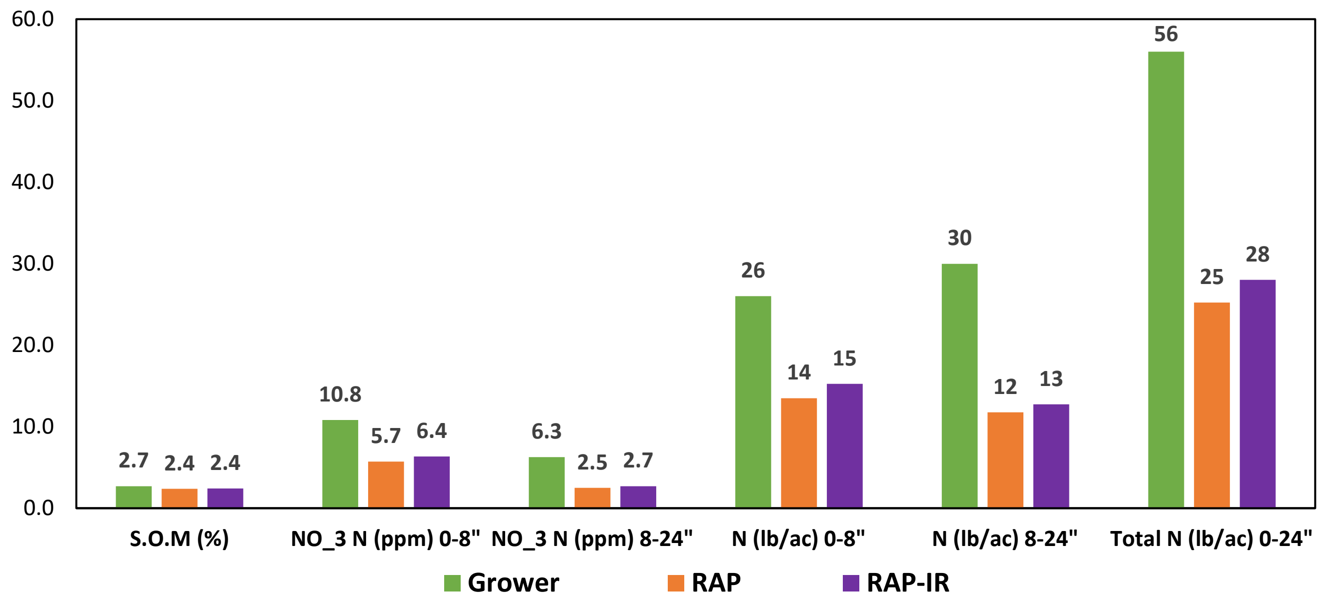


Figure 1. Post-harvest soil samples were taken in 12 treatment sectors (one sample per sector) for grower, risk-averse post-establishment (RAP), and risk-averse post-establishment increased-rate (RAP-IR) treatments. Soil organic matter (S.O.M.) in percent, nitrate nitrogen in ppm (NO_3 N), and nitrogen (N) in lb/ac are reported for two depths, 0-8” and 8-24”.

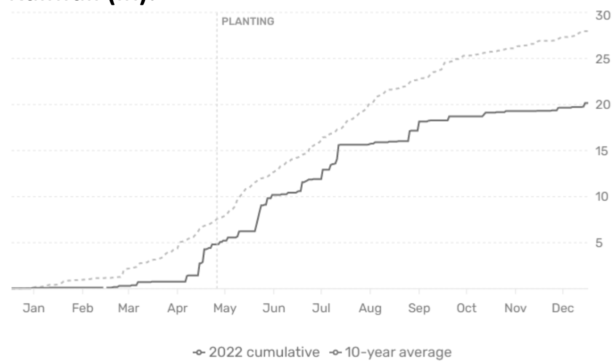
Summary:

- Both sensor based approaches resulted in a significant N fertilizer saving (98 lb N/ac) compared to the grower's management.
- Yield was not statistically different among treatments.
- A substantial reduction in N fertilizer while maintaining yields resulted in an $80/ac increase in profit for the RAP-IR approach and $93/ac increase in profit for the RAP approach compared to the grower’s management.
- Nitrogen efficiency was greater for the sensor-based management approaches compared to the grower's traditional management.
- RAP-IR treatment did not trigger an application during the increased rate period between V9 and V14; therefore, the treatment followed the same protocol as the RAP treatment.
- Both sensor-based fertigation approaches resulted in significantly lower residual soil nitrate values compared to the grower’s management (Figure 1).

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

Sensor-Based Nitrogen Fertigation Management

Study ID: 0205079202201
County: Hall
Soil Type: Hord silt loam 0-1% slope; Hord silt loam 1-3% slope; Hall silt loam 0-1% slope
Planting Date: 5/10/22
Harvest Date: 10/11/22
Seeding Rate: 27,000
Row Spacing (in): 30
Hybrid: Pioneer® P1185AM®
Reps: 7
Previous Crop: Seed corn
Tillage: Strip-till
Herbicides: ***Pre:*** 1.5 qt/ac Degree Xtra®, 32 oz/ac Roundup PowerMAX®, and 4 oz/ac DiFlexx® ***Post:*** 32 oz/ac Roundup PowerMAX®, 5 oz/ac Status®, and 3 pt/ac Warrant®
Seed Treatment: None
Foliar Insecticides: 6.4 oz/ac Brigade® 2EC, and 4 oz/ac Mustang® Maxx
Foliar Fungicides: 13.7 oz.ac Trivapro®
Note: Hail damage on 6/5 at the V5 growth stage
Irrigation: Pivot, Total: 9.35”, 8.4 ppm N in irrigation water
Rainfall (in):



Introduction: Corn nitrogen management may be improved by using sensors or imagery to detect and respond to corn nitrogen needs 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 or 60 lb/ac was triggered. This study compared the grower's standard management with two reactive, sensor-based fertigation approaches as follows:

Grower Management: Cooperating grower made the fertigation management decisions for this treatment throughout the growing season.

Risk-Averse Post-Establishment (RAP): Fertigation application decisions were made based on decision logic and analytics applied to aerial imagery from the V6 growth stage to the R3 growth stage.

Risk-Averse Post-Establishment Increased-Rate (RAP-IR): Fertigation application decisions were made based on decision logic and analytics applied to aerial imagery from the V6 growth stage to the R3 growth stage with application rate increased from 30 lb N/ac to 60 lb N/ac for any fertigation applications recommended between V9 and V14.

Application Table: Unless otherwise noted, N was applied using 32% UAN. Gray shaded area to the right of the striped line indicates where sensor-based management dictated N rates.

	5/1	5/23	7/8	7/13	Total N Applied
Treatment	--------------*lb N/ac applied*-----------				
Grower	3.5[a]	121[b]	35.5	35.5	**196**
RAP	3.5[a]	91[b]	-	-	**95**
RAP-IR	3.5[a]	91[b]	-	-	**95**

[a] Product used is 10-34-0 with planter
[b] Product used is 32-0-0 with coulter rig

Results:

	Total N rate (lb/ac)	Moisture (%)	Yield (bu/ac)†	Partial Factor Productivity of N (lb grain/lb N)	lb N/ bu grain	Marginal Net Return‡ ($/ac)
Grower	196 A*	19.9 A	277 A	79 B	0.71 A	1,663 B
RAP	95 B	19.6 A	271 B	161 A	0.35 B	1,707 A
RAP-IR	95 B	19.8 A	274 AB	161 A	0.35 B	1,725 A
P-Value	<0.0001	0.142	0.087	<0.0001	<0.0001	0.004

*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 $6.80/bu corn and $0.80/lb N.

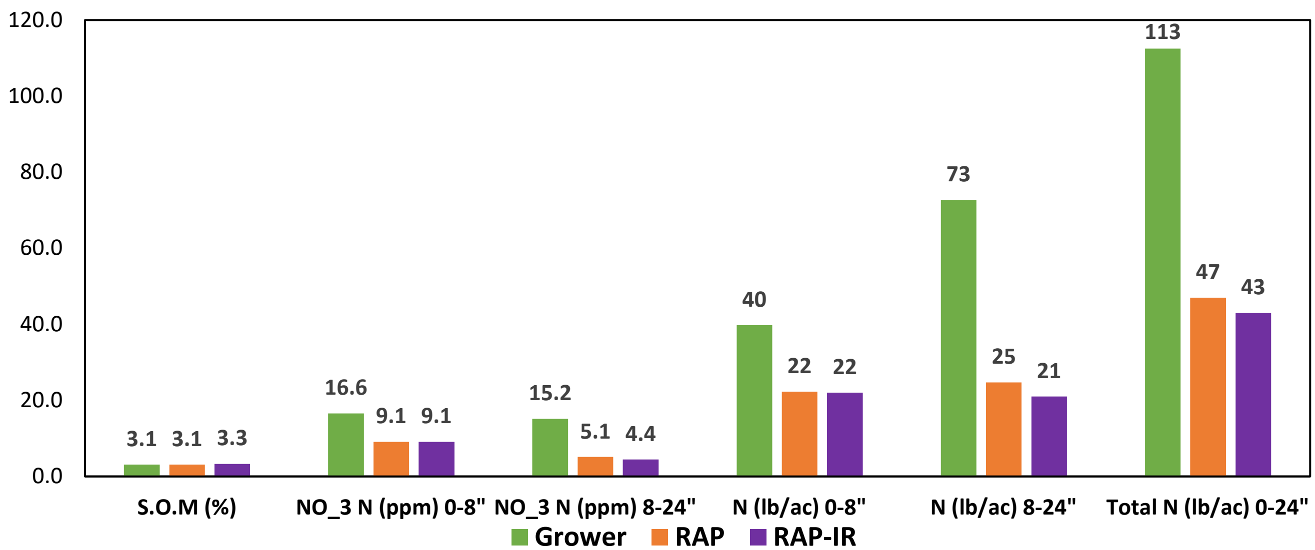


Figure 1. Post-harvest soil samples were taken in 12 treatment sectors (one sample per sector) for grower, risk-averse post-establishment (RAP), and risk-averse post-establishment increased-rate (RAP-IR) treatments. Soil organic matter (S.O.M.) in percent, nitrate nitrogen in ppm (NO_3 N), and nitrogen (N) in lb/ac are reported for two depths, 0-8" and 8-24".

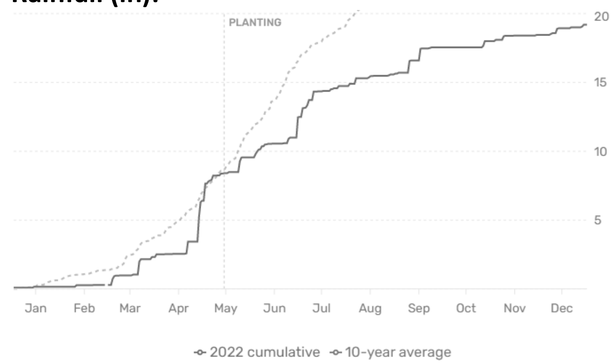
Summary:

- Both RAP and RAP-IR approaches resulted in a significant N fertilizer savings (100 lb N/ac) compared to the grower's traditional method. The N rate was identical for the sensor-based approaches as no fertigation events were triggered based on the imagery analysis.
- The RAP treatment resulted in a 6 bu/ac reduction in yield compared to the grower's management; however, the RAP-IR was not significantly different in yield compared to the grower's management or the RAP approach.
- The similar yields and large reduction in N fertilizer resulted in the RAP approaches being $44/ac more profitable than the grower's traditional management and RAP-IR being $62/ac more profitable than the grower's traditional management.
- Nitrogen efficiency was greatly increased with the sensor-based approaches.
- Neither sensor-based approaches triggered an application throughout the season.
- Both-sensor-based fertigation approaches resulted in significantly lower residual nitrate values compared to the grower's management (Figure 1).

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

Impact of Redstar™ Starguard Inhibitor with In-season UAN/ATS Application

Study ID: 0433141202201
County: Platte
Soil Type: Alcester silty clay loam 2-6% slopes; Geary silty clay loam 7-11% slopes, eroded
Planting Date: 5/14/22
Harvest Date: 10/13/22
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: DEKALB®
Reps: 4
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** 8 oz/ac dicamba, 2 qt/ac Degree Xtra®, and 2 oz/ac Balance® Flexx applied as burndown on 5/20/22 ***Post:*** 32 oz/ac Roundup®, 3 oz/ac Laudis®, and 1.5 pt/ac Warrant® on 6/17/22
Seed Treatment: Standard
Foliar Fungicides: 8 oz/ac Delaro® Complete applied aerially on 8/1/22
Irrigation: Pivot, Total: 13"
Rainfall (in):



Soil Tests (0-6" and 6-12"), May 11, 2022:

Location	Depth (in)	Sand (%)	Silt (%)	Clay (%)	OM (%)	CEC	pH	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	NO_3-N	Texture	Slope (%)
North	0-6	50	37	12	2.8	13.8	6.3	25	292	1859	280	7.7	Loam	7 to 11
	6-12	42	43	14	2.4	13	6.1	14	120	1709	277	12	Loam	
South	0-6	36	48	16	3.1	15.9	6.1	37	283	2053	228	7.9	Loam	2 to 6
	6-12	36	46	18	2.8	21.5	5.8	12	138	2542	543	8.3	Loam	

Introduction: Starguard is a nitrogen stabilizer and nitrification inhibitor. It is a mix of dicyandiamide (DCD) and N-(n-butyl) thiophosphoric triamide (NBPT). It is 20% by weight NBPT and 20% by weight DCD. The goal of this study was to evaluate the site-specific effect of inhibitors on corn yield, profit, nitrogen efficiency, available soil nitrate and ammonium, and nitrate-nitrogen (NO_3-N) concentration in soil water. A total of 150 lb N/ac and 12 lb S/ac were applied as 32% UAN and ammonium thiosulfate (ATS) blend on May 20, 2022 in-season with and without Redstar™ Starguard nitrogen inhibitor. Additional N applications through fertigation included 37 lb N/ac and 9 lb S/ac as a 32% UAN and ATS blend on July 13, 2022, and 60 lb N/ac and 8.7 lb S/ac as a 32% UAN and ATS blend on July 18, 2022. A total of 247 lb N/ac was applied over the growing season.

Water samples from lysimeters were taken for nitrate-N on 11 dates, starting June 7, 2022. Lysimeters were installed at 4 feet depth in two contrasting zones. Soil samples were collected at 0-12" depth, with seven cores collected for each sample, equally spaced diagonally across the row with three feet length between cores.

Results:

	Nitrogen Efficiency (lb N/bu grain)	Yield (bu/ac)†	Partial Profit‡ ($/ac)
Check	0.88 A*	268 A	1,759 A
Inhibitor	0.83 A	282 A	1,847 A
P-Value	0.409	0.414	0.448

*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 $6.57/bu corn and $7.65/ac for the inhibitor.

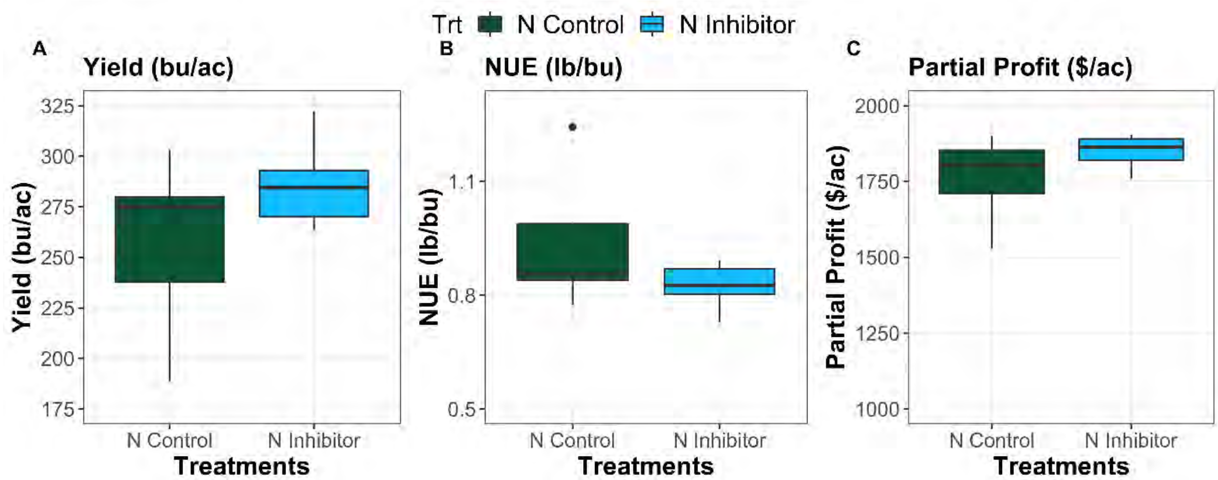


Figure 1. Box plots for grain yield (A), nitrogen use efficiency (B), and partial profit (C) by treatment. Treatments are no inhibitor control (green) and inhibitor (blue).

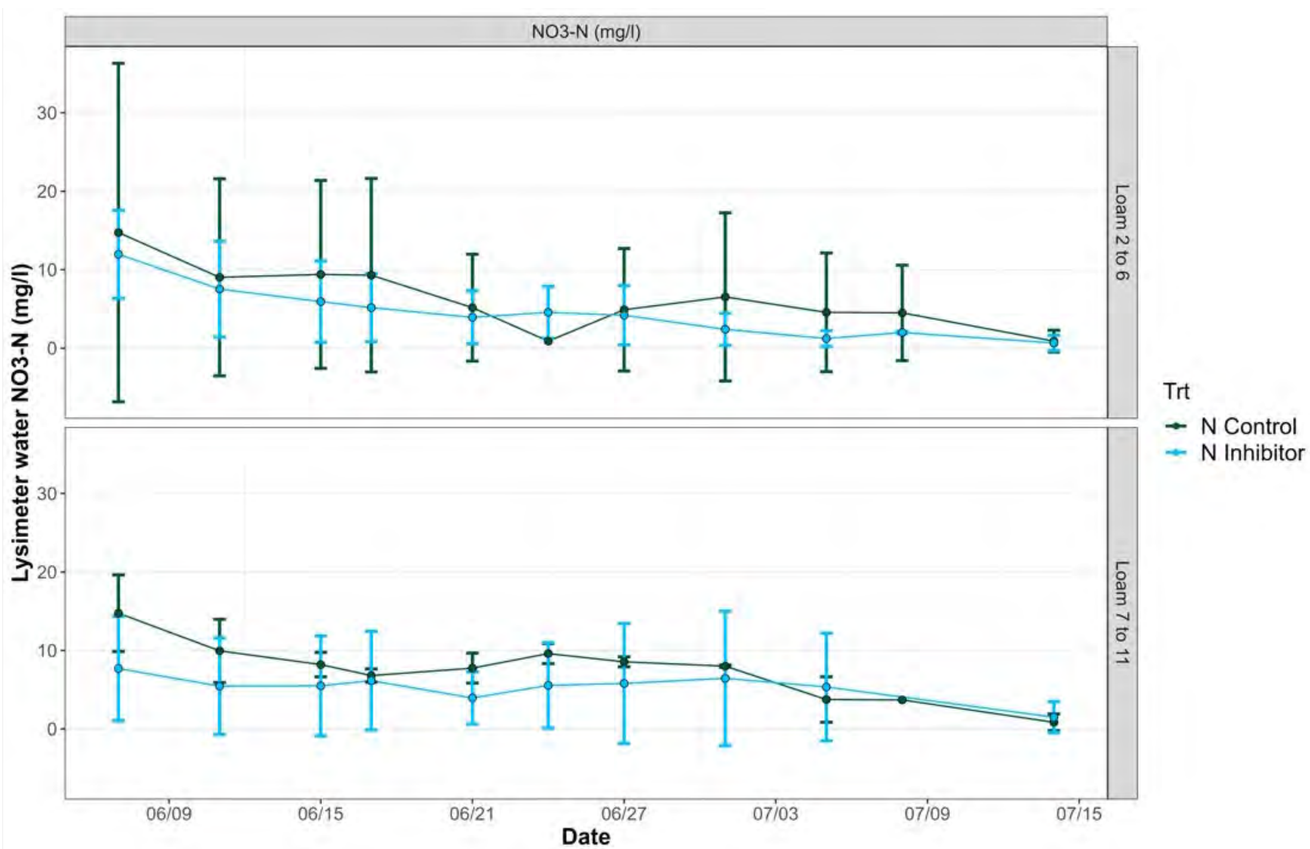


Figure 2. Lysimeter water (NO_3-N) by soil texture and sampling dates. Treatments are no inhibitor control (green) and inhibitor (blue). Points indicate the average NO_3-N concentrations with standard error bars. Lines indicate the trend of NO_3-N concentrations over time.

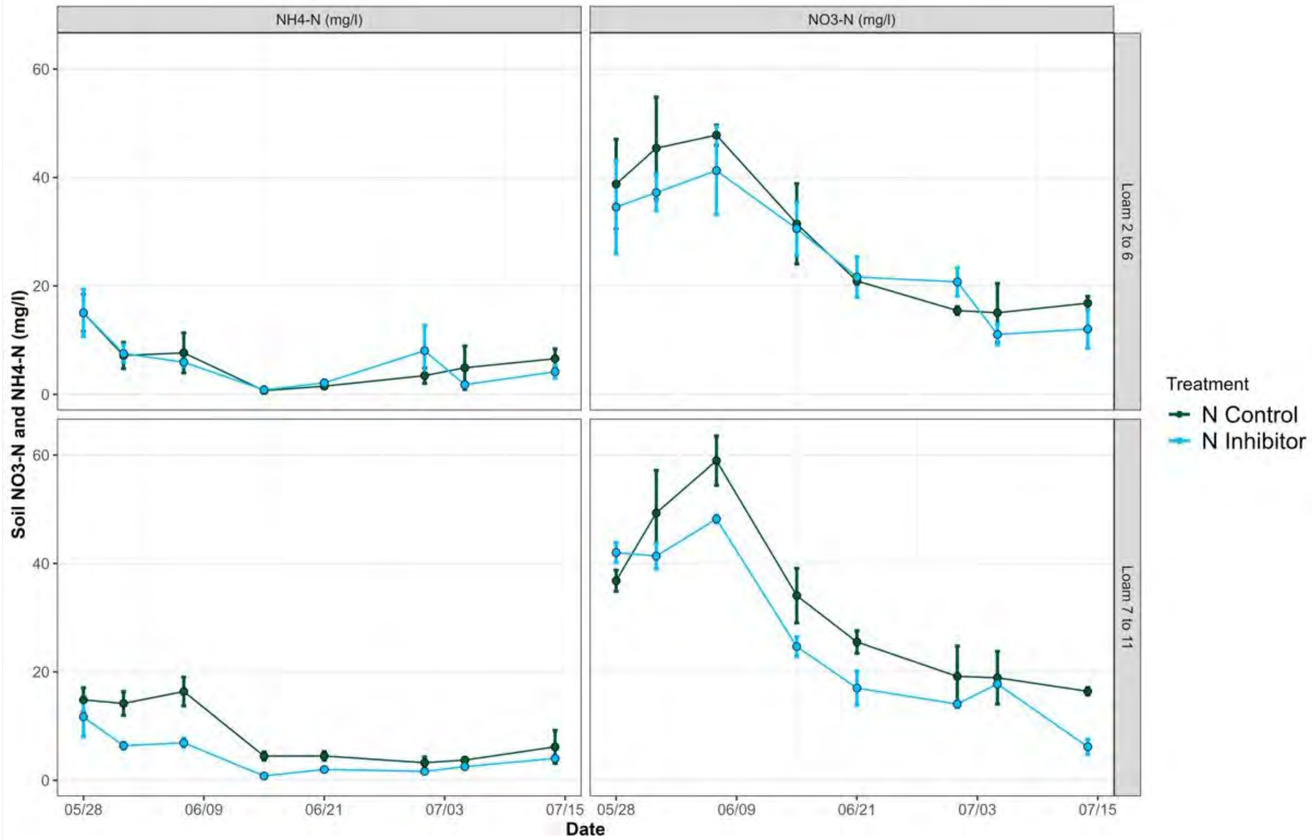


Figure 3. Soil nitrate-nitrogen (NO_3-N) and ammonium (NH4-N) by soil texture and sampling dates. Treatment are no inhibitor control (green) and inhibitor (blue). Points indicate the average soil NO3-N and NH4 concentrations with standard error bars and the lines indicate the trend of soil NO3-N and NH4 concentrations over time.

Summary:

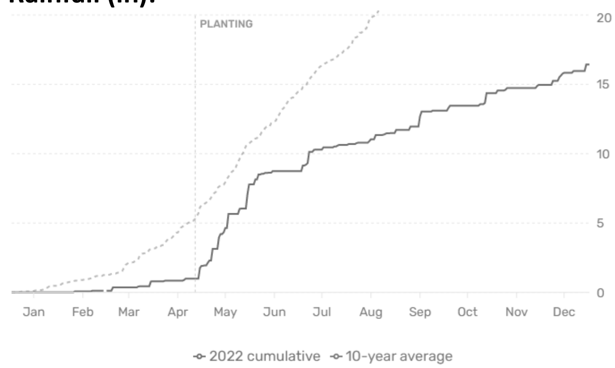
- On a whole-field basis, the use of N inhibitor did not result in differences in yield, partial profit or nitrogen use efficiency (Figure 1). Further analysis will look at the response of N inhibitor in contrasting zones.
- There was no treatment effect on soil lysimeter water nitrate collected at 4 feet depth (Figure 2).
- No statistical differences were found between treatments for soil nitrate and ammonium concentrations (Figure 3).

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

Impact of CENTURO® Inhibitor with In-season UAN Application

Study ID: 1256139202202
County: Pierce
Soil Type: Boelus loamy fine sand 2-6% slopes; Bazile soils 1-6% slopes; Hord silt loam 0-2% slopes, rarely flooded; Loretto loam 2-6% slopes
Planting Date: 4/26/22
Harvest Date: 10/17-10/18/22
Seeding Rate: 34,000 (irrigated) & 24,000 (dryland)
Row Spacing (in): 30
Hybrid: Pioneer® P1185Q™
Reps: 8
Previous Crop: Corn
Tillage: Disked 4/1/22 and field finish 4/25/22
Herbicides: ***Pre:*** 1.5 qt/ac Keystone® Lite on 4/28/22 ***Post:*** 4 oz/ac Realm® Q, 8 oz/ac atrazine, and 25 oz/ac Roundup PowerMAX® 3 on 6/8/22

Seed Treatment: Qrome®
Foliar Fungicides: 6.8 oz/ac Aproach® Prima and 4 oz/ac Sniper® applied through pivot on 7/15/22
Irrigation: Pivot, Total: 15"
Rainfall (in):



Soil Tests (0-6" and 6-12"), May 11, 2022:

Location	Depth (in)	Sand (%)	Silt (%)	Clay (%)	OM (%)	CEC	pH	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	NO3-N	Texture
West	0-6	74	19	7	1.5	9.4	6.1	22	120	1296	161	9.6	Sandy loam
	6-12	60	30	10	1.6	11.2	6.3	7	41	1601	224	8.5	Sandy loam
Middle	0-6	86	8	6	1.7	7	5.8	158	231	867	96	7.2	Loamy sand
	6-12	82	12	6	1.1	8.8	5.5	116	135	1046	115	6.8	Loamy sand
East	0-6	82	12	6	1.5	8.2	5.7	43	128	1054	114	9.5	Loamy sand
	6-12	82	11	7	1.2	10.1	5.4	17	55	1201	130	7.6	Loamy sand

Introduction: CENTURO™, by Koch Agronomic Services LLC, has known efficacy for inhibiting nitrification. The active ingredient in CENTURO is the chemical compound pronitridine. This product 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.

The goal of this study was to evaluate the site-specific effect of inhibitors on yield, available soil nitrate and ammonium, and nitrate-nitrogen (NO_3-N) concentration in soil water. The whole field received N fertilizer from: variable rate MAP applied in the spring (20 lb N/ac) and 35 lb N/ac as 32% UAN on April 26 at planting. The inhibitor treatments were applied on June 2 with UAN and thiosulfate, which resulted in 96 lb N/ac being applied. The June 2nd sidedress application was made with strips that contained CENTURO™ and strips with no inhibitor. Following the sidedress application, the field received five fertigation events: 17 lb N/ac as 32% UAN and thiosulfate blend on June 15, June 29, and July 6; and 18 lb N/ac as 32% UAN on July 15 and July 25. The total N application over the growing season was 238 lb N/ac.

Crop yield, soil nitrate, soil ammonium, and NO3-N concentration in soil water were measured. Water samples from lysimeters were taken for nitrate-N on eight dates, starting from June 21, 2022. Lysimeters were installed at 4 feet depth in three contrasting zones. Soil samples were collected at 1 foot along the band and across the band (6 cores for each in the band and out of band with 5 inches from each core).

Results:

	Yield (bu/ac)†	lb N/bu grain	Partial Profit‡ ($/ac)
Check	261 A	0.91 A*	1,580 A
Centuro™	260 A	0.92 A	1,563 B
P-Value	0.347	0.354	0.048

*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 $6.57/bu corn, $0.56/lb N fertilizer, and $10.50/acre for Centuro®.

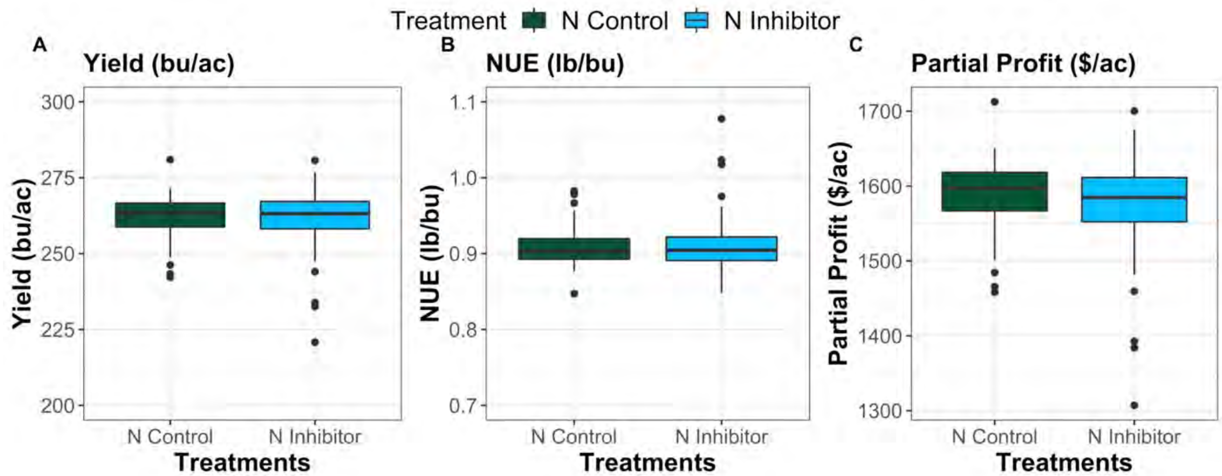


Figure 1. Box plots for grain yield (A), nitrogen use efficiency (B), and partial profit (C) by treatment. Treatments are no inhibitor control (green) and Centuro® nitrification inhibitor (blue).

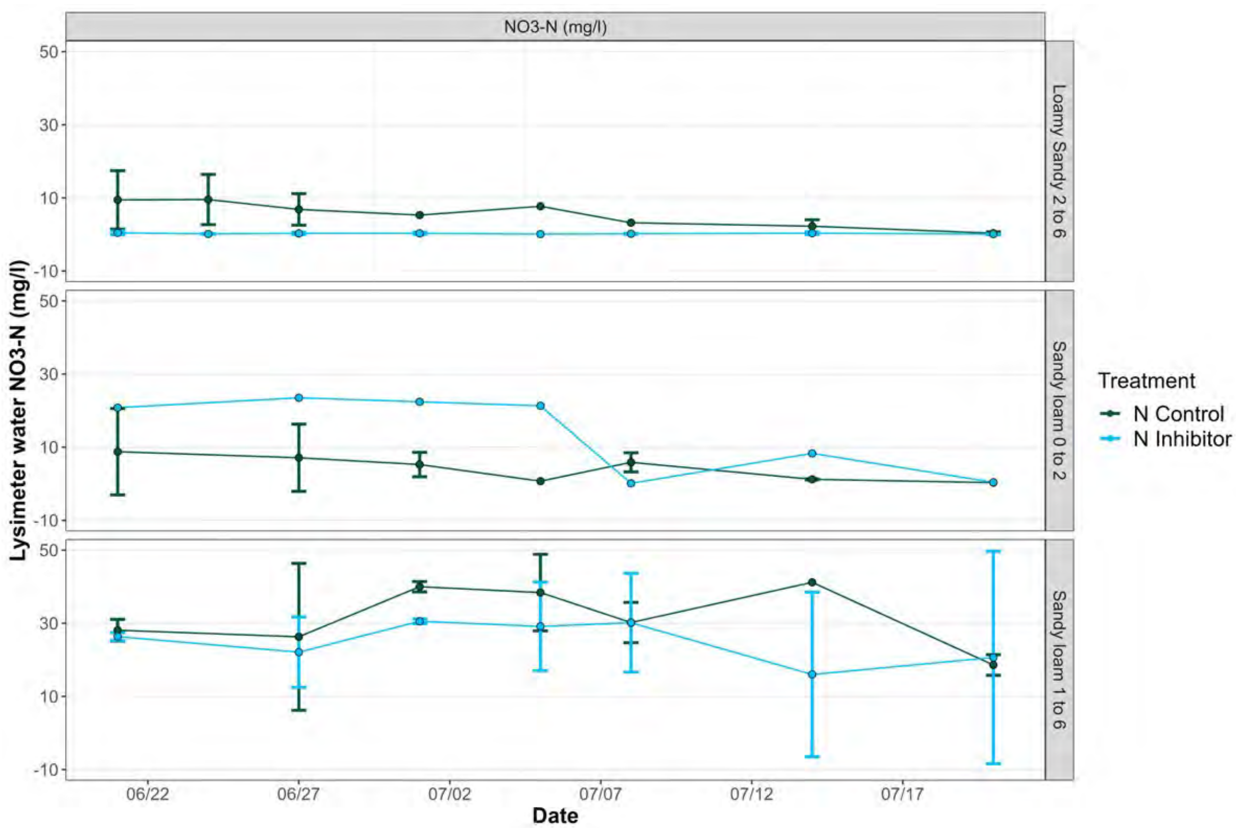


Figure 2. Lysimeter water (NO_3-N) by soil texture and sampling dates. Treatments are no inhibitor control (green) and Centuro® nitrification inhibitor (blue). Points indicate the average NO_3-N concentrations with standard error bars. Lines indicate the trend of NO_3-N concentrations over time.

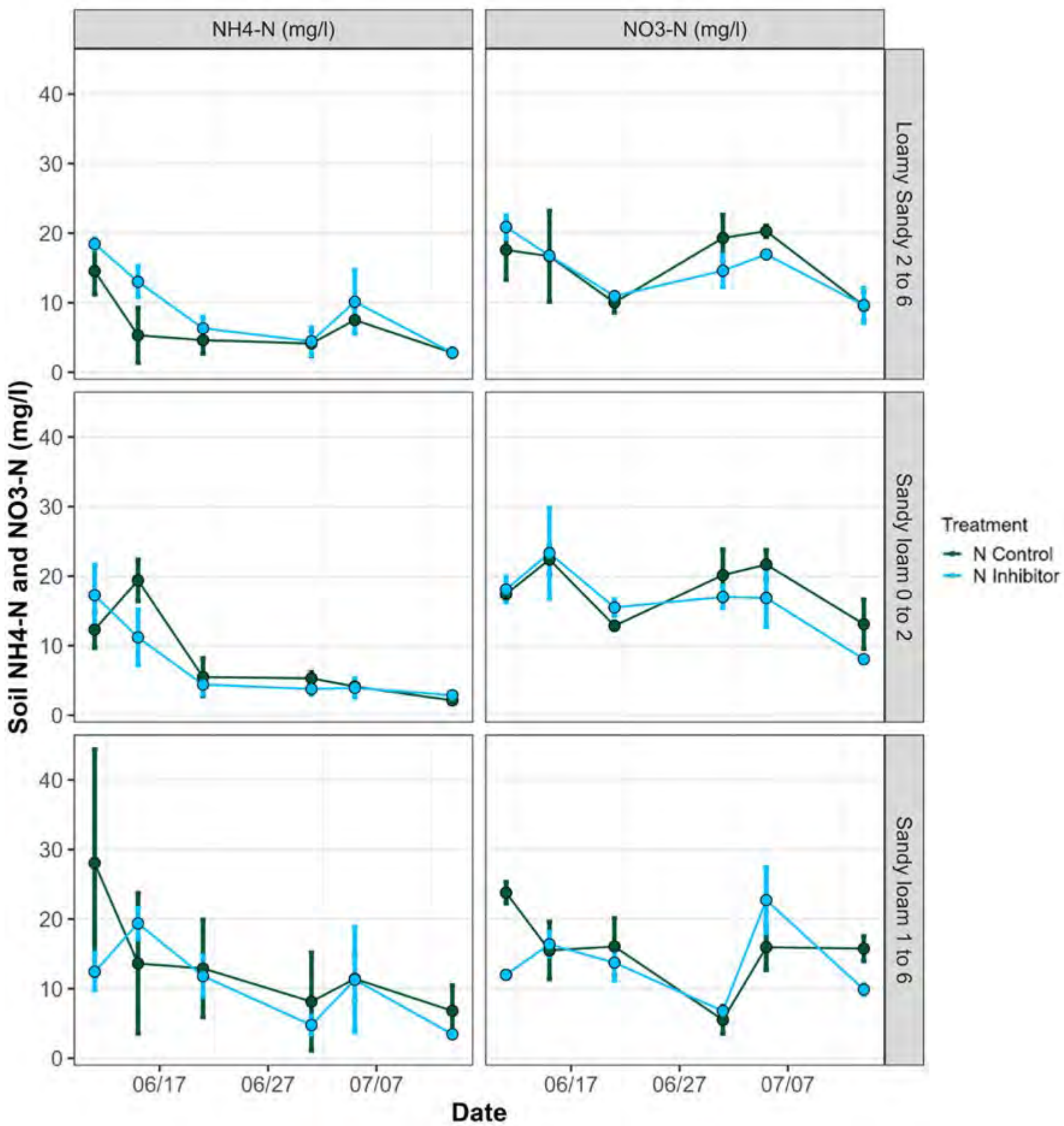


Figure 3. Soil nitrate-nitrogen (NO_3-N) and ammonium nitrogen (NH_4-N) by soil texture and sampling dates. Treatments are no inhibitor control (green) and Centuro® nitrification inhibitor (blue). Points indicate the average soil NO_3-N and NH_4 concentrations with standard error bars and the lines indicate the trend of soil NO_3-N and NH_4-N concentrations over time.

Summary:

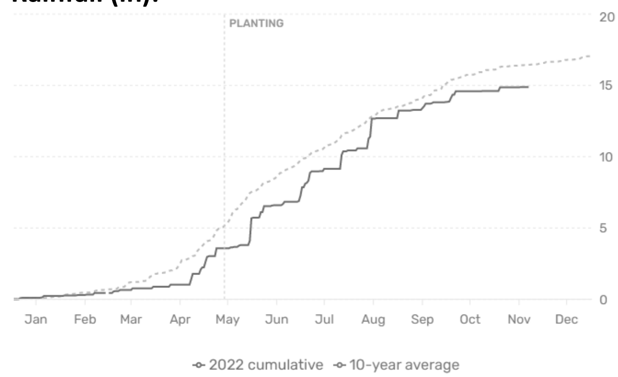
- On a whole-field basis, the use of the inhibitor did not improve yield or nitrogen use efficiency (Figure 1). Further analysis will examine the response of N inhibitor in contrasting zones.
- Net return was $16/ac lower for the inhibitor treatment due to the increased input costs for the inhibitor product.
- There was no treatment effect on soil lysimeter water nitrate collected at 4 feet depth (Figure 2). Lower than normal precipitation at the site may have reduced the likelihood of nitrate leaching.
- Soil nitrate and ammonium concentration were not statistically different between treatments (Figure 3).

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

Impact of CENTURO® and MicroSource® DCD Inhibitors with UAN Application

Study ID: 0015013202201
County: Box Butte
Soil Type: Alliance loam 0-1% slopes; Alliance loam, 1-3% slopes; Rosebud loam 1-3%
Planting Date: 5/13/22
Harvest Date: 11/8/22
Seeding Rate: 30,000
Row Spacing (in): 30
Hybrid: Stine® 9319-10
Reps: 4
Previous Crop: Sugarbeet
Tillage: Strip-till
Herbicides: ***Pre:*** Roundup® and Banvel® ***Post:*** Status®
Foliar Insecticides: None
Foliar Fungicides: None

Fertilizer: 36.5 gal/ac of 32% UAN (130 lb N/ac), 3.47 gal/ac 12-0-0-26s (5 lb N/ac), and 4.54 gal/ac 10-34-0 (5 lb N/ac) strip-till on 4/28/22; 20 lb P/ac, 1 lb Zn/ac, and 2 lb Mn/ac starter at planting on 5/13/22; 50 lb N/ac fertigated on 8/1/22
Note: Harvested the center 8 of the 12 treated rows.
Irrigation: Pivot, Total: 10-11"
Rainfall (in):



Baseline Soil Samples, 0-8" (January 2022)

	pH	OM LOI %	Nitrate – N ppm N	Bray P1 ppm	Sulfate-S ppm S	-------Melich lll------- K	Ca	Mg	Na	CEC me/100g	Zn	Mn	Fe	Cu
											(DTPA PPM)			
Sample	7.4	1.7	13	34	14	573	2507	314	87	17	1.9	3	10	0.5

Introduction: CENTURO® by Koch™ Agronomic Services LLC and MicroSource® DCD by Microsource LLC, are products with known efficacy for inhibiting nitrification. The chemical compound in CENTURO® is pronitridine, whereas the chemical compound in MicroSource® DCD is dicyandiamide (DCD). Both products inhibit 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.

The goal of this study was to evaluate these two nitrification inhibitor products. Nitrogen was applied in a strip-till application on April 28, 2022, at 8-10" depth. Products in the strip-till application include: 36.5 gal/ac 32% UAN (130 lb N/ac), 3.47 gal/ac 12-0-0-26S (5 lb N/ac), and 4.54 gal/ac 10-34-0 (5 lb N/ac). To evaluate the inhibitor products, one treatment applied Centuro® at a rate of 2.5 gal/ton of 32% UAN and another treatment applied MicroSource® DCD at a rate of 1 gal/ton of 32% UAN. The inhibitor treatments were compared to an untreated check. Additional N fertilizer was applied as starter at planting consisting of 20 lb P/ac, 1 lb Zn/ac, and 2 lb Mn/ac and through a fertigation of 50 lb N/ac on August 1, 2022. Total N applied was 190 lb N/ac. Corn was planted on May 13 directly on the strip-till band. Crop yield was measured by harvesting the center 8 rows of the 12-row plots.

Results:

	Early Season Stand Count (plants/ac)	Moisture (%)	Test Weight (lb/bu)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	28,598 A*	15.7 B	57 A	218 A	1,432 A
DCD	30,122 A	16.4 A	57 A	216 AB	1,405 A
CENTURO®	28,598 A	15.9 AB	57 A	210 B	1,359 B
P-Value	0.201	0.077	0.643	0.072	0.020

*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 $6.57/bu corn, $10.60/ac for DCD, and $21/ac for CENTURO® .

Summary:

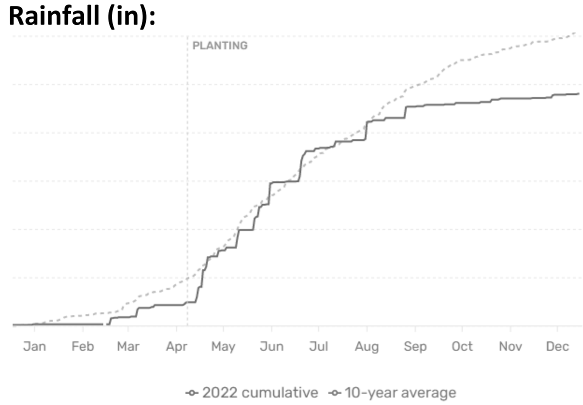
- There were no differences in stand counts between the inhibitor treatments and untreated check.
- Grain moisture was statistically different between the treatments with the DCD treatment 0.7% wetter than the untreated check.
- There were no differences in test weight.
- Yield for the check treatment was 8 bu/ac higher than the yield for the CENTURO® treatment. The DCD treatment did not differ in yield from the check or the CENTURO® treatment.
- Marginal net return for the CENTURO® treatment was lower than the marginal net return for the DCD and Check treatment.
- This is the second year this producer has evaluated DCD, CENTURO® , and an untreated check. In 2021, there were no differences in yield or net return between the inhibitors and the untreated check.

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

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

Study ID: 0118185202202
County: York
Soil Type: Hastings silt loam 0-1% slope; Hastings silt loam 1-3% slope
Planting Date: 4/22/22
Harvest Date: 9/21-22/22
Seeding Rate: 32,500
Row Spacing (in): 30
Hybrid: DEKALB® 59-82
Reps: 3
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** Balance® Flexx and Degree Xtra®

Note: Severe hail damage on 6/14/22 at the 12 leaf stage. Field wasn't totaled by insurance. Many barren tassels, ears 1 foot off ground, and palmer amaranth in field.
Irrigation: Pivot, Total: 6.5"
Rainfall (in):



Soil Test, 0-8" (November 2021):

						Ammonium Acetate (ppm)					% Base Saturation				
Rep	pH	OM LOI %	Nitrate – N ppm N	Mehlich P-III ppm P	Sulfate-S ppm	K	Ca	Mg	Na	CEC me/100g	H	K	Ca	Mg	Na
1	**6.9**	3.7	12.6	16	9.6	225	2453	350	74	16.1	0	4	76	18	2
2	**6.9**	3.9	16.3	23	10.7	392	3127	450	66	20.7	0	5	76	18	1
3	**6.9**	3.6	11	16	8.4	385	2541	328	52	16.7	0	6	76	16	1

Introduction: CENTURO®, by Koch™ Agronomic Services LLC, contains a product with known efficacy for inhibiting nitrification. 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 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.

The purpose of this study was to evaluate the impact of CENTURO® applied with anhydrous ammonia on crop yield and soil ammonium and nitrate. Anhydrous ammonia was applied at 150 lb/ac N at two different times; the fall application date was November 6, 2021 and the spring application date was March 17, 2022. The study compared both application timings with no inhibitors versus with CENTURO® applied at 10 gal/ton anhydrous ammonia. The field was planted on April 22, 2022. Hail damage occurred on June 14 at the 12 leaf stage, but the field wasn't totaled by insurance.

Crop yield and soil ammonium and nitrate were measured. Soil samples were collected at 1' depth for ammonium-N and nitrate-N analysis on November 8, 2021, and March 21, 2022 (Figure 1). Soil samples were collected starting in the band and at 7" and 15" on either side of the band for a total of five soil cores for each treatment, replication, and sampling date. On September 8, 2022, end of the season, deep soil nitrate samples (1', 2', and 3' depths) were collected for one replication (Figure 1). Stand count, stalk quality, yield, and net return were evaluated.

Results:

	Harvest Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Fall, no inhibitor	22,000 A*	21.83 A	17.2 A	111 A	674 A
Fall, CENTURO®	23,667 A	15.00 A	17.6 A	122 A	723 A
Spring, no inhibitor	22,167 A	18.33 A	17.5 A	121 A	737 A
Spring, CENTURO®	22,167 A	26.00 A	17.1 A	122 A	723 A
P-Value	0.868	0.376	0.965	0.274	0.439

*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 $6.57/bu corn, $0.38/lb N, and $23/ac for CENTURO® .

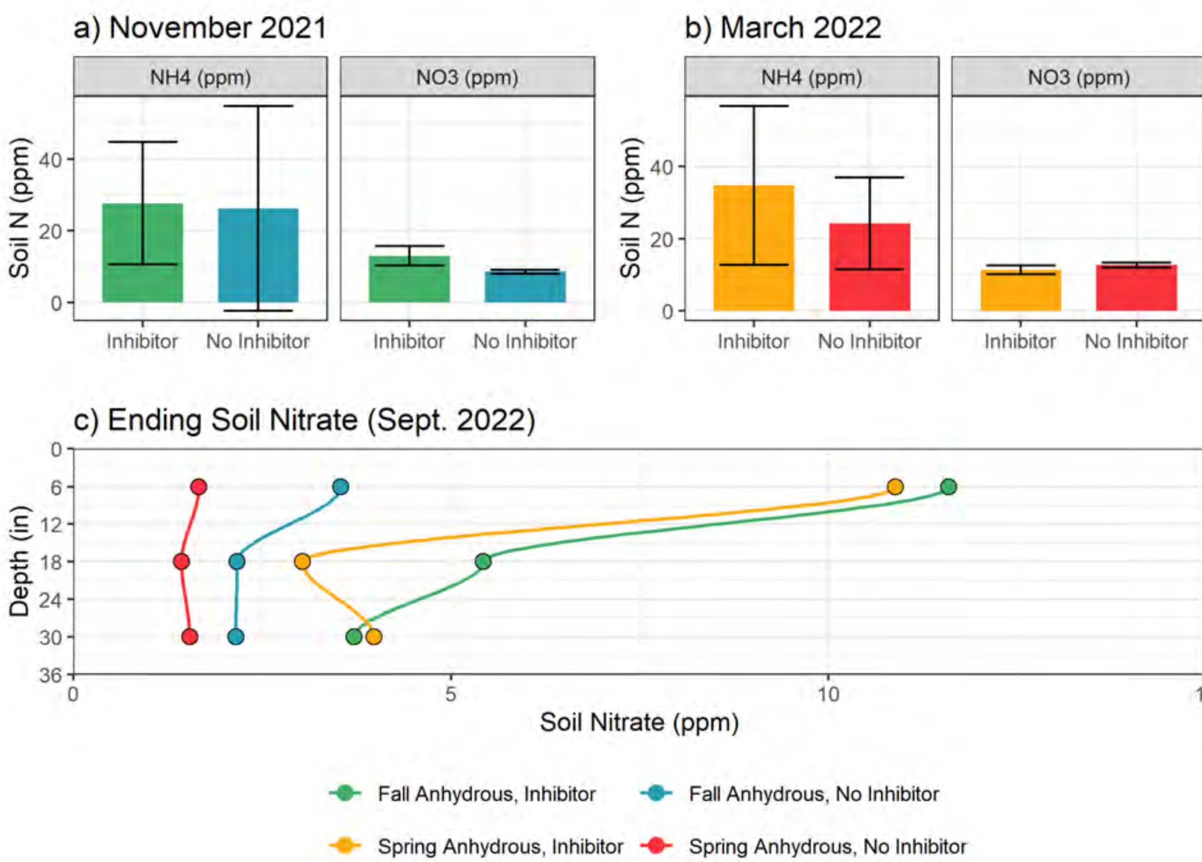


Figure 1. a) Soil ammonium (ppm) and nitrate (ppm) at one-foot depth for fall treatments in November 2021. **b)** Soil ammonium (ppm) and nitrate (ppm) at one-foot depth for spring treatments in March 2022. **c)** September 2022 end-of-season soil nitrate (ppm) at one, two, and three-foot depths for one replication.

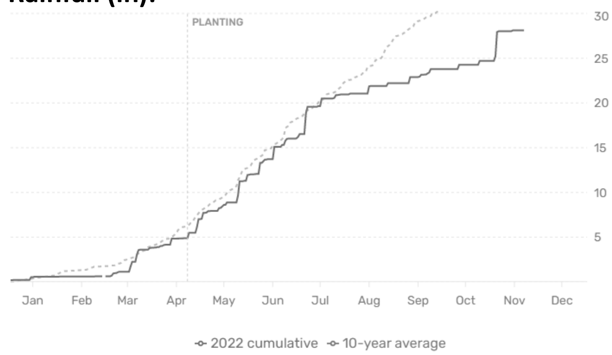
Summary:

- There were no differences in stalk rot, stand count, grain moisture, yield, or net return for the nitrogen timings and inhibitors evaluated.
- This is the third year this producer has repeated this study. In years one and two, there were also no differences in yield for the nitrogen timings and inhibitors evaluated.

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

Impact of CENTURO® Inhibitor with Fall Anhydrous Ammonia Application

Study ID: 0416147202203
County: Richardson
Soil Type: Monona silt loam 1-6% slopes; Pohocco silt loam 6-11% slopes, eroded
Planting Date: 4/22/22
Harvest Date: 9/26/22
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1185AM™
Reps: 4
Previous Crop: Soybean
Tillage: Strip-till
Herbicides: ***Pre:*** 0.825 oz/ac Basis® Blend, 1.4 pt/ac atrazine 4L, 16 oz/ac dicamba ***Post:*** 2.2 qt/ac Keystone® NXT, 24 oz/ac glyphosate, 5.33 oz/ac mesotrione
Foliar Fungicides: 7 oz/ac Veltyma® on 7/13/22
Fertilizer: 175 lb N/ac as anhydrous ammonia on 11/23/21; variable-rate 11-52-0 averaging 32 lb/ac; variable-rate gypsum averaging 124 lb/ac; variable-rate 0-0-60 averaging 124 lb/ac
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 leach through the root zone with rain in well drained soils or be converted to N_2O) or N_2 gases in anaerobic conditions. You can learn more about nitrogen inhibitors at http://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 purpose of this study was to evaluate the impact of CENTURO® applied with anhydrous ammonia on crop yield. Anhydrous ammonia was applied at a rate of 175 lb N/ac on November 23, 2021, at 7" depth with strip-till, following a previous crop of soybeans. The study compared no CENTURO® (check) to CENTURO® applied at 5 gal/ton of anhydrous ammonia (recommended rate). The field received variable-rate 11-52-0 fertilizer in the spring, and N contribution from the 11-52-0 in the plot area averaged 4 lb N/ac. The field was planted on April 22, 2022, with corn rows directly on the anhydrous band.

Results:

	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	243 A*	1,595 A
CENTURO®	242 A	1,578 B
P-Value	0.323	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 15.5% moisture.
‡Marginal net return based on $6.57/bu corn and $10.10/ac for CENTURO®.

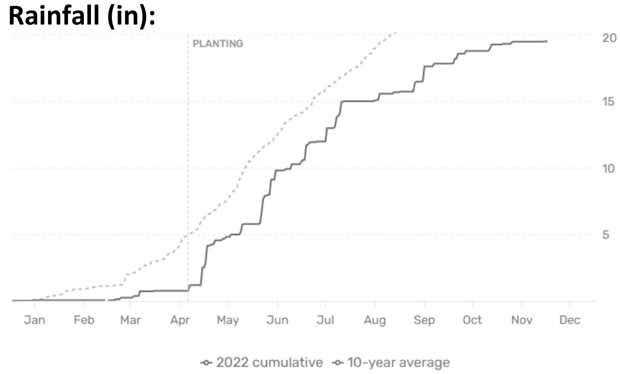
Summary:

- Yield was the same for the CENTURO® and check treatments.
- Net return was $18/ac lower for the CENTURO® treatment compared to the check.

Non-Traditional Products

ADM® CS43 Biostimulant Applied In-Furrow at Planting

Study ID: 1121019202202
County: Buffalo
Soil Type: Hord silt loam 0-1% slope; Cozad silt loam 6-11% slopes
Planting Date: 4/18/22 & 4/19/22
Harvest Date: 10/25/22 & 10/26/22
Seeding Rate: 36,273
Row Spacing (in): 30
Hybrid: Channel® 214-22STXRIB
Reps: 28
Previous Crop: Corn
Tillage: Strip-till
Herbicides: ***Pre:*** 1.5 qt/ac Degree Xtra® and 3 oz/ac mesotrione with 1% COC and 1% UAN on 4/20/22
Post: 1.25 qt/ac Harness® MAX and 1 pt/ac atrazine with 1% COC and 1% UAN on 6/1/22
Foliar Insecticides: 8 oz/ac Steward® EC at VT
Foliar Fungicides: 10 oz/ac Headline AMP® at VT
Fertilizer: Variable-rate 10-34-0 averaging 2.1 gal/ac (2 lb N/ac) applied with strip-till; 4 gal/ac 10-34-0 in-furrow (5 lb N/ac) and 12 gal/ac 28% UAN (35 lb N/ac) surface dribble applied at planting; 21 gal/ac 32% UAN (75 lb N/ac) through fertigation
Irrigation: Pivot, Total: 13.5"
Rainfall (in):



Baseline Soil Samples, 0-8" (November 2021):

	pH	OM LOI %	Nitrate – N ppm N	Bicarb- P ppm	Sulfate-S ppm S	K	Fe	Mn	Cu
Avg	6.7	3.2	9.9	63	8	338	22	6	0.8
Min	5.4	1.7	3.1	7	1	166	9	2	0.3
Max	7.4	4.5	38	782	35	789	65	18	4.5

Introduction: In this study the grower looked at the effect of ADM® CS43 on corn yield and economics compared to an untreated check. ADM® CS43 is described as a biostimulant that is designed to be used with starter fertilizer to increase nutrient use efficiency, enhance plant vigor, and boost yields. In this study, ADM® CS43 was applied at a rate of 1 gal/ac in-furrow at planting with 4 gal/ac 10-34-0 starter fertilizer and was compared to 4 gal/ac 10-34-0 starter fertilizer without ADM® CS43. The study had 28 replications for yield, grain moisture, and net return. Stand count and stalk rot data were recorded for a subset of 7 replications.

Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	32,238 B*	31,476 A	7.4 B	14.8 B	260 A	1,706 A
ADM® CS43	33,238 A	31,857 A	10.5 A	15.0 A	257 B	1,678 B
P-Value	0.065	0.594	0.069	0.059	<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 $6.57/bu corn and $9.50/ac for ADM® CS43 biostimulant.

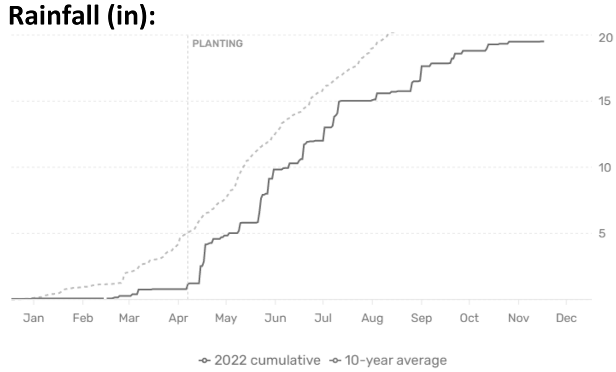
Summary:

- Early stand counts showed the ADM® CS43 had 1,000 more plants/ac than the untreated check. However, when stand counts were repeated again at harvest time, there were no significant differences between the treatments. Stalk rot recorded at harvest was 3% greater for the ADM® CS43 treatment.
- The ADM® CS43 treatment had 0.1% wetter grain at harvest. Yields for the check treatment were 3 bu/ac higher than yields for the ADM® CS43 treatment. The lower yields and increased cost for the ADM® CS43 treatment resulted in $28/ac lower marginal net return for the ADM® CS43 treatment.

ADM® CS43 Biostimulant Applied In-Furrow at Planting

Study ID: 1121019202203
County: Buffalo
Soil Type: Holdrege-Hall silt loam 0-1% slope; Coly silt loam 6-11% slopes
Planting Date: 4/20-21/22
Harvest Date: 10/6-8/22
Seeding Rate: 34,637
Row Spacing (in): 30
Hybrid: DEKALB® DKC59-82 VT2PRIB
Reps: 14
Previous Crop: Corn
Tillage: Strip-till
Herbicides: ***Pre:*** 1.5 qt/ac Degree Xtra® and 3 oz/ac mesotrione with 1% COC and 1% UAN on 4/21/22
Post: 1.25 qt/ac Harness® MAX and 1 pt/ac atrazine with 1% COC and 1% UAN on 6/1/22
Foliar Insecticides: 8 oz/ac Steward® EC at VT
Foliar Fungicides: 10 oz/ac Headline AMP® at VT

Seed Treatment: Standard Dekalb® seed treatment
Fertilizer: 18-46-0-9S-0.5Zn applied with fall strip-till; 4 gal/ac 10-34-0 (5 lb N/ac) applied in-furrow; 12 gal/ac 28% UAN (36 lb N/ac) surface dribble starter; 44 gal/ac 32% UAN (156 lb N/ac) fertigated
Irrigation: Pivot, Total: 8.6”
Rainfall (in):



Baseline Soil Samples, 0-8” (October 2021):

	pH	BpH	OM LOI %	Nitrate – N ppm N	Bicarb- P ppm	Sulfate-S ppm S	K	Fe	Mn	Cu
NE	8	7.2	2.7	6.8	42	9.7	493	8.5	2.6	0.7
SE-1	7.2	7.2	3.2	7	24	5.5	402	14	4.6	0.4
SE-2	6.8	7.2	2.9	8.1	36	5.1	379	13	4.7	0.3

Introduction: In this study the grower looked at the effect of ADM® CS43 on corn yield and economics compared to an untreated check. ADM® CS43 is described as a biostimulant that is designed to be used with starter fertilizer to increase nutrient use efficiency, enhance plant vigor, and boost yields. In this study, ADM® CS43 was applied at a rate of 1 gal/ac in-furrow at planting with 4 gal/ac 10-34-0 starter fertilizer and was compared to 4 gal/ac 10-34-0 starter fertilizer without ADM® CS43. The study had 14 replications for yield, grain moisture, and net return. Stand count and stalk rot data were recorded for a subset of 8 replications.

Results:

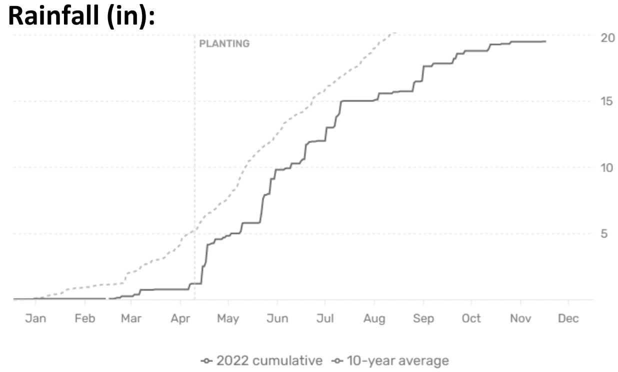
	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	31,667 A*	29,167 A	12.29 A	14.9 A	236 A	1,551 A
ADM® CS43	31,250 A	29,042 A	12.75 A	14.6 A	234 A	1,528 A
P-Value	0.265	0.831	0.784	0.315	0.383	0.150

*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 $6.57/bu corn and $9.50/ac for ADM® CS43.

Summary: There were no differences in early season or harvest stand counts, stalk rot, grain moisture, yield, or net return between the two treatments in this study.

ADM® CS43 Biostimulant Applied In-Furrow at Planting

Study ID: 1121019202204
County: Buffalo
Soil Type: Cozad silt loam 1-3% slope; Hord silt loam 0-1% slope
Planting Date: 4/23-24/22
Harvest Date: 10/9/22
Seeding Rate: 35,488
Row Spacing (in): 30
Hybrid: Hoegemeyer® 8235 Q
Reps: 6
Previous Crop: Corn
Tillage: Strip-till
Herbicides: ***Pre:*** 1.5 qt/ac Degree Xtra® and 3 oz/ac mesotrione with 1% COC and 1% UAN on 4/25/22
Post: 1.25 qt/ac Harness® MAX, 1 pt/ac atrazine, 20 oz/ac Roundup PowerMAX® 3, 5 oz/ac Status®, and 8.5 lb AMS/100 gal water on 5/31/22
Foliar Insecticides: 8 oz/ac Steward® EC at VT
Foliar Fungicides: 10 oz/ac Headline AMP® at VT
Seed Treatment: Standard Hoegemeyer® treatments
Fertilizer: 8.5 gal/ac 10-34-0 (10 lb N/ac), 0.5 gal/ac ZnSO4, 11 gal/ac 28% UAN (33 lb N/ac) with fall strip-till; 4 gal/ac 10-34-0 (5 lb N/ac) applied in-furrow and 12 gal/ac 28% UAN (36 lb N/ac) surface dribble starter; 49 gal/ac 32% UAN (174 lb N/ac) sidedressed
Note: The field experienced heavy hail damage in mid-August
Irrigation: Pivot, Total: 13”
Rainfall (in):



Baseline Soil Samples, 0-8” (October 2021):

	pH	BpH	OM LOI %	Nitrate – N ppm N	Bicarb- P ppm	Sulfate-S ppm S	K	Fe	Mn	Cu
NW	6.6	7.2	2.8	7.1	23	10.3	362	20.7	6.8	0.7
NE	6.9	7.2	2.2	4.1	8	2.5	174	8.3	3.5	0.3

Introduction: In this study the grower looked at the effect of ADM® CS43 on corn yield and economics compared to an untreated check. ADM® CS43 is described as a biostimulant that is designed to be used with starter fertilizer to increase nutrient use efficiency, enhance plant vigor, and boost yields. In this study, ADM® CS43 was applied at a rate of 1 gal/ac in-furrow at planting with 4 gal/ac 10-34-0 starter fertilizer and was compared to 4 gal/ac 10-34-0 starter fertilizer without ADM® CS43. The study had 6 replications.

Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	32,056 A*	30,389 A	18.0 A	14.1 A	192 A	1,264 A
ADM® CS43	31,167 B	29,445 A	19.5 A	14.0 B	192 A	1,253 A
P-Value	0.082	0.133	0.669	0.012	0.850	0.274

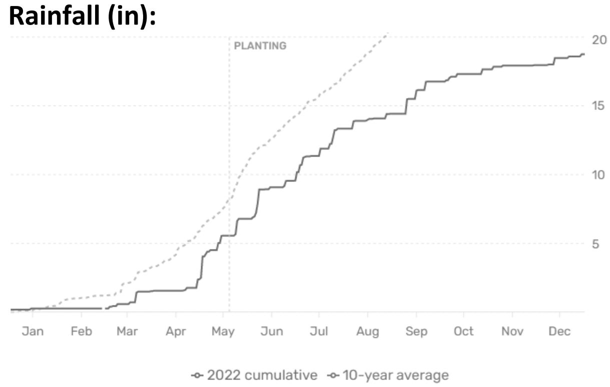
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $6.57/bu corn and $9.50/ac for ADM® CS43.

Summary:

- Early season stand counts were approximately 900 plants/ac higher for the check compared to the ADM® CS43 treatment. The field was hail damaged on August 20 and had a loss of 80-90% leaf area. When stand counts were repeated at harvest time there were no significant differences between the treatments. There were no differences in stalk rot between the treatments.
- At harvest, grain moisture was 0.1% higher for the check treatment. There were no differences in yield or marginal net return.

Evaluating BLACKMAX® 22 and EXTRACT Powered by Accomplish® on Corn

Study ID: 1404001202201
County: Adams
Soil Type: Hastings silt loam 0-1% slope
Planting Date: 5/19/22
Harvest Date: 12/14/22
Seeding Rate: 32,500
Row Spacing (in): 36
Hybrid: Channel® 214-22STXRIB
Reps: 4
Previous Crop: Corn
Tillage: No-till
Herbicides: ***Pre:*** 4 oz/ac Balance® Flexx, 32 oz/ac atrazine, and 8 oz/ac DiFlexx® on 5/16/22 ***Post:*** 48 oz/ac Harness® MAX, 16 oz/ac atrazine, 10 oz/ac DiFlexx®, 26 oz/ac glyphosate, and 4.7 oz/ac Helfire® on 6/12/22
Foliar Insecticides: 6 oz/ac Elevest® on 7/30/22; 6.4 oz/ac Brigade® 2 EC and crop oil on 9/1/22
Foliar Fungicides: 7 oz/ac Veltyma® and 11 oz/ac MasterLock® on 7/30/22
Fertilizer: Pro Phos™ 12-40-0 10S and 0.1 Zn variable-rate applied at 125 lb/ac; Agrisol elemental sulfur variable rate applied at 15 lb/ac; 180 lb N/ac as 32% UAN, and 10 gal/ac Thio-Sul® on 4/8/22; 5 gal/ac 10-34-0 on 5/19/22; 10 gal/ac 32% UAN fertigated
Irrigation: Pivot, Total: 10.3”
Rainfall (in):



Introduction:

Two plant nutrition products, manufactured by Loveland Products, were tested for their effect on corn yield. EXTRACT Powered by Accomplish® (EXTRACT PBA) and BLACKMAX ® 22 were each applied at planting with 10-34-0 starter fertilizer at a rate of 64 oz/ac. A combination of two products was also applied at planting with 10-34-0 starter fertilizer at a rate of 64 oz/ac of each product. The treatments were compared to an untreated check. EXTRACT PBA is a blend of Accomplish® LM, a fertilizer biocatalyst, and an N source that promotes the release of nutrients from crop residue and soils. The goal of the product is to optimize plantability and crop emergence, and extend nutrient availability later into the growing season. The goal of BLACKMAX® 22 is to enhance applied nutrient availability and uptake, nutrient mineralization and solubility, and promote beneficial soil microbes.

Early season stand counts were taken during the V4 crop growth stage on June 14, 2022. The tops of the plants were blown over at harvest time, but wind damage appeared consistent across the plots. The ends of the fourth replication were outside of the irrigated area. Stand counts, yield, and net return were evaluated.

Results:

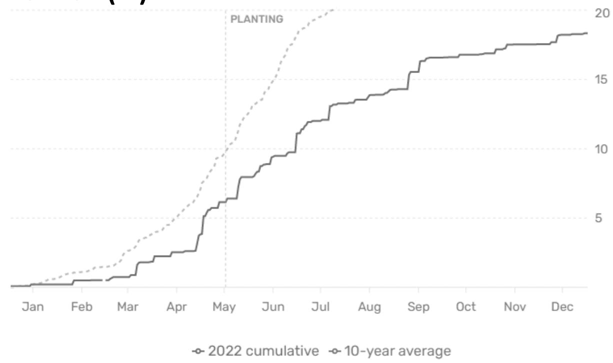
	Early Season Stand Count (plants/ac)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	30,803 A	256 A	1,684 A
BLACKMAX® 22	30,596 A	260 A	1,695 A
EXTRACT PBA	30,803 A	261 A	1,708 A
BLACKMAX® 22 and Extract	29,351 A	258 A	1,680 A
P-Value	0.171	0.267	0.286

*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 $6.57/bu corn, $11/ac for BLACKMAX® 22, and $6.50/ac for EXTRACT PBA.

Summary: There were no differences in stand counts, yield, or net return among the treatments evaluated.

Impact of Rhyzogreen® on Corn

Study ID: 0007155202301
County: Saunders
Soil Type: Wann fine sandy loam occasionally flooded; Gibbon silt loam 0-2% slopes, occasionally flooded
Planting Date: 5/16/22
Harvest Date: 10/26/22
Seeding Rate: 28,000-34,000
Row Spacing (in): 15
Hybrid: Channel® 214-22STX and Channel® 213-19VT2
Reps: 12
Previous Crop: Soybean
Tillage: Field finished
Herbicides: ***Pre:*** Corvus® on 5/17/22 ***Post:*** 72 oz/ac Impact®, 39 oz/ac Roundup PowerMAX®, 0.25 lb/ac atrazine, and 0.7 oz/ac Source™ with 17 lb/100 gal AMS and 0.5 gal/100 COC on 6/16/22
Foliar Fungicides: 12.8 oz/ac Quilt Xcel® and 4 oz/ac bifenthrin 2EC on 8/1/22
Fertilizer: 8 gal/ac 6-24-22 at planting; 200 lb N/ac as 32% UAN and Thio-Sul®
Irrigation: Pivot
Rainfall (in):



Introduction: The objective of this study was to evaluate the impact of Rhyzogreen® by Riogen® on corn yield and profitability. The Rhyzogreen® treatment was applied in-furrow at planting. Rhyzogreen® is a food source for soil microbes. It is designed to impact root structure, plant health, and yield. The product was evaluated on two hybrids, Channel® 214-22STX and Channel® 213-19VT2.

Results: There was no interaction between hybrid and Rhyzogreen® treatment (p=0.19); therefore, hybrid and Rhyzogreen® were analyzed separately.

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
	-------------------- *Rhyzogreen® Treatment* --------------------		
Check	15.2 A*	263 A	1,728 A
Rhyzogreen®	15.2 A	263 A	1,718 A
P-Value	0.638	0.977	0.402
	-------------------- *Variety* --------------------		
Channel® 214-22STX	16.0 A	260 B	-
Channel® 213-19VT2	14.5 B	266 A	-
P-Value	<0.0001	0.002	-

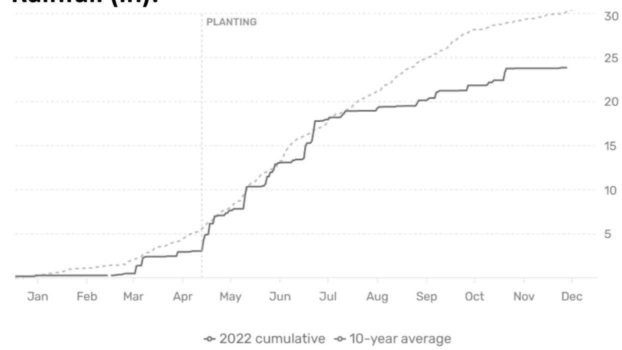
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $6.57/bu corn and $10/ac for Rhyzogreen®.

Summary:

- The use of Rhyzogreen® did not result in an increase in yield or net return.
- Channel® 213-19VT2 hybrid yielded 6 bu/ac more than Channel® 214-22STX. Data were not available to determine the marginal net return for each hybrid.

Impact of Sound Agriculture's SOURCE™ on Non-irrigated Corn

Study ID: 1226095202201
County: Jefferson
Soil Type: Crete silt loam 1-3% slope; Crete silty clay loam 3-7% slopes, eroded; Malmo clay 3-11% slopes, eroded
Planting Date: 4/27/22
Harvest Date: 9/12/22
Seeding Rate: 25,000
Row Spacing (in): 30
Hybrid: DEKALB® DKC59-81RIB and DKC59-82RIB
Reps: 4
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** Roundup® on 4/28/22 ***Post:*** Harness® MAX on 6/1/22; Roundup® on 6/15/22
Seed Treatment: Amplify-D®
Foliar Insecticides: None
Foliar Fungicides: 13.4 oz/ac Trivapro® on 7/22/22
Fertilizer: 15.5 gal/ac 28% UAN (46 lb N/ac) and 3 gal/ac 10-34-0 (3 lb N/ac) on 3/15/22; 6.5 gal/ac 10-18-4 (7 lb N/ac) on 4/27/22; 3 gal/ac 12-0-0-26S (4 lb N/ac) and 12.5 gal/ac 28% UAN (37 lb N/ac) on 5/22/22
Irrigation: None
Rainfall (in):



Introduction: Nitrogen fertilizer is a significant input in corn systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. SOURCE™ by Sound Agriculture is designed to stimulate microbes to allow producers to reduce fertilizer N application and increase yields. SOURCE™ was applied foliarly at V5 in a tank mix with 15 gal/ac of water. This study compared SOURCE™ to an untreated check. The total N rate on the field was 97 lb N/ac. Corn was planted on April 27, 2022, and a cereal rye cover crop was terminated on April 28, 2022, at about 5" height.

Results:

	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Sound Agriculture Source™	11.7 A*	120 A	776 A
Check	11.8 A	120 A	788 A
P-Value	0.972	0.925	0.696

*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 $6.57/bu corn and $14/ac for Source™.

Summary: There was no difference in grain moisture, yield, or net return between the SOURCE™ treatment and the untreated check. Dry conditions led to low yields.

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

PIVOT BIO STUDIES

Nitrogen (N) fertilizer is a significant input in corn-based systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. Pivot Bio products contain an N-fixing bacterial inoculant that is expected to fix N over the growing season. Use of biological N fixation in cereal crops has potential to reduce the use of synthetic N fertilizer, thus increasing N use efficiency and reducing N losses. The objective of these studies was to evaluate Pivot Bio PROVEN® (product available in 2021 only) and PROVEN® 40 on corn yield and net return. In all studies, Pivot Bio was applied at 12.8 oz/ac and compared to an untreated check. Nitrogen rates were selected by the growers. Some studies chose to evaluate Pivot Bio at one N rate, while others chose to evaluate Pivot Bio at additional reduced N rates. Eleven site-years of studies were conducted in Dawson, Buffalo, Richardson, Colfax, York, Dodge, and Seward counties 2021-2022 in Nebraska (Figure 1). Site details for 2021 and 2022 are displayed in Table 1.

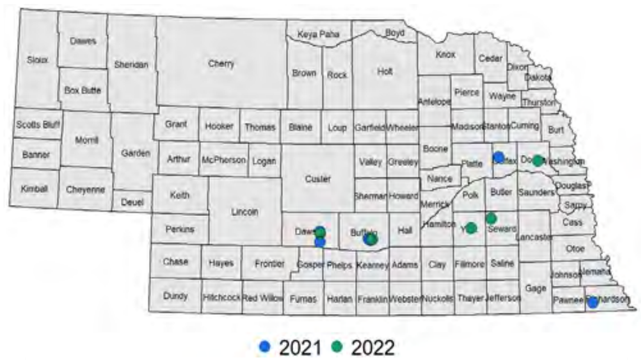


Figure 1. Pivot Bio study locations in Nebraska.

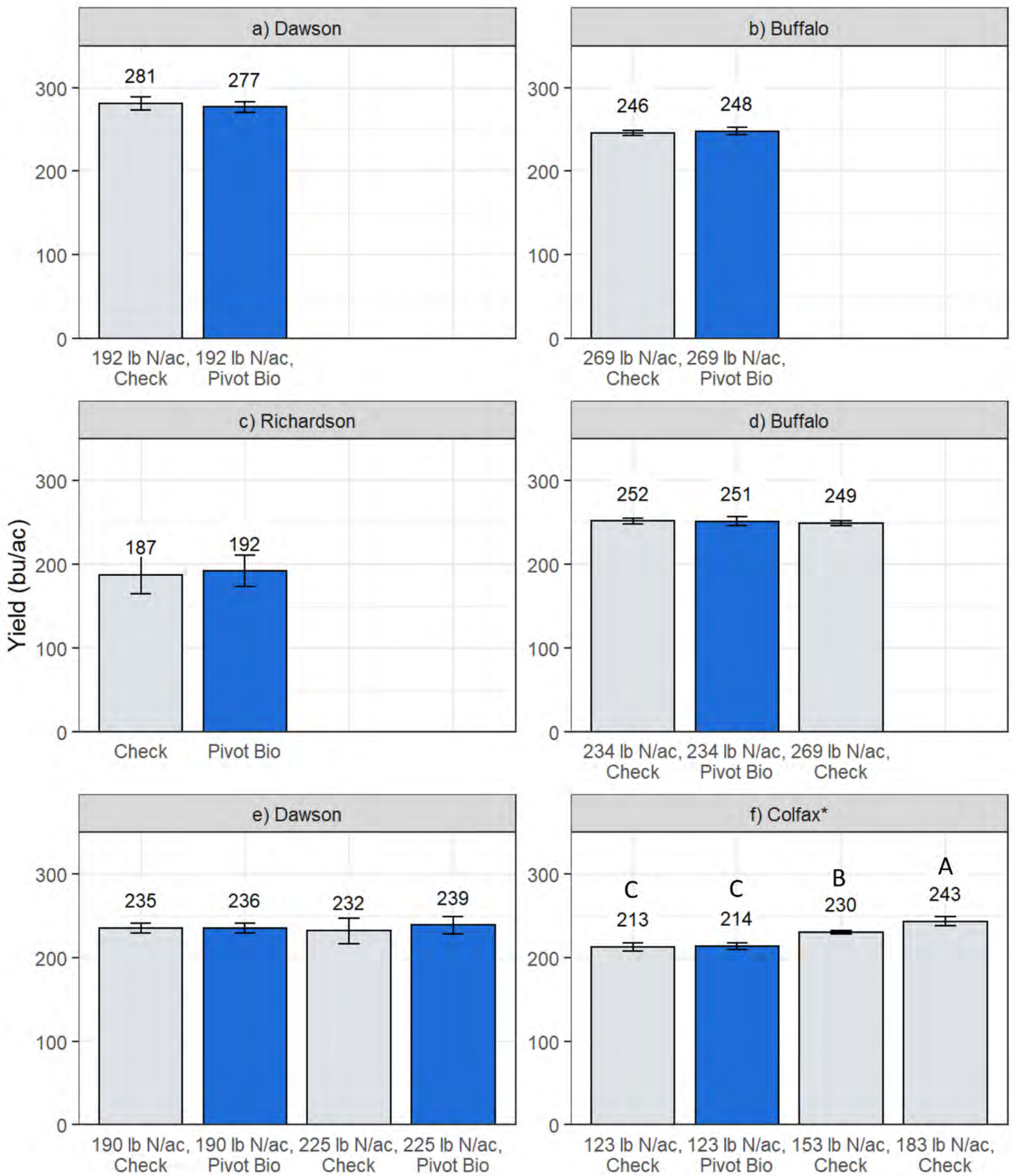
Table 1. Sites, location, nitrogen rates evaluated, Pivot Bio application method, Pivot Bio product, and irrigation method for eleven sites in 2021 and 2022.

ID	Report Book ID	County	Reps	N Rates Tested (lb N/ac)	Pivot Bio Application Method	Pivot Bio Product	Irrigation
2021-a	1262047202101	Dawson	10	192	In-furrow with 10-34-0 starter	PROVEN®	Pivot
2021-b	1121019202103	Buffalo	7	269	In-furrow with 10-34-0 starter	PROVEN®	Pivot
2021-c	1251147202101	Richardson	6	-	In-furrow	PROVEN®	None
2021-d	1121019202102	Buffalo	5	269, 234	In-furrow with 10-34-0 starter	PROVEN® 40	Pivot
2021-e	0709047202101	Dawson	4	225, 190	In-furrow with 1 gal/ac Altura™, 1 gal/ac ReaX™ K, and 0.25 gal/ac ReaX™ Zinc	PROVEN®	Gravity
2021-f	0996037202101	Colfax	4	183, 153, 123	In-furrow with 7-22-5 starter	PROVEN®	None
2022-g	1121019202201	Buffalo	6	238, 197	In-furrow with 10-34-0 starter	PROVEN® 40	Pivot
2022-h	0004053202201	Dodge	4	221, 178	In-furrow with 10-34-0 starter	PROVEN® 40	Pivot
2022-i	0118185202201	York	3	173, 153	In-furrow with 6-24-6 starter	PROVEN® 40	Pivot
2022-j	1402047202201	Dawson	4	185, 145, 105	In-furrow	PROVEN® 40	Pivot
2022-k	1395159202201	Seward	4	142, 106	With starter	PROVEN® 40	Pivot

RESULTS

Yield from the studies were evaluated for each site (Figures 2 and 3) and studies were analyzed as a group by comparing with and without Pivot Bio at the same N rate (Table 2). There was no significant effect of Pivot Bio on yield across 64 replications (p=0.698).

Figure 2: Yield for Pivot Bio product and untreated check at different nitrogen rates for six sites in 2021. Sites with a statistically significant yield difference between treatments are marked with an asterisk; within a site, bars with different letters are significantly different at a 90% confidence level.



RESULTS (CONTINUED)

Figure 3: Yield for Pivot Bio product and untreated check at different nitrogen rates for five sites in 2022. Sites with a statistically significant yield difference between treatments are marked with an asterisk; within a site, bars with different letters are significantly different at a 90% confidence level.

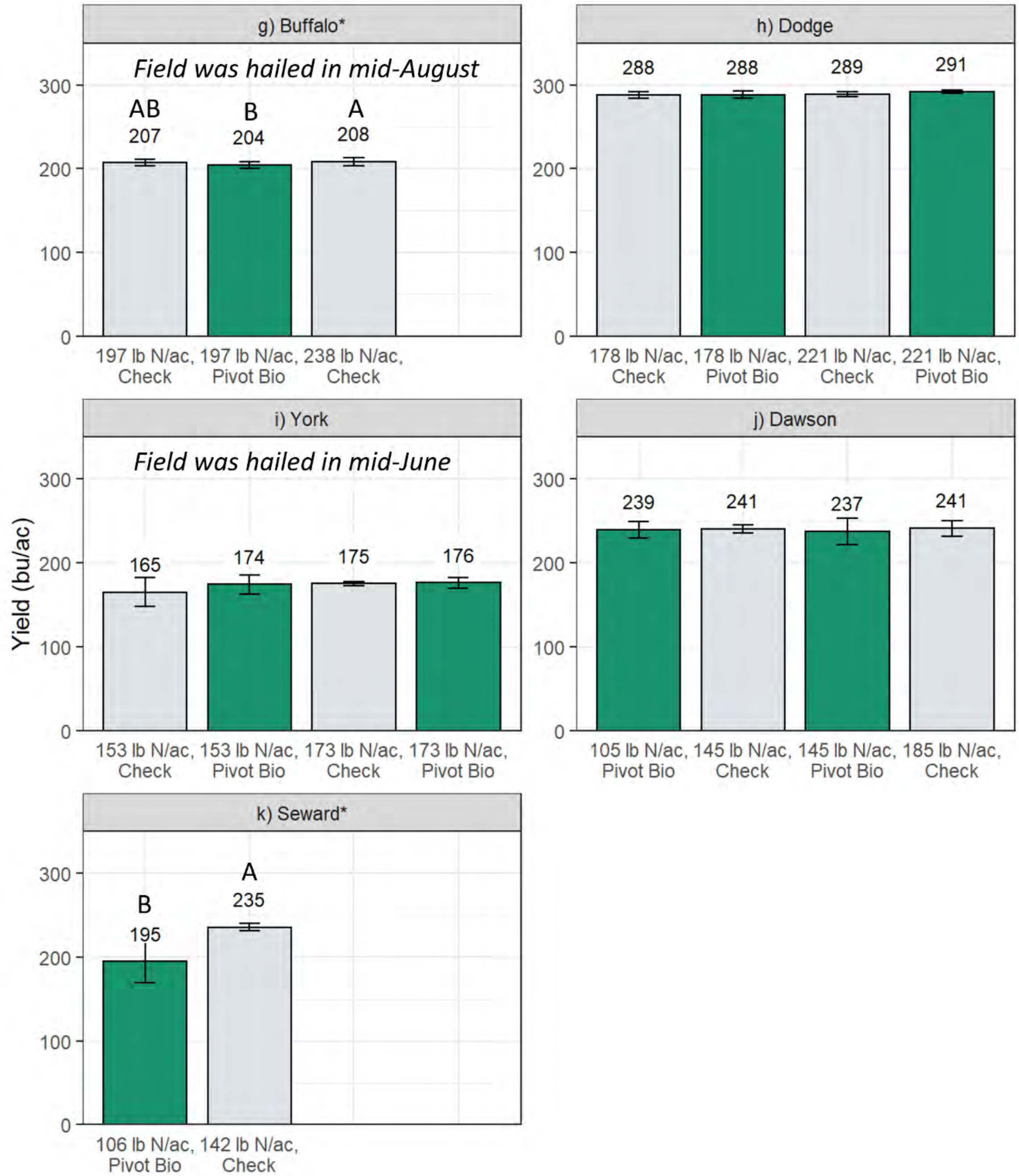


Table 2: Yield with and without Pivot Bio across 64 replications.

	Yield (bu/acre) †
Check	234 A*
Pivot Bio	235 A
Site (P>F)	<0.0001
Treatment (P>F)	0.698
Site*Treatment	0.875

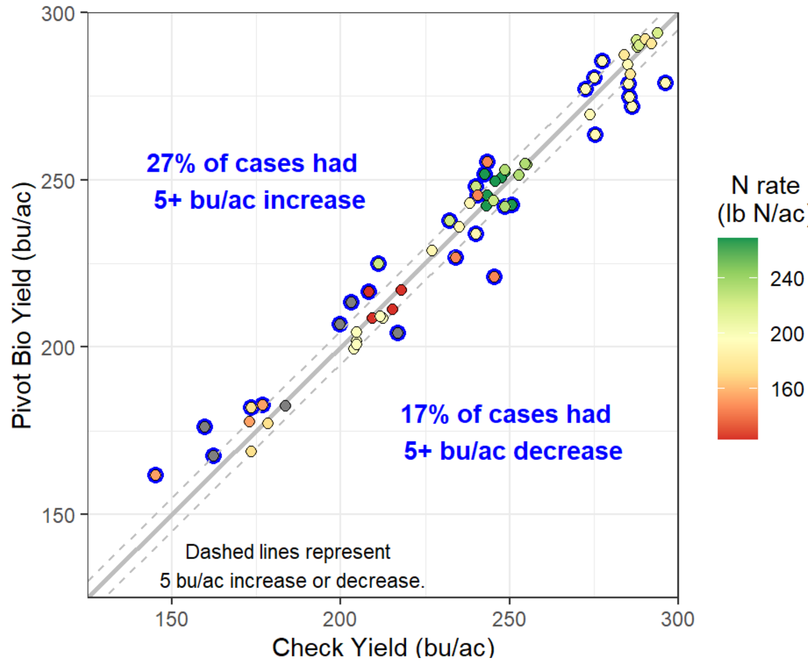
* Values with the same letter are not significantly different at a 90% confidence level.

† Bushels per acre corrected to 15.5% moisture.

RESULTS (CONTINUED)

Across 64 replications, there were 27% of cases where Pivot Bio had a 5 bu/acre or greater yield increase, 17% of cases where Pivot Bio had a 5 bu/acre or greater yield decrease, and 56% of cases where the yield difference was within +/- 5 bu/ac (Figure 4).

Figure 4: Comparison of yield with and without Pivot Bio at equal nitrogen rates across 64 replications.



SUMMARY

⇒ Individual site and combined site analysis did not show a significant effect of Pivot Bio on yield.

⇒ Future research will focus on testing Pivot Bio PROVEN® 40 at a wider range of N rates across different soil textures and landscape positions.

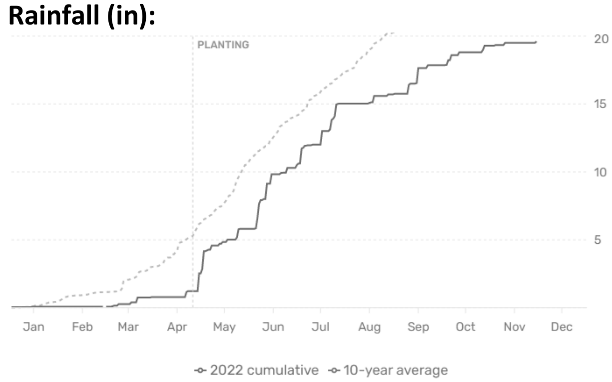
FARMBITS PODCAST

BIOLOGICAL BASICS

David Brown, Director of Engineering at Pivot Bio, joins this episode of the FarmBits podcast to discuss how Pivot Bio is evaluating their products using digital technology. In this episode, we cover the basic of Pivot Bio's PROVEN® products, the challenges with implementing and evaluating the efficacy of biological products, and how progress in evaluative technologies may occur in the near future.

Impact of Pivot Bio PROVEN® 40 at Two Nitrogen Rates on Corn

Study ID: 1121019202201
County: Buffalo
Soil Type: Hord silt loam 0-1% slope
Planting Date: 4/25/22
Harvest Date: 9/22-23/22
Seeding Rate: 34,637
Row Spacing (in): 30
Hybrid: DEKALB® 64-64SSRIB
Reps: 6
Previous Crop: Corn
Tillage: Strip-till
Herbicides: ***Pre:*** 1.5 qt/ac Degree Xtra®, 3 oz/ac generic mesotrione, 1% COC, and 1% UAN on 4/25/22 ***Post:*** none, cultivated
Seed Treatment: Standard Dekalb® seed treatments
Fertilizer: VR 10-34-0 averaging 2.1 gal/ac (2 lb N/ac) with strip-till; 4 gal/ac 10-34-0 (5 lb N/ac) in-furrow and 12 gal/ac 28% UAN (36 lb N/ac) surface dribble starter at planting; 55 gal/ac (contributing 195 lb N/ac for full N treatment) or 43.5 gal/ac (contributing 154 lb N/ac for the reduced N treatment) as 32% UAN on 6/3/22
Note: The field experienced heavy hail damage in mid-August
Irrigation: Pivot, Total: 11.8”
Rainfall (in):



Baseline Soil Samples, 0-8”:

	pH	BpH	OM LOI %	Nitrate – N ppm N	P ppm	Sulfate-S ppm S	-------Melich lll------- K	Ca	Mg	Na	Zn	Fe (DTPA ppm)	Mn	Cu
Average	6.7	7.2	3.3	14.4	25.5	12.4	347	2200	249	33	1.7	15	6.4	0.6
Min	6.3	6.8	2.4	6.8	11	3.4	175	1273	155	21	1.2	9	3.8	0.4
Max	7.1	7.2	3.7	36.7	58	25.2	448	2843	329	41	2.4	22	10	0.9

Introduction: Nitrogen fertilizer is a significant input in corn systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. Pivot Bio PROVEN® 40 is an N-fixing bacterial inoculant that is expected to fix 40 lb N/ac over the growing season. Biological N fixation for cereal crops has potential to increase N efficiency and decrease N losses. The objective of this study was to evaluate Pivot Bio PROVEN® 40 on corn yield and net return. Pivot Bio PROVEN® 40 was applied at a rate of 12.8 oz/ac in-furrow at planting and was compared to an untreated check. The product was evaluated at the grower's full N rate (238 lb N/ac) and a reduced N rate (197 lb N/ac). Fertilizer details are provided at the top of this report. The field experienced heavy hail damage in mid-August that resulted in 80-90% defoliation.

Results:

	Early Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Full N + No Pivot Bio	31,500 A*	15.9 A	208 A	1,253 A
Reduced N + No Pivot Bio	32,056 A	16.0 A	207 AB	1,267 A
Reduced N + Pivot Bio	31,278 A	15.9 A	204 B	1,230 B
P-Value	0.798	0.788	0.043	0.007

*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 $6.57/bu corn, $0.59/lb N for sidedress application, and $20/ac for Pivot Bio PROVEN® 40.

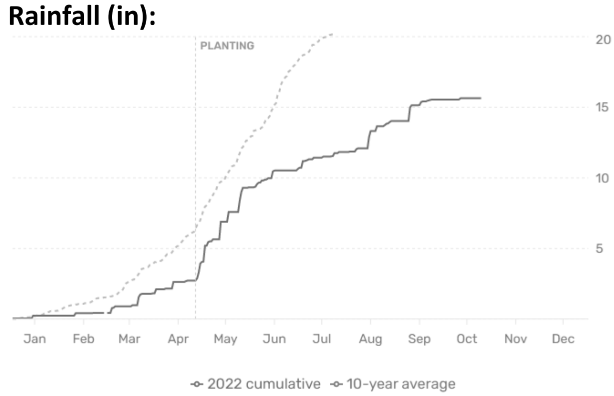
Summary:

- There were no differences in stand count or grain moisture between the three treatments evaluated.
- The full N rate with no Pivot Bio PROVEN® 40 resulted in yields that were 4 bu/ac higher than the reduced N with Pivot Bio PROVEN® 40. There were no statistically significant differences in yield between the reduced N with Pivot Bio PROVEN® 40 and without Pivot Bio PROVEN® 40.
- The reduced N with Pivot Bio PROVEN® 40 resulted in $30/ac lower net return on average than the treatments that did not use Pivot Bio PROVEN® 40.

Impact of Pivot Bio PROVEN® 40 at Two Nitrogen Rates on Corn

Study ID: 0004053202201
County: Dodge
Soil Type: Moody silty clay loam 2-6% slopes; Moody silty clay loam 0-2% slope; Moody silty clay loam 6-11% slopes; Alcester silty clay loam 2-6% slopes
Planting Date: 4/26/22
Harvest Date: 10/9/22
Seeding Rate: 33,600
Row Spacing (in): 30
Hybrid: Hoegemeyer® 8531 Q
Reps: 4
Previous Crop: Soybean
Tillage: Unknown
Herbicides: ***Pre:*** 2 qt/ac Keystone® LA on 4/28/22
Post: 31 oz/ac atrazine on 6/3/22
Seed Treatment:
Foliar Insecticides: 0.16 oz/ac Capture® LFR® on 4/26/22
Foliar Fungicides: 15 gal/ac FORTIX® on 6/22/22

Fertilizer: 5 gal/ac 10-34-0 contributing 6 lb N/ac on 4/26/22; 20.5 gal/ac 32% UAN contributing 73 lb N/ac on 4/28/22; 28 gal/ac (contributing 99 lb N/ac for reduced N treatment) or 40 gal/ac (contributing 142 lb N/ac for full N treatment) as 32% UAN on 6/2/22
Irrigation: Pivot
Rainfall (in):



Introduction: Nitrogen fertilizer is a significant input in corn systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. Pivot Bio PROVEN® 40 is an N-fixing bacterial inoculant that is expected to fix 40 lb N/ac over the growing season. Biological N fixation for cereal crops has potential to increase N efficiency and decrease N losses. The objective of this study was to evaluate Pivot Bio PROVEN® 40 on corn yield and net return. Pivot Bio PROVEN® 40 was applied at a rate of 12.8 oz/ac in-furrow with 5 gal/ac of 10-34-0 starter fertilizer and was compared to an untreated check. The product was evaluated at the grower's full N rate (221 lb N/ac) and a reduced N rate (178 lb N/ac).

Results:

	Early Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Full N Rate + No Pivot Bio	30,928 A*	14.5 AB	289 A	1,659 B
Full N Rate + Pivot Bio	32,147 A	14.7 A	292 A	1,654 B
Reduced N Rate + No Pivot Bio	30,579 A	14.3 B	288 A	1,697 A
Reduced N Rate + Pivot Bio	32,496 A	14.3 B	288 A	1,679 AB
P-Value	0.121	0.059	0.160	0.012

*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 $6.57/bu corn, $1.09/lb N fertilizer, and $20/ac for Pivot Bio PROVEN® 40.

Summary:

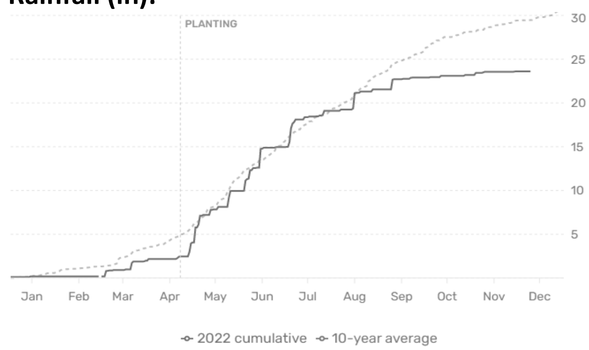
- There were no differences in stand counts among the N rates and products evaluated.
- There were statistically significant differences in grain moisture, but differences were not greater than 0.4% moisture.
- Yield averaged 289 bu/ac for the plot area and did not differ among the treatments evaluated. The use of Pivot Bio PROVEN® 40 did not increase yields at the low or high N rate. Further, the low N rate yielded as well as the high N rate.
- Marginal net return was significantly different among the treatments. The highest profit was obtained by the low N rate with no Pivot Bio PROVEN® 40, resulting in an increase of $37.20/ac compared to the grower's standard practice (high N with no Pivot Bio PROVEN® 40).

Impact of Pivot Bio PROVEN® 40 at Two Nitrogen Rates on Corn

This study was completed as part of the Innovative Youth Corn Challenge by the team Crop Science Investigation (CSI)-York

Study ID: 0118185202201
County: York
Soil Type: Hastings silt loam 0-1% slope; Hastings silt loam 1-3% slope
Planting Date: 4/22/22
Harvest Date: 9/23/22
Seeding Rate: 32,500
Row Spacing (in): 30
Hybrid: DEKALB® DKC59-82RIB
Reps: 3
Previous Crop: Soybean
Tillage: Planted no-till on ridges, row cultivated once to apply sidedress N
Herbicides: ***Pre:*** Balance® Flexx and Degree® Xtra

Fertilizer: 150 lb N/ac as anhydrous applied with CENTURO® in the fall; 5 gal/ac 6-24-6 (3 lb N/ac) applied during planting on 4/22/22; 20 lb N/ac applied with cultivator on 6/14/22 (only applied to Full N treatment strips)
Irrigation: Pivot, Total: 6.5"
Rainfall (in):



Introduction: Nitrogen fertilizer is a significant input in corn systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. Pivot Bio PROVEN® 40 is an N-fixing bacterial inoculant that is expected to fix 40 lb N/ac over the growing season. Biological N fixation for cereal crops has potential to increase N efficiency and decrease N losses. The objective of this study was to evaluate Pivot Bio PROVEN® 40 on corn yield and net return. Anhydrous ammonia was applied at a rate of 150 lb N/ac in the fall with CENTURO® inhibitor. Pivot Bio PROVEN® 40 was applied at a rate of 12.8 oz/ac in-furrow with 5 gal/ac of 6-24-6 starter fertilizer and was compared to an untreated check. 20 lb N/ac was applied on June 14 to the full N treatment strips prior to the hail event. The field had severe hail damage from the June 14 hailstorm, but was not totaled or replanted. An additional N application was planned for the full N treatment but was omitted due to the hail. Total N rates including the starter fertilizer were 173 lb N/ac for the full N treatment and 153 lb N/ac for the reduced N treatment.

Results:

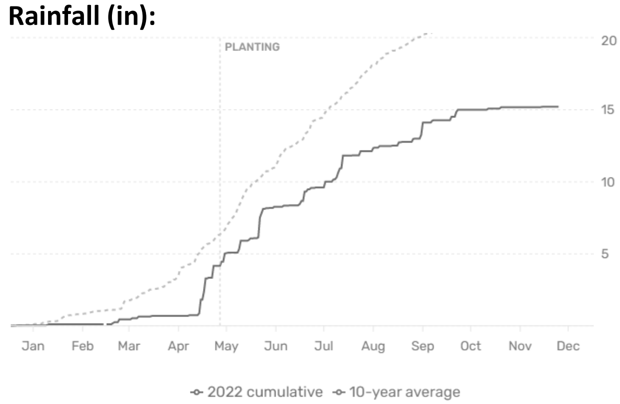
	Early Season Stand Count (plants/ac)	Late Season Stand Count (plants/ac)	Stalk Rot (%)	Grain Fill Tissue N (%)	Moisture (%)	Yield† (bu/ac)	Marginal Net Return‡ ($/ac)
Full N Rate + No Pivot Bio	28,333 A*	27,000 A	36.67 A	1.6	15.7 A	175 A	1,086 A
Full N Rate + Pivot Bio	27,333 A	25,333 A	33.33 A	1.9	16.1 A	176 A	1,068 A
Reduced N Rate + No Pivot Bio	30,000 A	27,333 A	35.00 A	1.9	15.8 A	165 A	1,027 A
Reduced N Rate + Pivot Bio	29,333 A	29,333 A	36.67 A	2.0	16.1 A	174 A	1,062 A
P-Value	0.477	0.298	0.895	-	0.244	0.285	0.514

*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 $6.57/bu corn, $0.38/lb N, and $25/ac for Pivot Bio PROVEN® 40.

Summary: There were no differences in stand counts, stalk rot, grain moisture, yield, or net return among the treatments. Tissue samples were only collected for one replication, so no conclusions can be drawn. It was observed that ears were low to the ground and Palmer amaranth was worse in the first replication.

Impact of Pivot Bio PROVEN® 40 at Three Nitrogen Rates on Corn

Study ID: 1402047202201
County: Dawson
Soil Type: Cozad silt loam 0-1% slope
Planting Date: 5/11/22
Harvest Date: 10/4-5/22
Seeding Rate: 34,000
Row Spacing (in): 36
Hybrid: Hoegemeyer® 8235
Reps: 4
Previous Crop: Corn
Tillage: Strip-till
Herbicides: ***Post:*** 6 oz/ac DiFlexx®, 1.5 qt/ac Resicore®, 1 pt/ac atrazine 4L, 16 oz/ac Destiny® HC, 28 oz/ac Cornerstone® 5 Plus, 3 oz/ac InterLock®, and 32 oz/ac Class Act® NG® on 5/27/22. 5 oz/ac Status®, 3 pt/ac Sequence®, 1 pt/ac atrazine 4L, 3 oz/ac InterLock®, and 29 oz/ac Class Act® NG® applied on 6/21/22
Seed Treatment: None
Fertilizer: 32% UAN applied at rates based on treatments applied on 4/9/22; 2 rounds of fertigation totaling 40 lb N/ac applied as 32% UAN; 17 lb N/ac from manure
Note: The pivot put on 1/2 inch between strip tillage and planting. The pivot rolled over in a storm 5/12/22. Pivot was replaced and running again 6/15/22
Irrigation: Pivot, Total: 21"
Rainfall (in):



Baseline Soil Samples, 0-8" (January 2022):

	pH	OM LOI %	Melich-lll P ppm	Nitrate – N ppm N	Sulfate-S ppm S	-------Melich lll------- K	Ca	Mg	Na	CEC me/100g
Sample 1	7.4	2.8	125	21.7	30	727	2990	485	69	21

Introduction: Nitrogen fertilizer is a significant input in corn systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. Pivot Bio PROVEN® 40 is an N-fixing bacterial inoculant that is expected to fix 40 lb N/ac over the growing season. Biological N fixation for cereal crops has potential to increase N efficiency and decrease N losses. The objective of this study was to evaluate Pivot Bio PROVEN® 40 on corn yield and net return. Pivot Bio PROVEN® 40 was applied at a rate of 12.8 oz/ac in-furrow and compared to an untreated check. The grower evaluated a no Pivot Bio PROVEN® 40 check at his standard rate (185 lb N/ac) and at a 40 lb N/ac reduction rate (145 lb N/ac). The Pivot Bio PROVEN® 40 product was evaluated at a 40 lb N/ac reduction rate (145 lb N/ac) and an 80 lb N/ac reduction rate (105 lb N/ac). Fertilizer rates were established with 32% UAN applied on April 9.

Results:

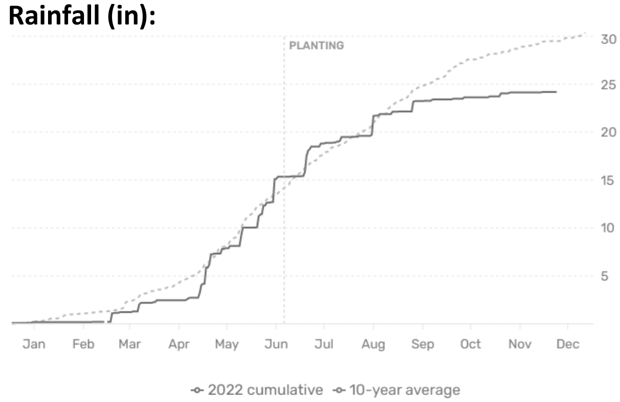
	Early Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Full N Rate + No Pivot Bio	31,917 A*	27.3 A	241 A	1,416 A
Reduced N 40 + No Pivot Bio	32,667 A	27.2 A	241 A	1,454 A
Reduced N 40 + Pivot Bio	32,167 A	27.2 A	237 A	1,410 A
Reduced N 80 + Pivot Bio	32,000 A	26.9 A	239 A	1,462 A
P-Value	0.578	0.536	0.877	0.369

*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 $6.57/bu corn, $1/lb N, and $21/acre for Pivot Bio PROVEN® 40.

Summary: There were no differences between treatments in the stand counts, grain moisture, grain yield, and marginal net return. The results of this study demonstrate an opportunity for N fertilizer savings in this field.

Impact of Pivot Bio PROVEN® 40 at Two Nitrogen Rates on Replanted Corn

Study ID: 0718185202201
County: York
Soil Type: Hastings silt loam 0-1% slope; Hastings silt loam 1-3% slope; Butler silt loam 0-1% slope
Planting Date: 6/20/22
Harvest Date: 11/2/22
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P0075Q
Reps: 8
Previous Crop: Seed corn
Tillage: Root slice before planting; row cultivation
Herbicides: ***Pre:*** 1.5 qt/ac Volley® ATZ NXT and 24 oz/ac Durango® at planting ***Post:*** 5 oz/ac Status®, 24 oz/ac Durango®, and 1.5 pt/ac Warrant® on 7/11/22
Seed Treatment: None
Foliar Insecticides: 6.4 oz/ac Brigade® 2 EC on 8/17/22
Fertilizer: 5 gal/ac 10-34-0 at planting; spring applied anhydrous ammonia at two rates resulting in 180 lb N/ac (reduced N rate treatment) and 220 lb N/ac (full N rate treatment)
Irrigation: Pivot, Total: 7"
Rainfall (in):



Soil Tests: (October 2021)

Soil pH 1:1	Soluble Salts 1:1 mmho/cm	OM LOI-%	KCl Nitrate ppm N	Nitrate lb N/ac	P ppm	-Ammonium Acetate- K ppm	Ca ppm	Mg ppm	NA ppm	------------DTPA------------ Zn ppm	Fe ppm	Mn ppm	Cu ppm	Sum of Cations me/100g	% Base ---Saturation--- H	K	Ca	Mg	Na
7.3	0.18	2.8	4.7	14	33	309	2393	297	68	2.01	19.6	3.3	0.39	15.5	0	5	77	16	2
7.3	0.17	3.0	7.9	24	26	324	2523	330	75	2.11	15.9	4.0	0.37	16.5	0	5	76	17	2

Introduction: Nitrogen fertilizer is a significant input in corn systems. Additionally, N losses through leaching, volatilization, and denitrification pose environmental concerns and reduce profit. Pivot Bio PROVEN® 40 is an N-fixing bacterial inoculant that is expected to fix 40 lb N/ac over the growing season. Biological N fixation for cereal crops has potential to increase N efficiency and decrease N losses. The objective of this study was to evaluate Pivot Bio PROVEN® 40 on corn yield and net return. Pivot Bio PROVEN® 40 was applied at a rate of 12.8 oz/ac in-furrow with 5 gal/ac of 10-34-0 starter fertilizer and was compared to an untreated check. Two rates of anhydrous ammonia were applied in the spring resulting in 220 lb N/ac (grower's normal rate) and 180 lb N/ac (reduced rate). Total N rates including the starter fertilizer were 226 lb N/ac for the full N treatment and 186 lb N/ac for the reduced N treatment.

Wheat was planted at the time of male row destruction in seed corn during 2021. The corn crop was planted into the green wheat, and wheat was terminated the same day. The corn crop planted on May 16, 2022, was hailed out on June 14, 2022. A root slicer was used on the hailed out corn and the second corn crop was planted onto the same rows on June 20, 2022. No additional nitrogen or Pivot Bio PROVEN® 40 was applied to the replant corn. The efficacy of the Pivot Bio PROVEN® 40 product is unknown given the non-optimal conditions for use.

Results:

	Stand Count (plants/ac)	Stalk Rot (%)	Greensnap (%)	Moisture (%)	Yield† (bu/ac)	Residual Nitrate (ppm)		Marginal Net Return‡ ($/ac)
						0-8”	8-24”	
Full N Rate + No Pivot Bio	28,333 A*	71.7 C	19 A	18.4 A	193 A	16 A	22 A	1,073 B
Full N Rate + Pivot Bio	27,833 A	75.8 BC	22 A	18.3 A	191 B	15 A	33 A	1,037 C
Reduced N Rate + No Pivot Bio	27,000 A	81.7 A	22 A	18.3 A	193 A	9 B	17 A	1,106 A
Reduced N Rate + Pivot Bio	29,833 A	77.5 AB	9 A	18.3 A	191 B	14 AB	29 A	1,072 B
P-Value	0.483	0.011	0.294	0.511	0.001	0.034	0.519	<0.0001

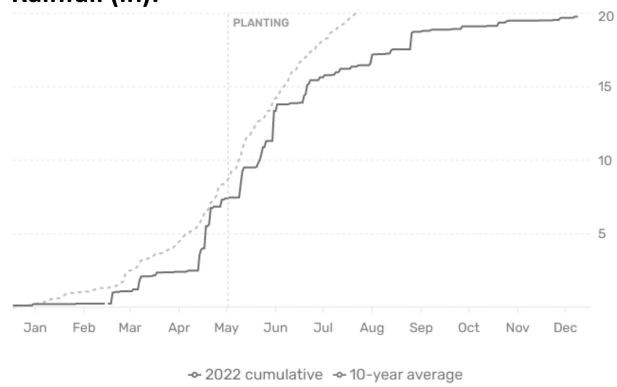
*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡Marginal net return based on $6.57/bu corn, $0.89/lb N, and $20/ac for Pivot Bio PROVEN® 40.

Summary:

- Because the field was replanted late following the hail event, the corn was killed prematurely by frost. The top portions of the plants were frost damaged on October 8, 2022, when the corn was at 1/3 milk line. The plants were then killed completely by a frost on October 16, 2022, when the corn was at 1/2 milk line.
- There were no differences in stand counts or greensnap among the treatments. Greensnap was caused by high winds on October 23, 2022. Stalk rot differed between the treatments, with the highest stalk rot for the reduced N treatment and the lowest stalk rot for the full N treatment. In total, stalk rot differed by 10% among treatments.
- Yield was 2 bu/ac higher for the treatments with no Pivot Bio PROVEN® 40 compared to the treatments with Pivot Bio PROVEN® 40. For the treatments without Pivot Bio PROVEN® 40, there were no differences in yield between the full N and reduced N. Similarly, for the treatments with Pivot Bio PROVEN® 40, there were no differences in yield between the full N and reduced N. The efficacy of the Pivot Bio PROVEN® 40 product is unknown given the non-optimal conditions for use with replanted corn.
- The highest marginal net return was for the reduced N treatment with no Pivot Bio PROVEN® 40, which was $33/ac higher than the grower’s traditional management (full N treatment with no Pivot Bio PROVEN® 40). The lowest marginal net return was for the full N with Pivot Bio PROVEN® 40 treatment, which was $36/ac lower than the grower’s traditional management (full N treatment with no Pivot Bio PROVEN® 40) and $69/ac lower than the most profitable treatment (reduced N rate with no Pivot Bio PROVEN® 40).
- End-of-season soil nitrate samples showed lower residual nitrate for the reduced N rate with no Pivot Bio PROVEN® 40 at the 0-8” depth. There were no differences among treatments at the 8-24” depth.

Biological Treatment Study in Corn

Study ID: 1395159202201
County: Seward
Soil Type: Muir silt loam 1-3% slope; Hall-Olbut complex 1-3% slope
Planting Date: 5/16/22
Harvest Date: 10/19/22
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Seitec® 6345
Reps: 4
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** 1.5 qt/ac generic Lexar®, 32 oz/ac Buccaneer 5 Extra®, 10 oz/ac generic Dual®, 2.5 lb/ac AMS, and 4.7 oz/ac Absorb 100 on 5/20/22
Post: 1.7 qt/ac generic Lexar®, 0.3 qt/ac atrazine 4L, 5 oz/ac Status®, 2.6 lb/ac AMS, and 5 oz/ac Padlock® on 6/14/22
Foliar Insecticides: 3 oz/ac Brigade® 2EC applied during burndown on 5/20/22
Foliar Fungicides: None
Fertilizer: 13.5 gal/ac 32% UAN, 1.5 gal/ac Thio-Sul®, and CVA® Elite Protect UAN applied at planting dribbled behind closing wheel; sidedress N according to treatments
Note: Headed (pre-pollination) rye cover crop was rolled down and sprayed to terminate at planting time
Irrigation: Pivot, Total: 10"
Rainfall (in):



Introduction: With increasing nitrogen costs, this study evaluated several biological products at different N rates to determine any impacts on yield and economics. The six treatments are as follows:

1. Check (total 142 lb N/ac): 48 lb N/ac with 2.75 gal/ac AgroLiquid® Pro-Germinator® 9-24-3-0.1% Iron and 0.25 gal zinc sulfate (4%) applied at planting and 94 lb N/ac applied as 32% UAN and thiosulfate on June 23.

2. Johnson-Su Compost High (total 106 lb N/ac): 48 lb N/ac at planting with 8 gal/ac compost extract in-furrow and 58 lb N/ac applied as 32% UAN and thiosulfate on June 23.

3. Johnson-Su Compost Low (total 48 lb N/ac): 48 lb N/ac at planting with 8 gal/ac compost extract in-furrow.

4. Turned Compost High (total 106 lb N/ac): 48 lb N/ac at planting with 8 gal/ac compost extract in-furrow and 58 lb N/ac applied as 32% UAN and thiosulfate on June 23.

5. Turned Compost Low (total 48 lb N/ac): 48 lb N/ac at planting with 8 gal/ac compost extract in-furrow.

6. Pivot Bio PROVEN® 40 (total 106 lb N/ac): 48 lb N/ac with 2.75 gal/ac AgroLiquid® Pro-Germinator® 9-24-3-0.1% Iron and 0.25 gal zinc sulfate (4%) applied at planting and 58 lb N/ac applied as 32% UAN and thiosulfate on June 23. Pivot Bio PROVEN® 40 was applied with starter at planting.

Johnson Su compost was produced as an aerobic static compost made from straw and cow manure (https://www.csuchico.edu/regenerativeagriculture/bioreactor/bioreactor-instructions.shtml). It was extracted into water at a rate of 3 lb compost/8 gal of water and applied at 8 gal extract/ac.

The Turned Compost was produced on farm with a wide range of material (wood chips, leaves, hay, manure, etc. https://www.livingsoil.ne). It was turned five times after reaching temperatures of 130-150°F. It was extracted into water at a rate of 3 lb compost/8 gal of water and applied at 8 gal extract/ac.

Biology from both composts are believed to improve fertility and help release soil nutrients.

Pivot Bio PROVEN® 40 is a N-fixing bacterial inoculant that is expected to fix 40 lb N/ac over the growing season. Biological N fixation for cereal crops has potential to increase N efficiency and decrease N losses.

Tissue samples were collected from one replication at three different times during the season to determine nitrogen content of the corn leaves. Haney and PLFA soil health tests were taken from the high rate of each treatment in the first replication on September 7, 2022. These were taken to determine any differences at this point of time and will be compared in a few years as the goal is to keep the treatments on the same strips.

Figure 1. Assembled turned Compost pile (left), creating compost extract from compost (center), field after planting (right).

Results:

Table 1. Tissue samples taken at V6, V10, and tassel growth stages during the 2022 growing season for one replication of check and biological treatments. No stats due to one rep.

	V6 (%N)	V10 (%N)	Tassel (%N)
Check	4.8	2.4	2.6
Johnson Su High	5.4	2.3	2.4
Johnson Su Low	5.4	2.0	2.1
Turned Compost High	4.5	2.1	2.8
Turned Compost Low	4.5	2.0	2.0
Pivot Bio	5.8	2.3	2.6

Table 2. Phospholipid fatty acid (PLFA) and Haney tests for the check and biological treatments at 0-8” depth taken on September 7, 2022 for one replication. No stats due to one rep.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
	------------------- 2022 -------------------					
Check	4040	1.02	1376	60	102.3	12.9
Johnson Su High	3230	0.95	1108	24	125.8	16.4
Turned Compost High	2728	0.80	841	17	111.8	15.7
Pivot Bio	4381	1.11	1559	97	141.7	19.6

	Stand Count (plants/ac)	Stalk Rot (%)	Test Weight (lb/bu)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	31,500 A*	31.88 C	58 A	16.0 A	235 A	1,399 A
Johnson Su High	31,500 A	46.88 BC	58 A	15.4 A	220 AB	1,365 A
Johnson Su Low	31,000 A	75.63 A	58 A	14.9 A	167 C	1,095 C
Turned Compost High	30,500 A	58.25 AB	58 A	15.5 A	212 AB	1,315 AB
Turned Compost Low	29,625 A	59.38 AB	58 A	15.6 A	164 C	1,068 C
Pivot Bio Proven® 40	31,625 A	61.88 AB	58 A	15.6 A	195 B	1,155 BC
P-Value	0.276	0.004	0.659	0.697	<0.0001	0.0001

*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 $6.57/bu corn, $6/ac for Turned compost, $4/ac for Johnson-Su, $21/ac for Pivot Bio PROVEN® 40, $1.27/lb of sidedress N, and $28/ac for starter.

Summary:

- There were no differences in stand counts, grain moisture, or test weight among the treatments evaluated.
- Stalk rot varied greatly among the treatments and was lowest for the check treatment.
- The check treatment had the highest yield. Yields for Johnson-Su and turned compost were significantly higher when the treatment had an additional 58 lb N/ac compared to the same treatments with no sidedress N. The Pivot Bio PROVEN® 40 with 58 lb N/ac, Johnson-Su with no sidedress, and turned compost with no sidedress all yielded significantly lower than the check.
- The highest net return was for the check treatment but was not significantly different than Johnson-Su with sidedress and turned compost with sidedress. Johnson-Su with sidedress and turned compost with sidedress were significantly more profitable than the same treatments with no sidedress. Pivot Bio PROVEN® 40 with sidedress, Johnson-Su without sidedress, and turned compost without sidedress all had significantly lower net return than the check.

COVER CROPS

COVER CROP INTERSEEDING STUDIES

These studies evaluated the impact of interseeded cover crops on corn and soybean yield and soil quality. This three-year on-farm research study is a collaboration of Nebraska Extension, The Nature Conservancy, Upper Big Blue Natural Resources District (NRD), USDA Natural Resources Conservation Service (NRCS), and Kellogg's.

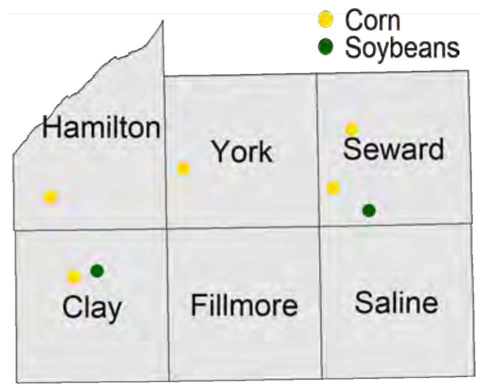


Figure 1. Interseeding study

SITES

Six sites evaluated the impact of interseeding into corn while two sites evaluated the impact of interseeding into soybeans. Sites were located in Seward, York, Clay, and Hamilton counties in 2020-2022 (Figure 1). Site details are displayed in Table 1. All cover crops were interseeded at the V3-V4 growth stage for corn and VC or V2 growth stage for soybean. Cover crop and weed biomass were measured for all corn sites in late September (Figure 2).

Table 1. Sites, location, cover crop mixtures, year, interseeding dates, row direction and irrigation status for eight sites evaluating cover crop interseeding into corn and soybean in 2020, 2021, and 2022.

Site	County	Cover Crop Mix	Interseeding Date			Row Direction	Irrigation	Crop
			2020	2021	2022			
CORN STUDIES								
1	Seward	Diversity Mix	6/1/20	-	6/1/22	East-West	SDI	Corn
2	Clay	Nitrogen Mix	6/3/20	6/2/21	5/31/22	North-South	Pivot	Corn
3	York	Custom Mix	6/1/20	6/6/21	-	North-South	Pivot	Corn
4	Seward	Diversity Mix	6/8/20	-	-	East-West	Pivot	Corn
5	Hamilton	Diversity Mix	6/3/20	6/14-15/21	-	East-West	Pivot	Corn
6	Seward	Diversity Mix	6/8/20	7/1/21	-	North-South	Pivot	Corn
SOYBEAN STUDIES								
7	Seward	Wheat/Red Clover	-	5/26/21	-	East-West	Pivot	Soybean
8	Clay	Wheat/Red Clover	-	6/4/21	-	East-West	Pivot	Soybean

MIXES

2020 Diversity Mix: The diversity mix consisted of 4 lb/ac hairy vetch, 4 lb/ac Pinkeye cowpea, 1 lb/ac red clover, 1 lb/ac yellow blossom sweetclover, 4 lb/ac Red Ripper cowpea, 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 the mix was used (13 lb/ac) at a cost of $16.86/ac.

2020 Nitrogen Mix: The nitrogen mix consisted of 4 lb/ac Laredo forage soybean, 2 lb/ac yellow blossom sweetclover, 1.5 lb/ac red clover, 4 lb/ac hairy vetch, 6 lb/ac Red Ripper cowpea, 4 lb/ac Pinkeye cowpea, 0.5 lb/ac Nitro radish, 0.5 lb/ac impact forage collards, and 4 lb/ac Mancan buckwheat. A half rate of the mix was used (13 lb/ac) at a cost of $18.16/ac.

2021 Diversity Mix: The diversity mix consisted of 2 lb/ac MT hairy vetch, 2 lb/ac Iron & Clay cowpea (less aggressive than Red Ripper in 2020), 1 lb/ac red clover, 1 lb/ac yellow blossom sweetclover, 5 lb/ac Winterhawk annual ryegrass (diploid), 0.51 lb/ac Nitro radish, 0.51 lb/ac impact forage collards, 3 lb/ac Mancan buckwheat, 1.51 lb/ac golden flax, and 0.51 lb/ac Laredo forage soybean. The total rate was 17 lb/ac and cost $22.15/ac.

2021 Nitrogen Mix: The nitrogen mix consisted of 4.8 lb/ac Laredo forage soybean, 3.3 lb/ac yellow blossom sweetclover, 3.3 lb/ac medium red clover, 4.8 lb/ac MT hairy vetch, 8 lb/ac Iron & Clay cowpea, 0.43 lb/ac purple top turnip, 0.54 lb/ac impact forage collards, and 6.4 lb/ac Mancan buckwheat. The total rate was 31.5 lb/ac and cost $46.21/ac.

2021 Mix for Soybean: The soybean mix included 26 lbs of hard red winter wheat and 10 lbs of red clover. The total rate was 36 lb/ac and cost $26.50/ac.

2022 Diversity Mix: The diversity mix consisted of 2.5 lb/ac Iron & Clay cowpea, 2 lb/ac mung beans, 3 lb/ac Laredo forage soybeans, 2 lb/ac yellow blossom sweetclover, 4 lb/ac medium red clover, 4 lb/ac Winterhawk annual ryegrass, 0.5 lb/ac impact forage collards, 0.5 lb/ac purple top turnips, 3 lb/ac Mancan buckwheat, and 2 lb/ac brown flax. The total rate was a half rate of 12.25 lb/ac and cost $22.89/ac.

RESULTS AND SUMMARY

WEED AND COVER CROP BIOMASS

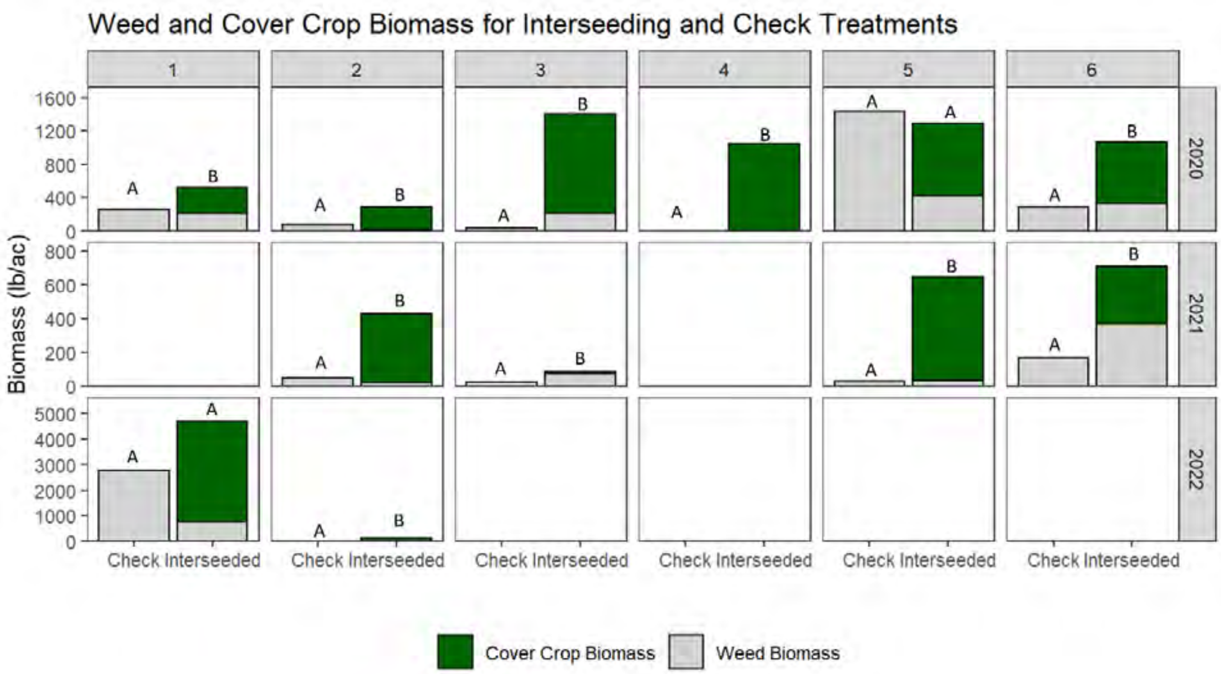


Figure 2. The average for weed and cover crop biomass for interseeded and check treatments for corn site numbers one through six. Values with the same letter are not significantly different at a 90% confidence level. Sites 3, 4, 5, and 6 in 2022 were lost due to June 14 hailstorm.

Average cover crop biomass accumulated varied by site and year (Figure 2).
In 2020, there was greater biomass due to aggressive Red Ripper cowpea and a July 9, 2020, windstorm that opened up the corn canopy. Biomass ranged from an average of 277 lb/ac at site 2 to 2,192 lb/ac at site 4.

In 2021, Iron & Clay cowpeas replaced the Red Ripper cowpeas in the nitrogen and diversity mixes to reduce aggressive growth. The cover crop in the corn at many of the 2021 sites would have benefited from an irrigation shortly after interseeding to help with establishment during a dry early June. Cover crop biomass ranged from an average of 87 lb/ac at site 3 to 710 lb/ac at site 6.

In 2022, a June 14 hailstorm resulted in the loss of sites 3 and 6. Sites 4 and 5 were abandoned due to residual herbicide issues interfering with interseeding. Excellent cover crop emergence and growth occurred at sites 1 and 2 due to early watering of the cover crops. A very tall, wide-leafed hybrid at site 2 shaded out the cover crop, greatly reducing the biomass by late September. At site 1, lack of rain and a subsurface drip irrigation system rather than center pivot may have reduced the efficacy of the residual in the pre-emerge herbicide. Dry conditions at post-emerge herbicide application may have also resulted in higher weed biomass at this location. Cover crop biomass ranged from an average of 121 lb/ac at site 2 to 3,926 lb/ac at site 1. In 10 of 12 cases where biomass was measured, the interseeded cover crop treatment had a greater total biomass (weed and cover crop) compared to the check treatment. Soybean biomass was not measured at site 7 to avoid damage to the soybeans prior to harvest and there was no biomass to measure at site 8 prior to harvest due to the thick soybean canopy shading out the cover crop.

YIELD AND NET RETURN

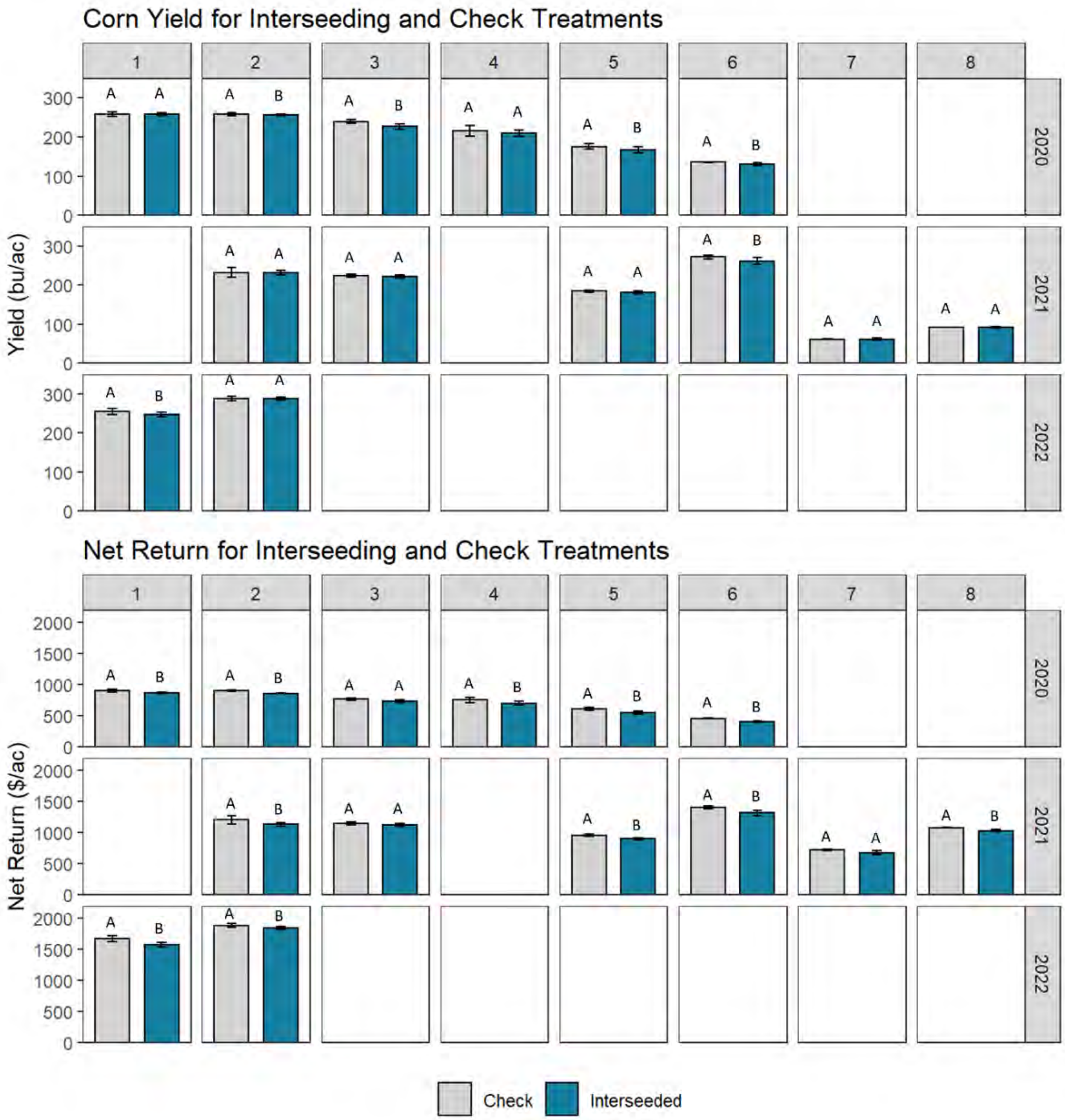


Figure 3. Average yield (top) and net return (bottom) for interseeded and check treatments for corn (sites 1 through 6) and soybean (sites 7 and 8). Values with the same letter are not significantly different at a 90% confidence level. Sites 3, 4, 5, and 6 in 2022 were lost due to June 14 hailstorm.

Yield and marginal net return impact varied by site (Figure 3).

Corn yield for six of the 14 site-years was reduced where cover crop was interseeded compared to the check. Overall, corn yields for both 2020 and 2021 were impacted by a July 9 wind event both years at seven of the 10 corn locations. In 2022, yield was only obtained from two of the six locations due to hail, which impacted the corn crop at two locations and residual herbicide from the previous soybean crop which impacted interseeding feasibility at the other two locations.

Soybean yield did not differ between the interseeded and check treatments.

Marginal net return was lower where the cover crop was interseeded compared to the check in 11 of the 14 corn site-years and one of the two soybean site-years.

SOIL MEASUREMENTS

Soil phospholipid fatty acid (PLFA), Haney tests, and standard soil tests were collected in year one and year three of the study for the check and interseeded cover crop (Table 2). Total microbial biomass and fungal species are used as indicators of soil quality. The Solvita® test measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health. Samples were collected at 0-8" depth in September 2020 and September 2022. Within a site, samples from all replications of a given treatment were combined for analysis. The following analyses examine the impact of interseeded cover crops on soils across six sites.

Table 2. Phospholipid fatty acid (PLFA), Haney, and standard soil tests for the check and interseeded cover crop at 0-8" depth from September 2020 and September 2022 across six sites (six replications). The difference in measurements from 2020 to 2022 are provided and were calculated by subtracting 2020 results from 2022 results for each of six sites.

	Total Microbial Biomass (ng/g)	Diversity Index	Total Bacterial Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
2020						
Check	1862.9 A	1.12 A	682.2 A	50.5 A	81.9 A	12.5 A
Cover Crop	1497 A	1.07 A	604.2 A	36.9 A	76.2 A	11.9 A
P-Value	0.207	0.400	0.624	0.440	0.363	0.329
2022						
Check	2354.7 A	1.49 A	984.5 A	252.3 A	143.1 A	17.2 A
Cover Crop	2309.5 A	1.46 A	965.8 A	222.3 A	140.2 A	16.8 A
P-Value	0.859	0.350	0.871	0.426	0.855	0.709
DIFFERENCE (2022-2020)						
Check	812.4 A	0.39 A	437.9 A	189.3 A	59.3 A	5.0 A
Cover Crop	484.3 A	0.35 A	262.1 A	180.0 A	53.8 A	4.0 A
P-Value	0.504	0.721	0.545	0.892	0.769	0.426

	OM	pH	P	S	H sat %	K sat %	Ca sat %	Mg sat %	Na sat %
2020									
Check	3.1 A	6.62 A	21.4 A	8.3 A	10.8 A	5.6 A	70.2 A	14.0 A	0.72 A
Cover Crop	3.1 A	6.55 A	18.2 A	7.9 A	106 A	5.5 A	69.0 A	12.8 A	0.67 A
P-Value	0.587	0.558	0.631	0.839	0.844	0.860	0.533	0.284	0.838
2022									
Check	3.3 A	6.4 A	33.1 A	13.0 A	13.1 A	5.3 A	70.7 A	14.3 A	--
Cover Crop	3.2 A	6.2 B	32.7 A	11.4 B	8.8 A	5.2 A	66.9 A	13.5 A	--
P-Value	0.317	0.079	0.919	0.076	0.161	0.772	0.148	0.311	--
DIFFERENCE (2022-2020)									
Check	0.29 A	-0.28 A	15.2 A	6.2 A	4.9 A	-0.33 A	0.50 A	0.67 A	0.43 A
Cover Crop	0.18 A	-0.43 A	10.3 A	2.0 A	-1.1 A	-0.43 A	-4.95 A	-0.03 A	0.33 A
P-Value	0.692	0.683	0.670	0.110	0.382	0.918	0.321	0.706	0.717

Microbial biomass, diversity index, bacterial biomass, fungi biomass, Solvita®, Haney, pH, P, and S were all greater in 2022 versus 2020 (data not shown); however, there were no differences between the check and interseeded treatment for soil health indicators or nutrient values between 2020 and 2022. Soil OM, pH, H sat %, K sat %, Ca sat %, Mg sat %, and Na sat % did not increase between 2020 and 2022.

KEY OBSERVATIONS:

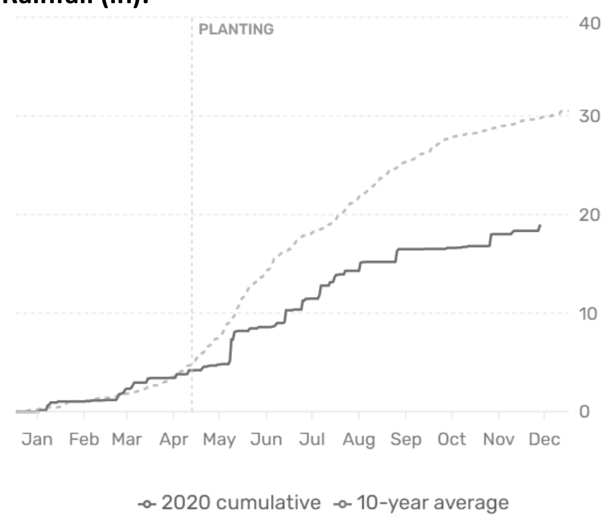
1. We have demonstrated that it is possible to obtain emergence and establishment of a variety of cover crop species when interseeding into V3-V4 corn and while using a number of pre-emerge herbicide chemicals. Good seed to soil contact obtained by drilling was a key part of this when interseeding in early season corn.
2. Irrigation and/or rainfall after interseeding in a dry spring is critical for cover crop establishment. It may be necessary to run the pivot 1-2 times, putting on 0.5" each time.
3. Cover crop biomass was always present at harvest. Other than the dry winter of 2021-2022, we have consistently had cover crop survival (sweetclover, red clover, hairy vetch, ryegrasses) over the winter.
4. Overall, there was minimal yield loss due to interseeding with the exception of 2020 when wind damage caused the corn canopy to be opened up and cover crops received more sunlight.
5. In one site (site 3) where soil moisture was monitored, the cover crop did not use more water compared to the check treatment.
6. Insects (grasshoppers and Japanese beetles) fed on the cover crop preferentially. In the interseeded strips, insects were observed feeding on the cover crop, whereas in the check strips, insects were observed feeding on the corn.
7. Buckwheat and flax increased the number of pollinators and insect diversity where the cover crop was interseeded.
8. Buckwheat and cowpea were the first covers to emerge and quickly shaded the ground with their large leaves, assisting with weed control. The fast emergence made them ideal for an interseeded cover crop mix. Forage collards were helpful in controlling weeds by covering the ground and were available for grazing post-harvest.
9. Cereal rye in the interseeded mix had patchy winter survival. Annual and Italian ryegrasses worked well in interseeded mixes and provided more winter survival compared to cereal rye.
10. Yellow sweetclover provided excellent survival and nitrogen production but was difficult to kill. This was problematic in a corn-soybean rotation.
11. When interseeding in soybeans at emergence, wheat did not survive, but clover did. Clover and wheat did not impact soybean yield.
12. Soybean hybrid is especially important when interseeding. Very tall, large-leafed hybrids resulted in shading out of the interseeded cover crop.
13. To assess nutrient contributions from cover crops, biomass samples for tissue analysis were preferred to end-of-season soil samples. Soil samples showed the interseeded treatment had less nutrients available in soil compared to the check (data not shown).
14. Soil moisture is critical. The top few inches of soil in subsurface drip irrigated fields can become very dry during the summer and result in cover crop death. Additionally, even in pivot irrigated corn fields, the top foot of soil can become very dry in the fall after irrigation has stopped; however, cover crops are still using moisture at this time and have not senesced. If soil moisture is not maintained after corn harvest, cover crops can die.
15. Future on-farm research will look at the feasibility and impact of perennial cover crops established between corn and soybean rows.

Impact of Interseeded Cover Crop at V3-V4 on Irrigated Corn - 3 Year Summary

(Cover crops were interseeded into corn in 2020, 2021, and 2022)

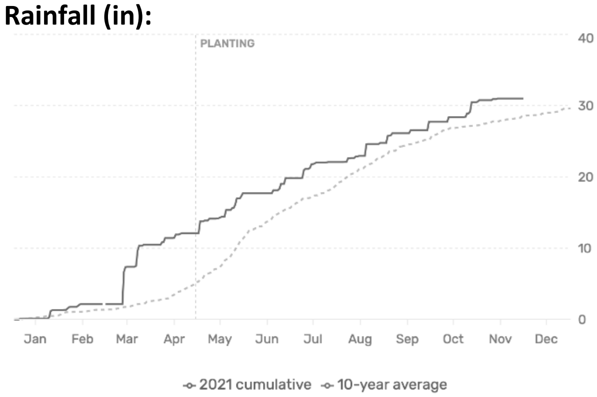
2020 Background Information

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 metolachlor, 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):



2021 Background Information

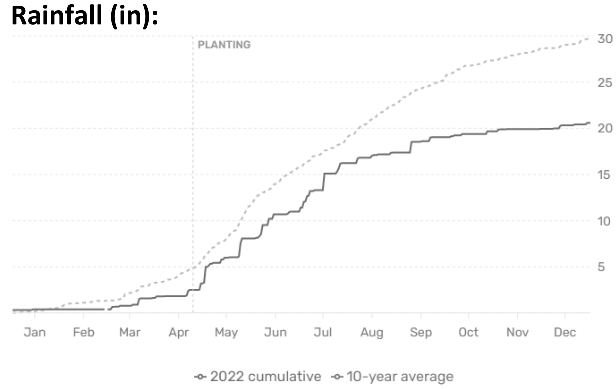
Study ID: 0580035202101
County: Clay
Soil Type: Crete silt loam 0-1% slope; Hastings silt loam 1-3% slope
Planting Date: 4/29/21
Harvest Date: 10/16/21
Seeding Rate: 33,000
Row Spacing (in): 30
Hybrid: Pioneer® P1353
Reps: 7
Previous Crop: Corn
Tillage: Strip freshener
Herbicides: ***Pre:*** 1.75 qt/ac Lexar® and 50 oz/ac Roundup® on 4/29/21 ***Post:*** 32 oz/ac Roundup® and 32 oz/ac Liberty® on 6/2/21
Foliar Fungicides: 14 oz/ac Quilt Xcel® at VT
Fertilizer: 170 lb N/ac as anhydrous ammonia in November; 17 gal/ac UAN 32% (60 lb N/ac) through pivot in July
Note: A windstorm on 7/9/21 impacted overall yield and resulted in 25% goose-necked plants with small ears. The field was rated at 12% green snap via crop insurance adjuster.
Irrigation: Pivot, Total: 10"
Rainfall (in):



<u>2022 Background Information</u>

Study ID: 0580035202201
County: Clay
Soil Type: Crete silt loam 0-1% slope; Hastings silty clay loam 3-7% slopes, eroded; Crete silt loam, thick solum, 0-1% slopes
Planting Date: 4/24/22
Harvest Date: 10/16/22
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1563Q
Reps: 7
Previous Crop: Corn
Tillage: Strip freshener
Herbicides: ***Pre:*** 1.8 qt/ac Lexar® on 4/20/22 ***Post:*** 32 oz/ac Liberty® and 18 oz/ac Roundup® on 5/29/22
Foliar Fungicides: 12 oz/ac Quilt Xcel® on 7/15/22

Fertilizer: 170 lb/ac anhydrous and 200 lb/ac 11-52-0 applied in the fall; 65 lb/ac 28-0-0-5 applied in June
Irrigation: Pivot, Total: 10.6"
Rainfall (in):



Introduction: This is the third year of this on-farm research study in collaboration with The Nature Conservancy, Upper Big Blue Natural Resource District (NRD), Natural Resource Conservation Service (NRCS), and Kellogg's. The study evaluated the impact of interseeded cover crops on corn yield and soil quality. There were two treatments: an interseeded cover crop mix and a no cover crop check. Cover crops were interseeded into the same cover crop strips in 2020, 2021, and 2022. The grower chose a nitrogen mix the first two years and a diversity mix in 2022. Yellow sweetclover, hairy vetch, and some red clover survived the winter of 2020. The yellow sweetclover survived the pre-emergence herbicide in 2021, but the nodules quit fixing for 30 days. It was still alive during interseeding, but was killed with the post-emergence herbicide. The dry winter of 2021 didn't allow for much cover crop survival. A very small amount of yellow sweetclover was present during interseeding in 2022 which was killed by the post-emergence herbicide.

2020 Nitrogen Mix: The nitrogen mix consisted of 4 lb/ac Laredo forage soybean, 2 lb/ac yellow blossom sweetclover, 1.5 lb/ac red clover, 4 lb/ac hairy vetch, 6 lb/ac Red Ripper cowpea, 4 lb/ac Pinkeye cowpea, 0.5 lb/ac Nitro radish, 0.5 lb/ac impact forage collards, and 4 lb/ac Mancan buckwheat. A half rate of the mix was used (13 lb/ac) at a cost of $18.16/ac. The cover crops were interseeded on June 3, 2020, when corn was V4.

2021 Nitrogen Mix: The nitrogen mix consisted of 4.8 lb/ac Laredo forage soybean, 3.3 lb/ac yellow blossom sweetclover, 3.3 lb/ac medium red clover, 4.8 lb/ac MT hairy vetch, 8 lb/ac Iron & Clay cowpea, 0.43 lb/ac purple top turnip, 0.54 lb/ac impact forage collards, and 6.4 lb/ac Mancan buckwheat. The total rate was 31.5 lb/ac and cost $46.21/ac. The cover crops were planted on June 2, 2021, when corn was V4.

2022 Diversity Mix: The diversity mix consisted of 2.5 lb/ac Iron & Clay cowpea, 2 lb/ac mung beans, 3 lb/ac Laredo forage soybean, 2 lb/ac yellow blossom sweetclover, 4 lb/ac medium red clover, 4 lb/ac Winterhawk annual ryegrass, 0.5 lb/ac impact forage collards, 0.5 lb/ac purple top turnips, 3 lb/ac Mancan buckwheat, and 2 lb/ac brown flax. A half rate of this mix was used (12.25 lb/ac) and cost $22.89/ac. The cover crops were interseeded on May 31, when corn was V3.

Corn yield, stand counts, and stalk quality were measured (Table 1). Cover crop and weed biomass were also measured by sampling 18.75 sq ft per treatment on September 23, 2020, September 27, 2021, and September 26, 2022 (Table 2). Samples were sent to the University of Nebraska-Lincoln for biomass measurement in 2020-2021 and Ward Laboratories, Kearney, Nebraska in 2022. Nutrient analysis were completed for the cover crops' biomass samples, and carbon and nitrogen results are reported here. The main purpose of these analyses were to determine the nitrogen present in the interseeded biomass to determine any potential nitrogen credits the following year. Soil health and regular soil tests were collected in year one and year three of the study (Tables 3 and 4).

Figure 1: Interseeded cover crop growth after canopy closure Aug. 18, 2020 (left). Yellow sweetclover that survived the winter of 2020 as well as pre-emerge and burndown herbicide applications in 2021, taken the day of interseeding on June 2, 2021 (middle). Cover crop after harvest October 15, 2021 (right).

Results:

Table 1. Stand counts, stalk rot, grain moisture, corn yield, and net return for the check and interseeded cover crop treatments in 2020, 2021, and 2022.

	Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
	---------- 2020 ----------				
Check	32,071 A*	1.79 A	16.7 A	259 A	908 A
Cover Crop	31,857 A	0.71 A	16.4 A	256 B	863 B
P-Value	0.639	0.356	0.280	0.090	0.0001
	---------- 2021 ----------				
Check	30,714 A	0 A	16.9 A	232 A	1,206 A
Cover Crop	29,714 A	0 A	17.0 A	231 A	1,136 B
P-Value	0.172	N/A	0.838	0.762	0.012
	---------- 2022 ----------				
Check	30,000 A	2.00 A	18.0 A	288 A	1,889 A
Cover Crop	30,500 A	0.50 B	18.1 A	287 A	1,848 B
P-Value	0.606	0.071	0.263	0.982	0.011

*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.
‡2020 marginal net return based on $3.51/bu corn, $18.16/ac for cover crop seed cost, and $18/ac for interseeding. 2021 marginal net return based on $5.20/bu corn, $46.21/ac for cover crop seed, and $18/ac for drilling. 2022 marginal net return based on $6.57/bu corn, $22.89/ac for cover crop seed, and $18/ac for cover crop application.

Table 2. Biomass measurements were collected on September 23, 2020, September 27, 2021, and September 26, 2022, for the interseeded and check treatments. Plants were sorted into weed or cover crop, and weights were reported on a dry matter basis. Average carbon and nitrogen in the interseeded treatment biomass (cover crop only) were determined by Ward Laboratories using tissue analysis in 2021 and 2022.

	Weed Biomass (lb/ac)	Cover Crop Biomass (lb/ac)	Total Biomass (lb/ac)	Carbon (lb/ac)	Nitrogen (lb/ac)
	2020				
Check	73 A*	-	73 B	-	-
Cover Crop	13 A	277	290 A	-	-
P-Value	0.283	N/A	0.005	-	-
	2021				
Check	45 A	-	45 B	-	-
Cover Crop	19 A	409	428 A	185	14
P-Value	0.259	N/A	0.0001	N/A	N/A
	2022				
Check	0	-	0 B	-	-
Cover Crop	0	121	121 A	21	1.7
P-Value	N/A	N/A	0.013	N/A	N/A

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

Table 3. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8" depth from September 2020 (top) and September 2022 (bottom). Total microbial biomass and fungal species are used as indicators of soil quality. Solvita® test measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health. Samples from all replications were combined for PLFA tests in 2020 and 2022 and for Solvita® and the Haney soil health score in 2022; therefore, statistics could not be calculated.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
	2020					
Check	1448	0.93	703	0	98.4 A	13.34 A
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
	2022					
Check	2684	1.50	1144	285	165.6	19.72
Cover Crop	2147	1.50	902	235	151.8	17.81

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

Table 4. Soil tests from September 2020 and September 2022 for check and interseeded cover crop at 0-8" depth. Aggregate stability was collected in 2020 only.

	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
	2020																				
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
Cover Crop	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
	2022																				
Check	6.8	7.2	3.3	10.4	25	308	17.8	2.17	32	10	0.69	2380	208	63	14.7	0	5	81	12	2	21
Cover Crop	6.9	7.2	3.3	5.5	13	356	16.9	2.03	27	8.8	0.67	2710	253	69	16.9	0	5	80	13	2	20

	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.)
	2020						
Check	36	36	0.19	0.25	2.04	36.81	17.53
Cover Crop	38	38	0.18	0.24	1.89	36.64	18.7

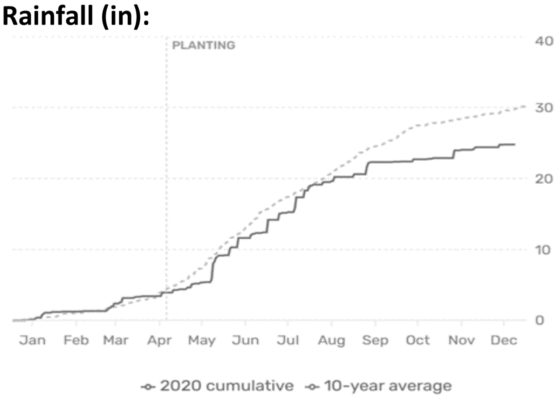
Summary:

- In 2020, 290 lb/ac of biomass was produced in the interseeded cover crop treatment, of which 13 lb/ac was weeds (Table 2). There was 73 lb/ac of weeds in the check treatment. In 2021, there was 428 lb/ac of interseeded cover crop biomass, of which 19 lb/ac was weeds. There was 45 lb/ac of weed biomass in the check treatment. In 2022, the interseeded cover crop produced approximately 121 lb/ac biomass, of which 0 lb/ac was weeds. The check did not have any cover crop biomass, and had no weeds. The corn hybrid in 2022 was very tall and shaded out a lot of the cover crop that emerged.
- There was no difference in stand count between the two treatments in any year (Table 1). The check treatment had slightly more stalk rot (2%) compared to the interseeded cover crop treatment (0.5%) in 2022; there were no differences in stalk rot between the treatments in 2020 or 2021.
- In 2020, yield was 3 bu/ac lower and net return was $45.31/ac lower for the cover crop treatment compared to the check (Table 1). In 2021 and 2022 there were no differences in yield between the interseeded cover crop treatment and the check. However, due to the increased seed and establishment costs, the cover crop treatment had a $70/ac lower net return in 2021 and $41/ac lower net return in 2022.
- Tissue analysis of the biomass in the interseeded cover crop treatment showed an average of 185 lb C/ac and 14 lb N/ac in 2021, and 21 lb C/ac and 1.7 lb N/ac in 2022 (Table 2).
- All PLFA and Haney soil health indicators numerically increased for both the check and interseeded cover crop treatments from 2020 to 2022 (Table 3). There were no numerical changes in organic matter (OM), pH, or phosphorus (P) from 2020 to 2022 (Table 4). There was a numerical increase in sulfur (S) for both the cover crop and check treatments from 2020 to 2022, and also a numerical increase in potassium (K) for only the cover crop treatment during that period. This field was grazed each fall, and cereal rye was also planted in this field across all treatments after harvest. These factors may have contributed to any numerical increases of soil measurements in the check treatment.

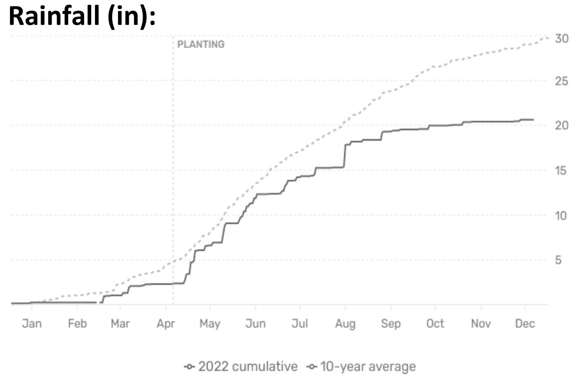
Impact of Interseeded Cover Crop at V3-V4 on Irrigated Corn – 3 Year Summary

(Cover crops were interseeded into corn in 2020 and 2022)

<u>2020 Background information</u>
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):



<u>2022 Background Information</u>
Study ID: 0145159202201
County: Seward
Soil Type: Muir silt loam rarely flooded; Hobbs silt loam occasionally flooded; Hobbs silt loam frequently flooded
Planting Date: 4/20/22
Harvest Date: 10/7/22
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: NC+ 11-15
Reps: 7
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Pre:*** 14 oz/ac Verdict® and 24 oz/ac glyphosate on 4/21/22. ***Post:*** 12 oz/ac Outlook®
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 100 lb N/ac as fall anhydrous, 60 lb N/ac applied as 32% UAN at sidedress, and 135 lb/ac 11-52-0
Irrigation: SDI, Total: 10"
Rainfall (in):



Introduction: This is the third year of this on-farm research study in collaboration with The Nature Conservancy, Upper Big Blue Natural Resource District (NRD), Natural Resource Conservation Service (NRCS), and Kellogg's. The study evaluated the impact of interseeded cover crops on corn yield and soil quality. There were two treatments: an interseeded cover crop mix and a no cover crop check. Cover crops were interseeded in the cover crop strips in 2020. In 2021, soybeans were grown and no cover crops were interseeded. Red clover, annual and Italian ryegrasses, yellow sweetclover, and hairy vetch had survived the winter. They were killed with the PRE soybean herbicide in 2021. In 2022, cover crops were again interseeded into the same strips as 2020.

2020 Diversity Mix: The diversity mix consisted of 4 lb/ac hairy vetch, 4 lb/ac Pinkeye cowpea, 1 lb/ac red clover, 1 lb/ac yellow blossom sweetclover, 4 lb/ac Red Ripper cowpea, 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.

2022 Diversity Mix: A half rate (12.25 lb/ac) of the following diversity mix was seeded: 2.5 lb/ac Iron & Clay cowpea, 2 lb/ac mung beans, 3 lb/ac Laredo forage soybean, 2 lb/ac yellow blossom sweetclover, 4 lb/ac medium red clover, 4 lb/ac Winterhawk annual ryegrass, 0.5 lb/ac impact forage collards, 0.5 lb/ac purple top turnips, 3 lb/ac Mancan buckwheat, and 2 lb/ac brown flax. The cover crops were interseeded on June 1, when corn was V2-V3.

Corn yield, stand counts, and stalk quality were measured (Table 1). Cover crop and weed biomass were also measured by sampling 18.75 sq ft per treatment on September 24, 2020, and September 27, 2022 (Table 2). Samples were sent to Ward Laboratories, Kearney, NE for biomass measurement. Nutrient analysis were completed for the cover crops' biomass samples, and carbon and nitrogen results are reported here. The main purpose of these analyses were to determine the nitrogen present in the interseeded biomass to determine any potential nitrogen credits the following year. Soil health and regular soil tests were collected in year one and year three of the study (Tables 3 and 4).

Figure 1. Interseeded cover crops on June 23, 2022 (left), July 21, 2022 (middle), and September 27, 2022 (right).

Results:

Table 1. Stand counts, stalk rot, grain moisture, corn yield, and net return for the check and interseeded cover crop treatments in 2020 and 2022.

	Harvest Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
	2020				
Check	30,286 A*	7.14 A	15.6 A	258 A	905.36 A
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
	2022				
Check	29,800 A	0.00 A	-	255 A	1,677 A
Cover Crop	30,800 A	0.50 A	-	247 B	1,581 B
P-Value	0.178	0.374	-	0.026	0.002

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

†Bushels per acre corrected to 15.5% moisture.

‡2020 marginal net return based on $3.51/bu corn, $16.86/ac for cover crop seed cost, and $18/ac for interseeding. 2022 marginal net return based on $6.57/bu corn, $22.89/ac for cover crop seed, and $18/ac for drilling.

Table 2. Biomass measurements were collected on September 24, 2020, and September 27, 2022, for the interseeded and check treatments. Plants were sorted into weed or cover crop, and weights were reported on a dry matter basis. Average carbon and nitrogen in the interseeded treatment biomass (cover crop only) were determined by Ward Laboratories using tissue analysis in 2022.

	Weed Biomass (lb/ac)	Cover Crop Biomass (lb/ac)	Total Biomass (lb/ac)	Carbon (lb/ac)	Nitrogen (lb/ac)
	---------- 2020 ----------				
Check	253 A*	-	253 B	-	-
Cover Crop	205 A	312	516 A	-	-
P-Value	0.632	N/A	0.037	-	-
	---------- 2022 ----------				
Check	2,788 A	-	2,788 A	-	-
Cover Crop	1,415 A	3,926	4,541 A	258	18
P-Value	0.131	N/A	0.206	N/A	N/A

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

Table 3. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8" depth from September 2020 (top) and September 2022 (bottom). Total microbial biomass and fungal species are used as indicators of soil quality. The Solvita® test measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health. Samples from all replications were combined for PLFA tests in 2020 and 2022 and for Solvita® and the Haney soil health score in 2022; therefore, statistics could not be calculated.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
	---------- 2020 ----------					
Check	1905	1.21	312	13	86 A	12 A
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
	---------- 2022 ----------					
Check	2984	1.50	1163	297	133	14.7
Cover Crop	3002	1.52	1201	403	60	9.4

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

Table 4. Soil tests from September 2020 and September 2022 for check and interseeded cover crop at 0-8" depth. Aggregate stability was only taken in 2020.

	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
											2020										
Check	7	7.2	2.4	3.3	8	266	4.6	1.65	16.0	43.9	0.34	1342	151	7	8.7	0	8	77	15	0	8
Cover Crop	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
											2022										
Check	7	7.2	2.2	3.2	8	303	6.3	2.66	22.1	8.3	0.56	1879	198	14	11.9	0	7	79	14	0	17
Cover Crop	6.8	7.2	2.5	3.7	9	292	6.2	4.33	21.1	9.1	0.57	1883	186	10	11.8	0	6	80	13	0	19

	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.)
				2020			
Check	33	34	0.19	0.25	2.03	33.26	14.03
Cover Crop	43	44	0.19	0.25	1.97	32.32	13.64

Summary:

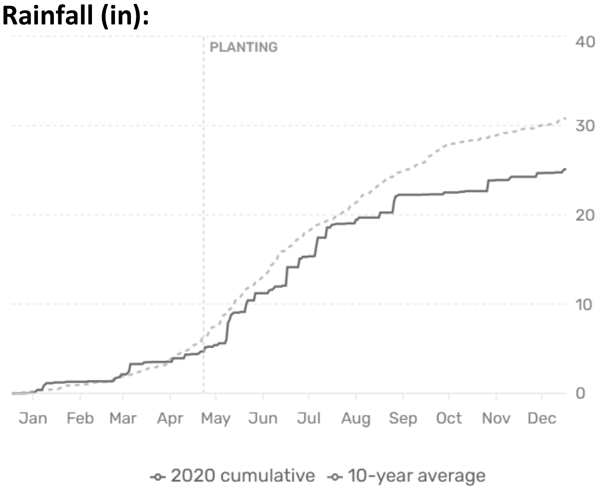
- In 2020, the interseeded treatment had an average of 516 lb/ac of biomass, of which 205 lb/ac were weeds (Table 2). The check did not have any cover crop biomass, but had 253 lb/ac weeds. In 2022, the interseeded treatment produced approximately 4,541 lb/ac biomass, of which 1,415 lb/ac was weeds. The check did not have any cover crop biomass, but had 2,788 lb/ac weeds. Dry spring weather in 2022 and a subsurface drip irrigation system rather than center pivot may have reduced the activation and efficacy of the residual in the pre-emerge herbicide. Dry conditions at post-emerge herbicide application may have also resulted in higher weed biomass at this location.
- There was no difference in stand count or stalk quality between the corn with interseeded cover crop and the check in either year (Table 1).
- In 2020, there was no yield difference between the corn in the cover crop or check treatments, but the interseeded treatment had a $35/ac lower net return due to the increased input costs (Table 1). In 2022, the corn in the check yielded 8 bu/ac more than the corn in the interseeded cover crop treatment. The reduced yield for the interseeded cover crop treatment combined with the increased input costs resulted in a $96/ac lower net return compared to the check.
- Tissue analysis of the biomass in the interseeded cover crop treatment showed an average of 258 lb C/ac and 18 lb N/ac (Table 2).
- There were no differences in the Solvita® or Haney soil health scores between the corn with interseeded cover crop and the check in 2020 (Table 3). No statistics are available for the PLFA tests (total biomass, diversity index, total bacteria biomass, and total fungi biomass) in either year or for the Solvita® and Haney soil health score in 2022 because the samples from the replications were combined. The interseeded cover crop treatment resulted in a numerical increase in all soil health indicators from 2020 and 2022 other than Solvita® and Haney soil health scores (Table 3). The check treatment had a numerical increase from 2020 to 2022 in all the indicators. Rye was planted into this field in the fall of each year across the treatments, which may have also benefited any numerical soil changes observed in the check treatment.
- Organic matter and pH did not show a numerical change from 2020 to 2022 for either the check or cover crop treatments (Table 4). There was a numerical increase in sulfur and phosphorus for both treatments.

Impact of Interseeding Cover Crop at V4-V5 on Irrigated Corn - 3 Year Summary

(Cover crops interseeded into corn in 2020 and 2021)

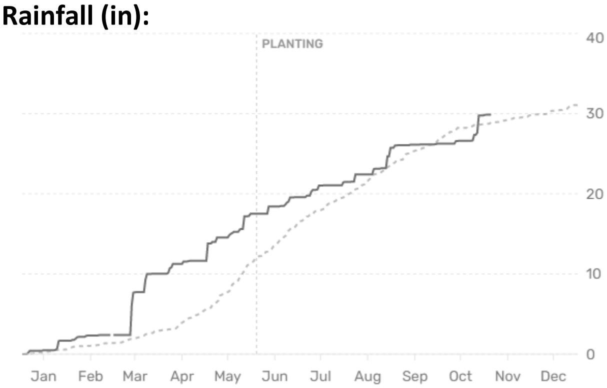
2020 Background Information

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):



2021 Background Information

Study ID: 0918159202101
County: Seward
Soil Type: Hastings silty clay loam 3-7% slopes, eroded; Hastings silty clay loam 7-11% slopes, eroded
Planting Date: 6/3/21
Harvest Date: 11/5/21
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: NK® 10-82
Reps: 4
Previous Crop: Corn
Tillage: Ridge-till
Herbicides: ***Pre:*** 2 pt/ac Staunch® ll, 6 oz/ac dicamba, and 24 oz/ac Roundup® on 5/25/21; ***Post:*** 4 oz/ac Status® and 2 oz/ac Callisto® on 6/18/21
Soil Applied Insecticide: 9 oz/ac Capture® LFR® at planting
Foliar Fungicides: Headline AMP®
Fertilizer: 25 gal/ac 32% UAN (89 lb N/ac) on 5/25/21; 25 gal/ac 32% UAN (89 lb N/ac) on 6/25/21
Irrigation: Pivot, Total: 6.5”
Rainfall (in):



Introduction: This is the third year of this on-farm research study in collaboration with The Nature Conservancy, Upper Big Blue Natural Resource District (NRD), Natural Resource Conservation Service (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 where no cover crops were interseeded and an interseeeded diversity mix (Figure 1).

2020: The diversity mix consisted of 4 lb/ac hairy vetch, 4 lb/ac Pinkeye cowpea, 1 lb/ac red clover, 1 lb/ac yellow blossom sweetclover, 4 lb/ac Red Ripper cowpea, 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. A July 9, 2020, windstorm resulted in 45% greensnap, which opened the canopy creating a large amount of cover crop and weed biomass.

2021: The diversity mix consisted of 2 lb/ac MT hairy vetch, 2 lb/ac Iron & Clay cowpea, 1 lb/ac medium red clover, 1 lb/ac yellow blossom sweetclover, 5 lb/ac Winterhawk annual ryegrass, 0.51 lb/ac Laredo forage soybean, 0.51 lb/ac impact forage collards, 3 lb/ac Mancan buckwheat, 0.51 lb/ac Nitro radish, and 1.51 lb/ac golden flax. The cover crops were interseeded on July 1, 2021, when corn was V5-6.

Corn yield, stand counts, and stalk quality were measured. Cover crop species and biomass were also measured by sampling 18.75 sq ft per treatment on September 24, 2020, and September 27, 2021. A second set of cover crop biomass samples was collected in 2021 from only the interseeded treatments and sent to Ward Laboratories, Kearney, NE for nutrient analyses. The carbon and nitrogen results are reported here. The main purpose of these analyses were to determine the nitrogen present in the interseeded biomass to determine any potential nitrogen credits the following year. Soil health tests were collected in 2020 and 2022.

Figure 1: (left) A solid stand of annual ryegrass, yellow sweetclover, and red clover survived winter. Photo was taken on May 19, 2021; (middle) The corn stand was uneven and had variable growth stages due to heavy cover crop survival and lack of moisture in non-irrigated area. Photo taken July 1, 2021, during interseeding of the 2021 cover crop; (right) Prior to corn harvest, the cover crops observed were predominantly cowpeas.

Results:

Table 1. Stand counts, stalk rot, grain moisture, corn yield, and net return for the check and interseeded cover crop treatments in 2020 and 2021.

	Harvest Stand Count (plants/ac)	Stalk Rot (%)	Green Snap (%)	Moisture (%)	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
	---------- 2020 ----------					
Check	16,375 A	1.25 A	46 A	9.5 A	131 A	459.05 A
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
	---------- 2021 ----------					
Check	31,000 A*	21 A	0 A	8.7 A	271 A	1,410 A
Cover Crop	31,667 A	8 A	1 A	8.8 A	261 B	1,316 B
P-Value	0.529	0.310	0.391	0.518	0.079	0.019

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡2020 marginal net return based on $3.51/bu corn, $16.86/ac for cover crop seed cost, and $18/ac for interseeding. 2021 marginal net return based on $5.20/bu corn, $22.15/ac for cover crop seed, and $18/ac for drilling.

Table 2. Biomass measurements were collected on September 24, 2020, and September 27, 2021, for the interseeded and check treatments. Plants were sorted into weed or cover crop, and weights were reported on a dry matter basis. Average carbon and nitrogen in the interseeded treatment biomass (cover crop only) were determined by Ward Laboratories using tissue analysis in 2021.

	Weed Biomass (lb/ac)	Cover Crop Biomass (lb/ac)	Total Biomass (lb/ac)	Carbon (lb/ac)	Nitrogen (lb/ac)
	---------- 2020 ----------				
Check	286 A*	N/A	286 B	N/A	N/A
Cover Crop	328 A	739	1,067 A	N/A	N/A
P-Value	0.817	N/A	0.026	N/A	N/A
	---------- 2021 ----------				
Check	164 B	N/A	164 B	N/A	N/A
Cover Crop	364 A	345	710 A	91	5
P-Value	0.083	N/A	0.022	N/A	N/A

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

Table 3. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8” depth from September 2020 and September 2022. Total microbial biomass and fungal species are used as indicators of soil quality. Solvita® test measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health. Samples from all replications were combined for PLFA tests in 2020 and 2022 and for Solvita® and the Haney soil health score in 2022; therefore, statistics could not be calculated.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
	---------- 2020 ----------					
Check	1492.5	1.17	51.34	2.74	70.1 B	11.4 B
Cover Crop	1351.5	0.93	47.75	0.49	95.1 A	13.2 A
P-Value	N/A	N/A	N/A	N/A	0.066	0.080
	---------- 2022 ----------					
Check	2511	1.4	1033	237	165	20.1
Cover Crop	2239	1.4	954	199	159	18.0

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

Table 4. Soil tests from September 2020 and September 2022 for check and interseeded cover crop at 0-8” depth. Aggregate stability tests were only taken in September 2020.

	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
	---------- *2020* ----------																				
Check	6.2	6.7	3.7	2.0	5	220	4.6	3.55	56.2	35.7	0.57	1904	209	18	15.1	21	4	62	12	1	23
Cover Crop	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
	---------- *2022* ----------																				
Check	5.7	6.6	3.7	26.4	63	338	8.9	2.57	64.9	16.9	1.65	2853	481	30	23.6	18	4	60	17	1	35
Cover Crop	5.6	6.5	3.7	28.9	69	325	9.5	2.62	64.0	20.6	1.63	2715	437	31	22.8	20	4	59	16	1	56

	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.)
	---------- *2020* ----------						
Check	51	53	0.19	0.25	2.01	37.64	18.66
Cover Crop	49	51	0.2	0.26	2.11	37.63	17.68

Summary:

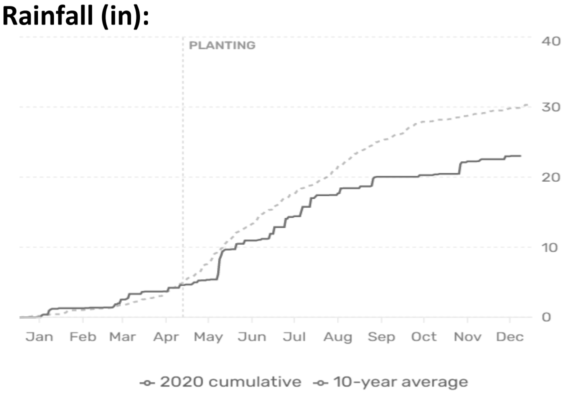
- In 2020, the interseeded cover crop treatments produced approximately 1,067 lb/ac biomass, of which 328 lb/ac was weeds (Table 2). The check did not have any cover crop biomass, but had 286 lb/ac weeds. The 45% greensnap opened up the canopy to higher rates of both weeds and cover crop biomass in this field, impacting yield and stand counts.
- In 2021, the interseeded cover crop treatment contained approximately 710 lb/ac biomass, of which 364 lb/ac was weeds (Table 2). The check did not have any cover crop biomass, but had 164 lb/ac weeds. Irrigating shortly after interseeding could have improved cover crop establishment and growth in 2021.
- In 2021, greater weed biomass was observed for the interseeded cover crop treatment compared to the check, despite having the same herbicide program (Table 2). A possible reason for this is that the sweetclover that had overwintered in the interseeded treatment protected weed seedlings from herbicide, and prevented herbicide from reaching the ground as well.
- There was no difference in stand count or stalk quality between the corn with interseeded cover crop and the check in either 2020 or 2021 (Table 1).
- In 2020, the corn in the interseeded cover crop yielded 4.8 bu/ac lower than the corn with no interseeded cover crop and resulted in a $51.75/ac lower net return (Table 1). In 2021, the corn in the interseeded cover crop yielded 10 bu/ac lower than the corn with no interseeded cover crop and resulted in a $93.90/ac lower net return.
- Tissue analysis of the biomass in the interseeded cover crop treatment in 2021 showed an average of 91 lb C/ac and 5 lb N/ac (Table 2). Tissue samples were not collected for the sweetclover and annual ryegrass that survived the winter of 2020, so we were unable to determine nutrients available to the 2021 corn crop.
- Statistics are not available for many of the soil measurements from Tables 3 and 4 as samples for a treatment were combined across replications. There was a statistically significant difference in Solvita® and Haney soil health score in 2020 with the interseeded cover crop treatment having greater values than the no cover crop check. From 2020 to 2022, all microbial counts, Solvita®, and Haney soil health scores numerically increased for both the cover crop and check treatments.

Impact of Interseeded Cover Crop at V4 on Irrigated Corn - 3 Year Summary

(Cover crops were interseeded in 2020 and 2021)

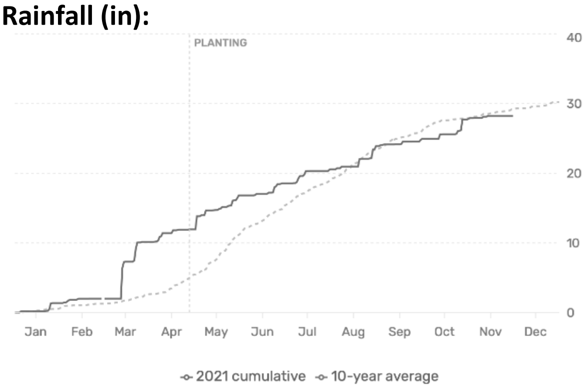
2020 Background Information

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 Hybrids® 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 bromoxynil 1 day prior to interseeding
Seed Treatment: Acceleron® P250
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):



2021 Background Information

Study ID: 0916185202101
County: York
Soil Type: Hastings silt loam 0-1% slope
Planting Date: 4/27/21
Harvest Date: 10/19/21
Seeding Rate: 32,000
Row Spacing (in): 36
Hybrid: Pioneer® P1563AM™
Reps: 4
Previous Crop: Corn
Tillage: Ridge-till and cultivate
Foliar Insecticides: 7 oz/ac bifenthrin applied in-furrow
Foliar Fungicides: None
Fertilizer: 185 lb N/ac as anhydrous ammonia on 4/5/21
Note: Wind event on 7/9/21 caused 8-10% greensnap and goose-necking
Irrigation: Pivot, Total: 11"
Rainfall (in):



Introduction: This is the third year of this on-farm research study in collaboration with The Nature Conservancy, Upper Big Blue Natural Resource District (NRD), Natural Resource Conservation Service (NRCS), and Kellogg's. In 2019, 2020, and 2021 this site has had interseeded cover crops on the same strips.

2020: 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 cowpea, 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.

2021: The study evaluated the impact of interseeded cover crops on corn yield and soil quality. The producer was interested in the impact of herbicides with and without residual on cover crop biomass and weed control. The farmer used Vilify™ Powered by Bellum™, which is a herbicide with residual weed control and has active ingredients of metolachlor, atrazine, and mesotrione. There were three treatments:

- A check with no cover crops interseeded and weeds controlled with a pre-emerge herbicide consisting of 2 qt/ac Vilify™ Powered by Bellum™ (a herbicide with residual weed control) and 24 oz/ac Roundup PowerMAX® on May 11, 2021.
- An interseeded cover crop with weeds controlled with a pre-emerge herbicide consisting of 2 qt/ac Vilify™ Powered by Bellum™ (a herbicide with residual weed control) and 24 oz/ac Roundup PowerMAX® on May 11, 2021.
- An interseeded cover crop with weeds controlled with only 30 oz/ac Roundup PowerMAX® on May 11, 2021, and no herbicide with residual weed control.

The cover crop mix consisted of 1 lb/ac Iron & Clay cowpea, 2 lb/ac mung beans, 1 lb/ac medium red clover, 2 lb/ac yellow sweetclover, 0.3 lb/ac forage collards, 0.3 lb/ac winter camelina, 1 lb/ac buckwheat, and 1 lb/ac flax. The cover crops were interseeded on June 9, 2021, when corn was V4.

Corn yield, stand counts, and stalk quality were measured all years (Table 1). Cover crop and weed biomass were also measured by sampling 27 sq ft per treatment on September 24, 2020, and September 27, 2021 (Table 2). A second set of cover crop biomass samples was collected from only the interseeded treatments in 2021, and sent to Ward Laboratories, Kearney, NE for nutrient analyses. The carbon and nitrogen results are reported here. The main purpose of these analyses were to determine the nitrogen present in the interseeded biomass to determine any potential nitrogen credits for the following year. Soil tests were collected in 2020 and 2022 to determine any impacts of the treatments on soil properties (Tables 3 and 4).

Figure 1. Interseeder that the cooperator built (left). Cover crop biomass inside of the cornfield after July 9, 2020, windstorm opened the canopy. The plants bent and grew upright, but didn't snap (right photo).

Results:

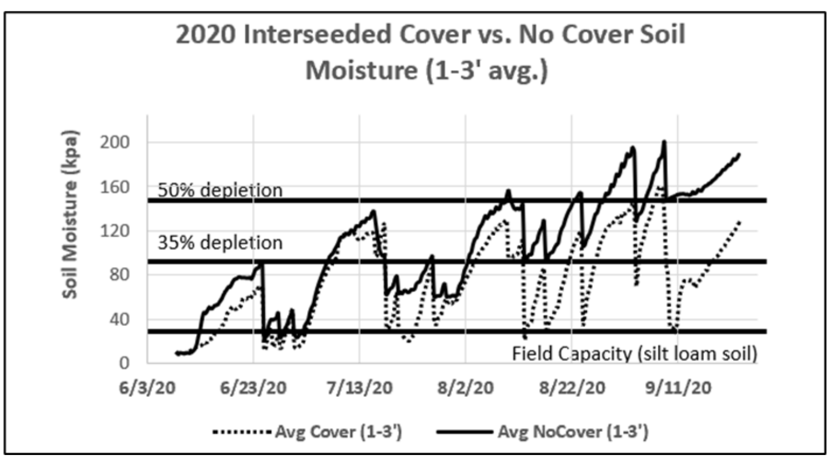


Figure 2. WATERMARK™ Soil Moisture Sensors were installed at 1', 2', 3' depths in corn that was interseeded (Cover) and the check (No Cover). In one replication, the corn with no cover was drier than the corn with the cover crop interseeded; however, no conclusions can be drawn as data was not replicated.

Table 1. Stand counts, stalk rot, grain moisture, corn yield, and net return for the check and interseeded cover crop treatments in 2020 and 2021.

	Stand Count (plants/ac)	Stalk Rot (%)	Green Snap (%)	Moisture (%)	Corn Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
	------------------------------------- 2020 ----------------------------------					
Check (31,000 seeds/ac Corn)	29,375	13.75	-	22.3 A	239 A	768.49 A
Cover Crop (31,000 seeds/ac Corn)	29,500	3.75	-	21.9 A	227 B	738.23 AB
Cover Crop (27,000 seeds/ac Corn)	27,000	3.75	-	22.2 A	217 B	716.66 B
P-Value	N/A	N/A	N/A	0.582	0.007	0.039
	------------------------------------ 2021 -----------------------------------					
Check	30,000 A*	1.9 A	4 A	17.4 A	224 A	1,152 A
Interseeded, pre-herbicide with residual	29,750 A	5.6 A	1 A	17.1 B	221 A	1,112 A
Interseeded, pre-herbicide without residual	29,500 A	3.1 A	3 A	17.3 AB	222 A	1,131 A
P-Value	0.905	0.468	0.618	0.032	0.753	0.205

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

†Bushels per acre corrected to 15.5% moisture.

‡2020 marginal net return based on $3.51/bu corn, $16.86/ac for cover crop seed cost, and $18/ac for interseeding. ‡Marginal net return based on $5.20/bu corn, $11/ac for Vilify™ Powered by Bellum™ used in the 'check' treatment, $11/ac for Vilify, $15.34/ac for cover crop seed, and $10/ac for drilling for the cover crop with Vilify™ Powered by Bellum™ (total treatment cost of $36.64/ac), and $15.34/ac for cover crop seed and $10/ac for drilling for the cover crop without Vilify™ Powered by Bellum™ (total treatment cost of $25.34/ac).

Table 2. Biomass measurements were collected on September 24, 2020, and September 27, 2021, for the interseeded and check treatments. Plants were sorted into weed or cover crop, and weights were reported on a dry matter basis. Average carbon and nitrogen in the interseeded treatment biomass (cover crop only) were determined by Ward Laboratories using tissue analysis in 2021.

	Weed Biomass (lb/ac)	Cover Crop Biomass (lb/ac)	Total Biomass (lb/ac)	Carbon (lb/ac)	Nitrogen (lb/ac)
	-- 2020 ---				
Check	39 B*	-	39 B	-	-
Cover Crop	205 A	1199	1404 A	-	-
P-Value	0.080	N/A	0.036	-	-
	-- 2021 ---				
Check	-	24 AB	24 B	-	-
Interseeded 1	20	19 B	38 B	16	1
Interseeded 2	17	119 A	136 A	124	8
P-Value	N/A	0.07	0.031	N/A	N/A

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

Table 3. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8" depth from September 2020 and September 2022. Total microbial biomass and fungal species are used as indicators of soil quality. The Solvita® test measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health. Samples from all replications were combined for PLFA, Solvita®, and the Haney soil health score in 2022; therefore, statistics could not be calculated.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
	---------- 2020 ----------					
Check	2479 A	1.37 A	1081 A	177 A	47.9 A	11.4 A
Interseeded	2691 A	1.40 A	1172 A	194 A	50.9 A	11.8 A
P-Value	0.291	0.844	0.173	0.829	0.689	0.619
	---------- 2022 ----------					
Check	2703	1.48	1102	236	97.5	15.5
Interseeded 1	1895	1.50	847	221	163.5	18.6
Interseeded 2	1877	1.44	821	152	136.8	16.2

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

Table 4. Soil tests from September 2020 and September 2022 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
	---------- *2020* ----------																				
Check	6.5	6.8	2.7	3.7	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	6.7	2.7	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	-	1	0.32	0.3	0.12	0.72	0.6	0.04	0.18	1	0.03	0.06	0.06	0.43	0.29	0.18	0.34	0.25	-	0.79
	---------- *2022* ----------																				
Check	6.6	7.2	3.6	4.9	12	381	10.1	1.86	39.9	10.3	0.81	2530	324	47	16.5	0	6	77	16	1	14
Interseeded1	6.0	6.7	3.6	15.6	37	353	14.3	2.09	53.5	16.4	0.86	2315	262	49	17.9	17	5	65	12	1	13
Interseeded2	6.1	6.7	3.3	10.1	24	317	12	1.79	55.1	16.7	0.81	2087	227	41	16.3	18	5	64	12	1	13

Summary:

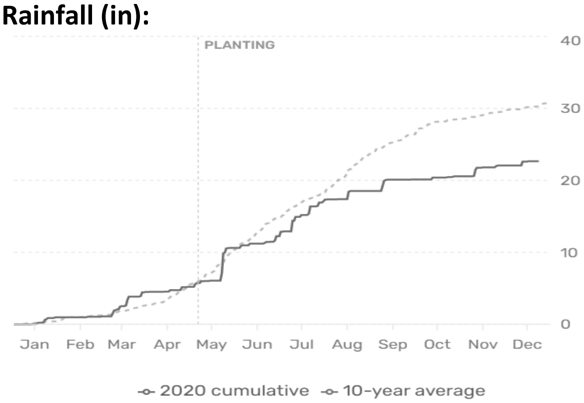
- In 2020, the interseeded cover crop produced approximately 1,404 lb/ac biomass, of which 205 lb/ac was weeds (Table 2). The check did not have cover crop biomass, but had 39 lb/ac weeds. In 2021, the cover crop treatment without a residual pre-emerge herbicide had approximately 100 lb/ac more weeds than the treatments that used a pre-emerge herbicide with residual control. The use of the pre-emerge herbicide with a residual did not impact the interseeded cover crop treatments; biomass production was similar at 17 to 20 lb/ac of cover crop. This was less biomass than produced in 2020. There may be several reasons for this including; (1) Pioneer® P1563AM being a tall, leafy hybrid that may have increased shading of the cover crop in 2021; and (2) a lower seeding rate of cover crops being interseeded in 2021.
- In 2020, 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 (Table 1). The check yielded 21.8 bu/ac more, and had a $30/ac higher marginal net return than the corn with interseeded cover crop and seeded at 27,000 seeds/ac. In 2021, yield and marginal net return were not impacted by the cover crop treatments.
- There were no differences in total microbial biomass, diversity index, bacterial or fungal biomass, Solvita® test, or Haney soil health score between the interseeded cover crops and the check in 2020 (Table 3). In 2022, replications were combined for the soil tests; therefore, no statistical analysis was conducted. Numerically, organic matter, fungal biomass, Solvita®, and soil health index increased for both the check and interseeded treatments from 2020 to 2022.
- Tissue analysis of the interseeded cover crop biomass averaged 70 lb C/ac and 5 lb N/ac (Table 2).

Impact of Interseeding Cover Crop at V4 on Irrigated Corn - 3 Year Summary

(Cover crops were interseeded into corn in 2020 and 2021)

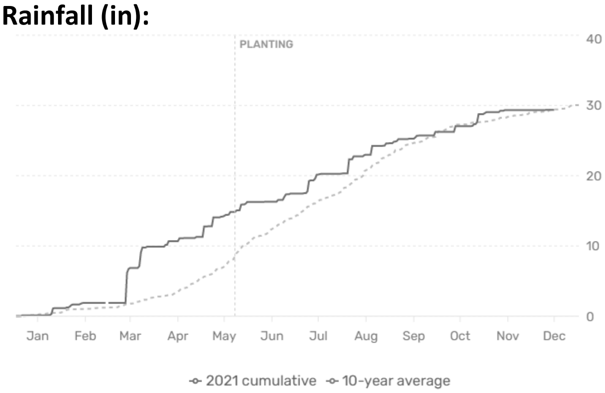
2020 Background Information

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):



2021 Background Information

Study ID: 0073081202101
County: Hamilton
Soil Type: Hastings silty clay loam 3-7% slopes
Planting Date: 5/22/21
Harvest Date: 10/26/21
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1306WAM
Reps: 7
Previous Crop: Corn
Tillage: Unknown
Herbicides: ***Pre:*** 1.5 qt/ac Acuron®, 1 qt/ac AAtrex®, and 1 qt/ac Durango® on 5/24/21 ***Post:*** 2.5 oz/ac Status® and 16 oz/ac Liberty® on 6/15/21
Fertilizer: 10 gal of 32% UAN (36 lb N/ac) with herbicide on 5/24/21; 150 lb N/ac as urea around 7/12/21
Note: A wind event on 7/9/21 resulted in goose-necked plants.
Irrigation: Pivot, Total: 3"
Rainfall (in):



Introduction: This is a three year on-farm research study in collaboration with The Nature Conservancy, Upper Big Blue Natural Resource District (NRD), Natural Resource Conservation Service (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 where no cover crops were interseeded and an interseeeded diversity mix. The sweetclover and ryegrass from 2020 survived the winter, and were then killed with pre-emerge herbicide.

2020 Diversity Mix: The diversity mix consisted of 4 lb/ac hairy vetch, 4 lb/ac Pinkeye cowpea, 1 lb/ac red clover, 1 lb/ac yellow blossom sweetclover, 4 lb/ac Red Ripper cowpea, 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.

2021 Diversity Mix: The diversity mix consisted of 2 lb/ac MT hairy vetch, 2 lb/ac Iron & Clay cowpea, 1 lb/ac medium red clover, 1 lb/ac yellow blossom sweetclover, 5 lb/ac Winterhawk annual ryegrass, 0.51 lb/ac Laredo forage soybean, 0.51 lb/ac impact forage collards, 3 lb/ac Mancan buckwheat, 0.51 lb/ac Nitro radish, and 1.51 lb/ac golden flax. The cover crops were interseeded on June 14 and 15, 2021, when corn was V4.

Corn yield, stand counts, and stalk quality were measured both years (Table 1). Cover crop and weed biomass were measured by sampling 18.75 sq ft per treatment on September 23, 2020, and September 27, 2021 (Table 2). A second set of cover crop biomass samples was collected from only the interseeded treatments, and sent to Ward Laboratories, Kearney, NE for nutrient analysis in 2021. The carbon and nitrogen results are reported here. The main purpose of these analyses were to determine the nitrogen present in the interseeded biomass to determine any potential nitrogen credits for the following year. Soil quality was also measured with the Haney test, PFLA tests, and standard soil tests (Tables 3 and 4) in year one and year three.

Figure 1. (left) Newly planted corn with annual ryegrass and sweetclover between the rows that survived winter of 2020. These cover crops were killed with pre-emerge herbicide. (right) Prior to corn harvest in 2021, the cover crops observed were predominantly cowpeas.

Results:

Table 1. Stand counts, greensnap, stalk rot, grain moisture, corn yield, and net return for the check and interseeded cover crop treatments in 2020 and 2021.

	Harvest Stand Count (plants/ac)	**Greensnap (%)**	**Stalk Rot (%)**	**Moisture (%)**	**Corn Yield (bu/ac)†**	**Marginal Net Return‡ ($/ac)**
	------------ 2020 ------------					
Check	30,700 A	7 A	12.50 A	15.5 A	175 A	614.51 A
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
	------------ 2021 ------------					
Check	33,429 A*	18.9 A	0 A	18.2 B	184 A	956.25 A
Cover Crop	32,357 A	32.5 A	3 A	18.8 A	181 A	902.61 B
P-Value	0.293	0.123	0.143	0.001	0.132	0.0004

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre corrected to 15.5% moisture.
‡2020 marginal net return based on $3.51/bu corn, $16.86/ac for cover crop seed cost, and $18/ac for interseeding. 2021 Marginal net return based on $5.20/bu corn, $22.15/ac for cover crop seed, and $18/ac for drilling.

Table 2. Biomass measurements of interseeded cover crops and weeds collected on September 23, 2020, and September 21, 2021. Plants were sorted into a weed or cover crop category, and weights were reported on a dry matter basis. Average carbon and nitrogen in the interseeded treatment biomass (cover crop and weeds) were determined by Ward Laboratories using tissue analysis.

	Weed Biomass (lb/ac)	Cover Crop Biomass (lb/ac)	Total Biomass (lb/ac)	Carbon (lb/ac)	Nitrogen (lb/ac)
	2020				
Check	1,435 A*	-	1,435 A	-	-
Cover Crop	419 A	869	1,289 A	-	-
P-Value	0.133	N/A	0.694	-	-
	2021				
Check	28 A	-	28 B	-	-
Cover Crop	34 A	615	649 A	264	16
P-Value	0.789	N/A	0.006	N/A	N/A

*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 from September 2020 and September 2022. Aggregate stability and soil bulk density was not measured in 2022.

	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
	2020																				
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
Cover Crop	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
	2022																				
Check	5.7	6.6	3.5	7.4	18	339	12.4	2.48	97.4	24.9	1.09	2071	224	24	18.3	28	5	56	10	1	20
Cover Crop	5.7	6.5	3.5	9.3	22	368	13.8	2.59	87.2	26.7	1.05	2022	222	27	17.5	26	5	57	11	1	18

	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.)
	2020						
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" in September 2020 and September 2022. Total microbial biomass and fungal species are used as indicators of soil quality. The Solvita® test is a measure of carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health. Samples from all replications were combined for PLFA tests in 2020 and 2022 and for Solvita® and the Haney soil health score in 2022; therefore, statistics could not be calculated.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm C)	Haney Soil Health Score
	---------- 2020 ----------					
Check	2715	1.03	1418	103	72 A	11 A
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
	---------- 2022 ----------					
Check	1895	1.4	751	130	135	16
Cover Crop	2510	1.6	1047	298	153	18

Summary:

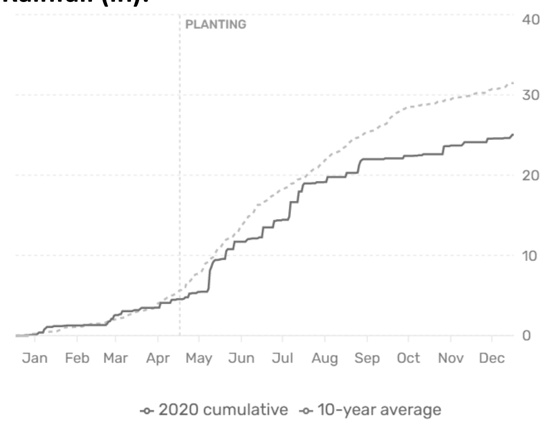
- In 2020, the interseeded cover crop produced approximately 1,289 lb/ac biomass, of which 419 lb/ac was weeds (Table 2). The check did not have any cover crop biomass, but had 1,435 lb/ac weeds. In 2021, the interseeded cover crop produced less biomass than 2020. Approximately 649 lb/ac biomass were produced in 2021, of which 34 lb/ac was weeds. The check did not have any cover crop biomass, but had 28 lb/ac weeds. Applying irrigation shortly after interseeding may have helped improve cover crop establishment and subsequent biomass.
- There were no differences in stand count or stalk quality between the corn with interseeded cover crop and the check in 2020 or 2021 (Table 1).
- In 2020, the corn in the interseeded cover crop yielded 8.6 bu/ac lower and resulted in a $65.18/ac lower net return than the corn with no interseeded cover crop (Table 1). In 2021, there were no yield differences between the corn with the interseeded cover crop and the check. Profit was lower for the interseeded cover crop ($53.64/ac) due to the increased cost of seed and drilling. It should be noted that the profit analysis does not take into account any increase in revenue due to potential for grazing livestock on the cover crops.
- There were no differences in the Solvita® test or Haney soil health score between the corn with interseeded cover crop and the check in 2020 (Table 3). No statistics are available for the PLFA tests (total biomass, diversity index, total bacteria biomass, and total fungi biomass) in either year or for the Solvita® and Haney soil health score in 2022 because the samples from the replications were combined. The interseeded cover crop treatment resulted in a numerical increase in all soil health indicators from 2020 and 2022 (Table 4). The check treatment also had a numerical increase from 2020 to 2022 in all the indicators other than total microbial biomass and total bacteria biomass.

Impact of Interseeded Cover Crop at V4 Corn and VC Soybean - 3 Year Summary

(Cover crops were interseeded into corn in 2020 and soybean in 2021)

2020

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% greensnap
Irrigation: Pivot, Total: 3.75"
Rainfall (in):



Introduction: This on-farm study is in collaboration with The Nature Conservancy, Upper Big Blue Natural Resource District (NRD), Natural Resource Conservation Service (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 cowpea, 1 lb/ac red clover, 1 lb/ac yellow blossom sweetclover, 4 lb/ac Red Ripper cowpea, 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% greensnap.

Results:

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

	Stand Count (plants/ac)	Stalk Rot (%)	Greensnap (%)	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

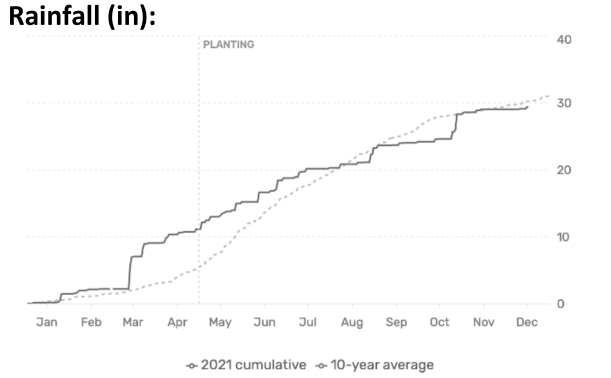
*Values with the same letter are not significantly different at a 90% confidence level.

Summary:

- The interseeded cover crop with 1 drill unit configuration produced 1,227 lb/ac of biomass, whereas 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® test or the Haney soil health score 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.

2021

Study ID: 0618159202101
County: Seward
Soil Type: Hastings silty clay loam 3-7% slopes; Hastings silty clay loam 7-11% slopes
Planting Date: 4/30/21
Harvest Date: 9/28/21
Seeding Rate: 140,000
Row Spacing (in): 15
Variety: Enlist®
Reps: 3
Previous Crop: Corn
Tillage: No-till
Herbicides: ***Pre:*** 6 oz/ac Zidua®, 24 oz/ac glyphosate, and 1 pt/ac TENKōZ® Lo-Vol 6, 2,4-D on 4/20/21 ***Post:*** 32 oz/ac glyphosate on 6/17/21
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: None
Irrigation: Pivot, Total: 4.5"
Rainfall (in):



Introduction: This is the second year of this on-farm research study in collaboration with The Nature Conservancy, Upper Big Blue Natural Resource District (NRD), Natural Resource Conservation Service (NRCS), and Kellogg's. At this site in year one, cover crops were interseeded into corn. In year two, cover crops were interseeded into soybeans. It was not possible to maintain the exact same strips of the check and interseeded cover crops, as soybeans were planted at an angle compared to the corn planting direction. This study evaluated the impact of interseeded cover crops on soybean. A rye cover crop was terminated with glyphosate on April 20, prior to planting soybeans on April 30. There were two treatments: a check where no cover crops were interseeded and an interseeded mix. The mix consisted of 26 lb/ac hard red winter wheat and 10 lb/ac red clover. Additionally, 50,000 seeds/ac of soybeans were added to the mix to replace some of the soybeans that would be killed during the interseeding. The cover crop was interseeded when soybeans were at VC on May 26. Soybean yield and stand counts were measured. During the season, the wheat eventually died from shading; however, the red clover survived through soybean harvest (Figure 1). Cover crop biomass was not collected at this site.

Figure 1. (top left) Wheat and red clover established nicely in the interseeded areas as seen on June 17, 2021; (top right) Soybeans were close to canopy, and interseeded wheat is nearly as tall as soybeans as seen on June 28, 2021; (bottom left) Red clover was surviving between the soybean rows; however, wheat died out due to shading. Photo taken September 17, 2021, prior to soybean harvest; (bottom right) Following harvest of soybeans, surviving red clover was present in the field. The field had been seeded to rye after harvest, but rye had not yet emerged at time the photo was taken on December 2, 2021.

Table 3. Stand counts, yield, and net return for the check and interseeded cover crop treatments.

	Stand Count (plants/ac)	**Moisture (%)**	**Soybean Yield (bu/ac)†**	**Marginal Net Return‡ ($/ac)**
Check	123,333 A*	13.1 A	61 A	719.66 A
Interseeded Cover Crop	109,667 B	13.2 A	61 A	679.15 A
P-Value	0.093	0.547	0.864	0.187

*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 $11.80/bu soybean, $26.50/ac for cover crop seed (the cost of additional interseeded soybeans was not included), and $18/ac for interseeding.

Summary:
- Soybean plant stand was higher for the check compared to the interseeded cover crop. This is likely due to the killing of soybeans when the cover crop was interseeded.
- There were no differences in soybean moisture, yield, or net return between the interseeded cover crop treatment and the check.

Table 4. Phospholipid fatty acid (PLFA) and Haney tests for the check and interseeded cover crop at 0-8” depth from September 2020 (top) and September 2022 (bottom). Total microbial biomass and fungal species are used as indicators of soil quality. The Solvita® test measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health. Samples from all replications were combined for PLFA tests in 2020 and 2022 and for Solvita® and the Haney soil health score in 2022; therefore, statistics could not be calculated.

	Total Biomass (ng/g)	**Diversity Index**	**Total Bacteria Biomass (ng/g)**	**Total Fungi Biomass (ng/g)**	**Solvita® (ppm C)**	**Haney Soil Health Score**
	---------- 2020 ----------					
Check	1138	1.01	528	7	83 A	12 A
Interseeded (1 Drill Unit)	800	1.06	428	8	65 A	10 A
Interseeded (3 Drill Units)	1568	1.07	795	19	68 A	13 A
P-Value	N/A	N/A	N/A	N/A	0.718	0.262
	---------- 2022 ----------					
Check	1351	1.49	602	149	145	17
Interseeded (1 Drill Unit)	2421	1.49	1153	255	172	19
Interseeded (3 Drill Units)	1727	1.47	754	163	154	18

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

Table 5. Soil tests from September 2020 and September 2022 for check and interseeded cover crop at 0-8" depth. Aggregate stability was not measured in 2022.

	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
2020																					
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
2022																					
Check	6.5	6.9	2.9	5.8	14	316	13	3.47	94	7.9	2.28	2590	378	29	18.2	7	4	71	17	1	89
Interseeded (1 Unit)	6.3	6.9	3.3	6.9	17	407	16.8	3.21	61.1	9.5	1.73	2402	338	22	17.3	8	6	69	16	1	80
Interseeded (3 Units)	6.4	6.7	3.3	9.1	22	483	17.4	3.11	179.4	8.6	2.10	2291	398	27	18.7	14	7	60	18	1	74

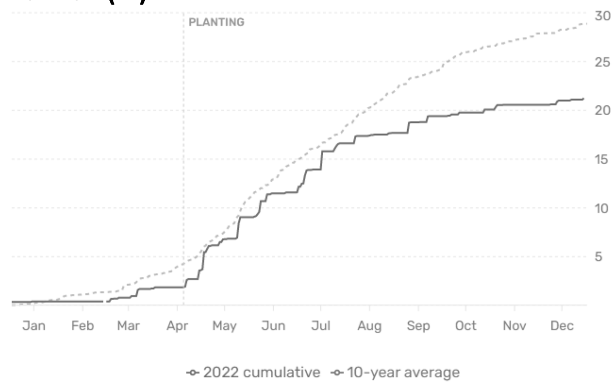
	Aggregate Stability 1-2 mm (%)	Aggregate Stability 1-2 mm in bulk soil (%)	Available Water (g H_2O/g soil)	Available Water (in H_2O/in soil)	Total Available Water (in H_2O/samples)	Field Capacity % (wt.)	Permanent Wilting Point % (wt.)
Check	45	43	0.21	0.28	2.21	32.82	11.84
Interseeded (1 Unit)	43	41	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

Three Year Soil Summary: No statistics are available for the PLFA tests (total biomass, diversity index, total bacteria biomass, and total fungi biomass) in either year or for the Solvita® test and Haney soil health score in 2022 because the samples from the replications were combined. The interseeded cover crop treatment resulted in a numerical increase in all soil health indicators from 2020 to 2022 (Table 4). The check treatment also had a numerical increase from 2020 to 2022 in all the indicators other than total microbial biomass and total bacteria biomass. A rye cover crop was planted in this field across all treatments in the fall, which may have also been a factor in the check treatment showing numerical increases. Soil organic matter and phosphorus increased from 2020 to 2022 for both the check and interseeded treatments while pH decreased during the same time frame for both treatments (Table 5).

Evaluating the Impact of Perennial Clover Cover Crop in Soybean

Study ID: 0686035202201
County: Clay
Soil Type: Crete silt loam 0-1% slope; Fillmore silt loam frequently ponded; Hastings silt loam 0-1% slope
Planting Date: 4/19/22
Harvest Date: 10/28/22
Seeding Rate: 140,000
Row Spacing (in): 30
Hybrid: Seitec® Genetics B280XF
Reps: 3
Previous Crop: Corn
Tillage: Strip-till
Seed Treatment: Fungicide, insecticide, and inoculant

Fertilizer: None
Irrigation: Pivot, Total: 9.4"
Rainfall (in):



Introduction: The objective of this study was to evaluate the impact of a perennial clover cover crop. The entire field had a rye cover crop; a 5-acre area of clover cover crop was drill seeded into the rye using a 10' interseeder (3 disks between 30" row spacing) on March 16, 2022. The inoculated Mammoth red clover cover crop was seeded at a rate of 10 lb/ac. Five-acre blocks of no clover were left for a check. The blocks allowed for three replications. The field was strip-tilled on April 4 and planted on April 18.

Herbicide applications varied between the clover cover crop and check strips and are as follows:

Cover Crop Herbicide Plan: 3.25 oz/ac Zidua® SC on April 21, 8 oz/ac clethodim on May 18, and 2.5 oz/ac Zidua® SC on May 20. Total cost of the cover crop herbicide plan was $34.32/ac. The clover was also hand rogued to remove low weed pressure of velvetleaf, lambsquarters, and sunflower.

Check Herbicide Plan: 2.45 oz/ac Anthem® MAXX and 32 oz/ac glyphosate on April 21, 3.25 oz/ac Anthem® MAXX, 22 oz/ac glyphosate, 12.8 oz/ac Engenia®, 12 oz/ac Quiz®, 9.6 oz/ac FieldGoal®, 9.6 oz/ac crop oil, and 20 oz/ac VaporGrip® Xtra on June 2. Total cost of the check herbicide was $48.58/ac.

Stand counts, grain moisture, yield, and net return were evaluated. Soil samples were collected for baseline soil tests on September 26, 2022, in the first year of the study. Biomass was determined by collecting clover and weed plant samples from a 18.75 sq. ft. area in the clover and check blocks. Nutrient analysis was conducted for the clover to determine biomass N. The goal is to maintain these cover crop blocks for at least three years to evaluate the impact on crop yield within the cropping system, profitability from any reductions in herbicide and/or fertilizer inputs, and soil health over time.

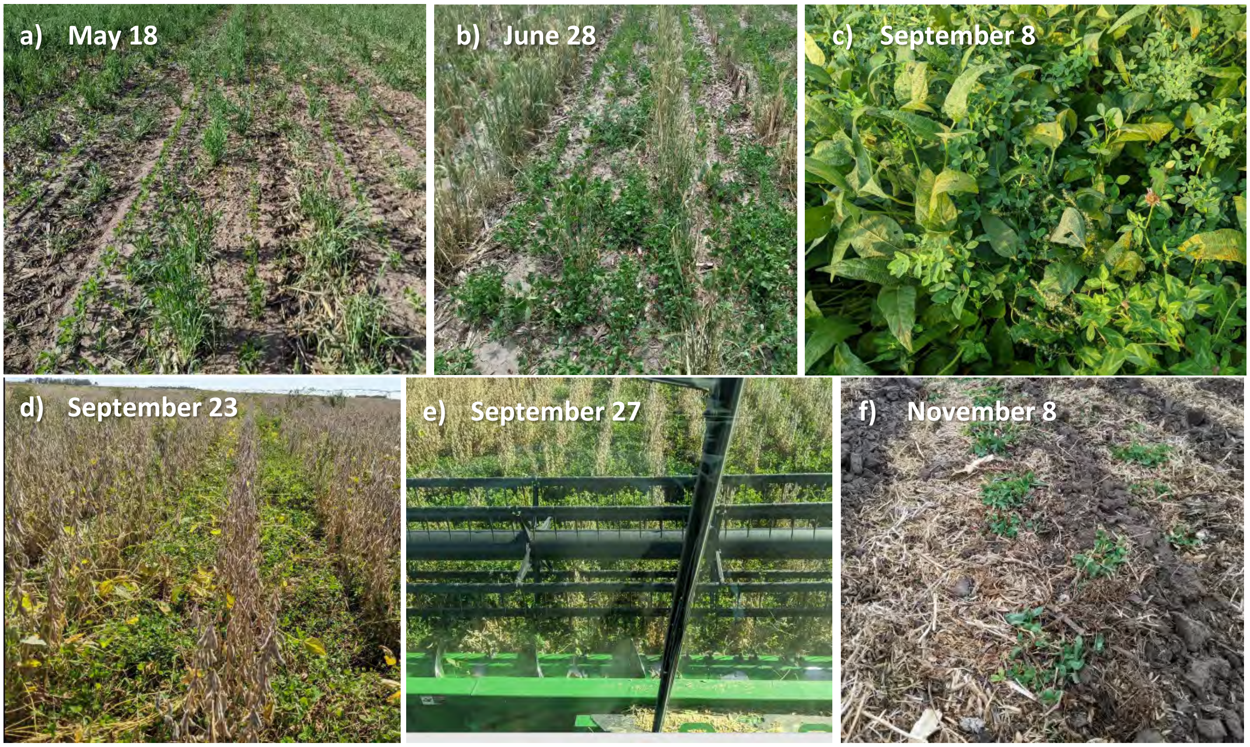


Figure 1. a) May 18, soybean planted into rye cover crop, b) June 28, recovery following June 7 hailstorm, c) September 8, soybean and clover cover crop, d) September 23, drying soybeans with green looking clover cover crop, e) September 27, harvesting of soybeans, f) November 8, clover remaining after soybean harvest.

Results:

Table 1. Harvest stand counts, grain moisture, soybean yield, and marginal net return for check and clover cover crop treatments.

	Harvest Stand Count (plants/ac)	Moisture (%)	Soybean Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	72,833 A*	9.2 B	74 A	955 A
Clover Cover Crop	76,167 A	10.2 A	68 B	905 A
P-Value	0.791	0.032	0.066	0.155

*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 $13.97/bu soybean, $48.58/ac for herbicides in the check treatment, $34.32/ac for herbicides in the cover crop treatment, $30/ac for cover crop seed, and $17/ac for cover crop drilling.

Table 2. Basic soil tests collected on September 26, 2022, for check and cover crop at 0-8" depth.

	pH	Buffer pH	OM LOI %	lb N /ac	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	6.1	6.8	3.1	22	267	10.8	3.2	45.5	14.8	0.72	2131	238	44	15.5	13	4	69	13	1	16
Cover Crop	6.1	6.7	3.3	20	297	12.6	6.9	64.4	16.7	0.91	2236	253	53	17.4	18	4	64	12	1	35

Table 3. PLFA (phospholipid fatty acid) and Haney test at a 0-8" depth for the no cover crop check and cover crop on September 26, 2022. Total microbial biomass and fungal species are used as indicators of soil quality. The Solvita® test measures carbon dioxide emitted from microbes. The Haney soil health score is an aggregated indicator of soil health. Data was only collected for one replication; therefore, a statistical analysis was not completed.

	Total Biomass (ng/g)	Diversity Index	Total Bacteria Biomass (ng/g)	Total Fungi Biomass (ng/g)	Solvita® (ppm CO2-C)	Haney Soil Health Score
Check	1763	1.46	748	165	138	16.5
Clover Cover Crop	2581	1.49	1152	288	185	20.8

Summary:

- There were no difference in soybean stand counts between the check and cover crop treatment.
- Grain moisture was 1% wetter for the soybeans growing in the cover crop treatment.
- There was severe hail damage on June 7. Following the hail, the clover cover crop recovered faster than the soybean, which resulted in the clover being taller than the soybean at harvest. Yield was impacted, with the cover crop treatment yielding 6 bu/ac less than the check treatment.
- There were no significant differences in net return.
- The clover produced 1,037 lb/ac of biomass, which contained 459 lb/ac of C and 31 lb/ac of N.

Effects of Grazing Cover Crops in a Three-Year Non-irrigated Rotation
6-year summary report

Study ID: 0720129202201
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 corn residue, 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. Cover crops were only planted following the wheat phase of the rotation. Cool-season cover crops were planted after wheat in the first 6 years of this study. The second 6 years of the study will include warm-season cover crops after wheat to determine any economic differences. Watermark™ Soil Moisture Sensors were installed to determine treatment impacts for each growing season. Soil physical and health parameters of each treatment were taken at the beginning of the study and every three years for comparison over time. An economic analysis is provided for the system each year, and the economics will be tracked over time.

Year 1 (2017 Corn)

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	1.50 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 soil moisture in the cover crop treatments was around 35% depleted (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 Palmer amaranth emerge 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 Soybean)

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 Wheat)

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 analyses 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 analyses 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 the 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 on soil bulk density 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.

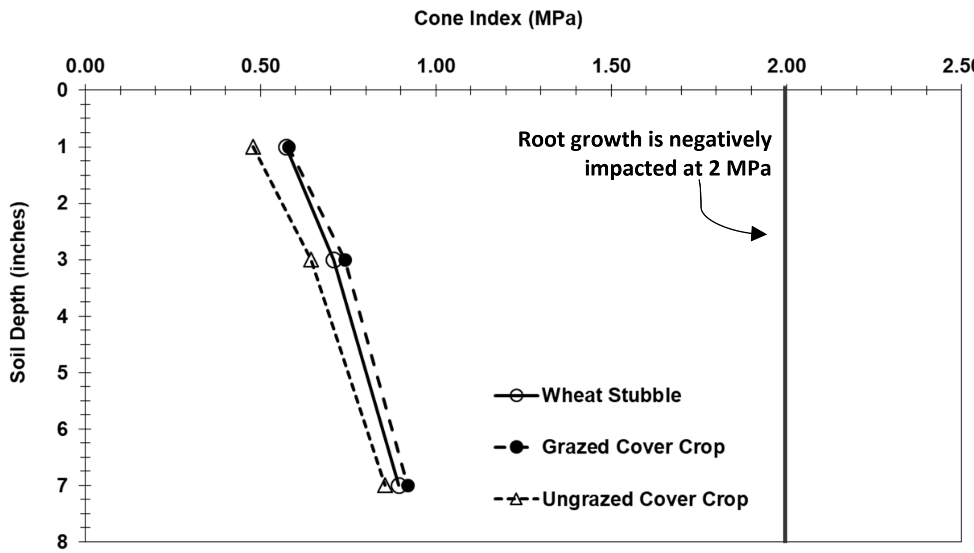
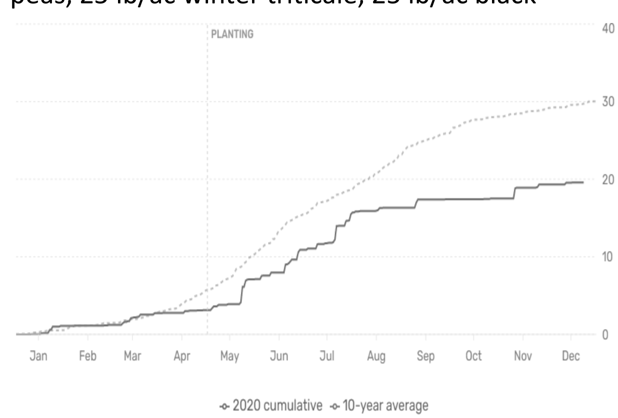


Figure 2. Three-year follow-up soil cone index values by treatment taken August 5, 2019. The line on the far right represents where root growth is negatively impacted, because roots are no longer able to easily penetrate through the soil.

Year 4 (2019 Cool-Season Cover Crop and 2020 Corn)

Following wheat harvest, 20 ton/ac manure were applied, then a cool-season cover crop was planted on September, 3, 2019. 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. However, only 8.7 AUM were available, which was less than the 19.0 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 were applied on March, 15, 2020. Pioneer® P1244 was planted no-till on May, 1, 2020, at a seeding rate of 25,000 seeds/ac in 30" rows. Six gallons of starter fertilizer (10-34-0) were 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 August, 20, 2020, Headline AMP® at 10 oz/ac was applied for southern rust. Harvest occurred on October, 13, 2020. 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).

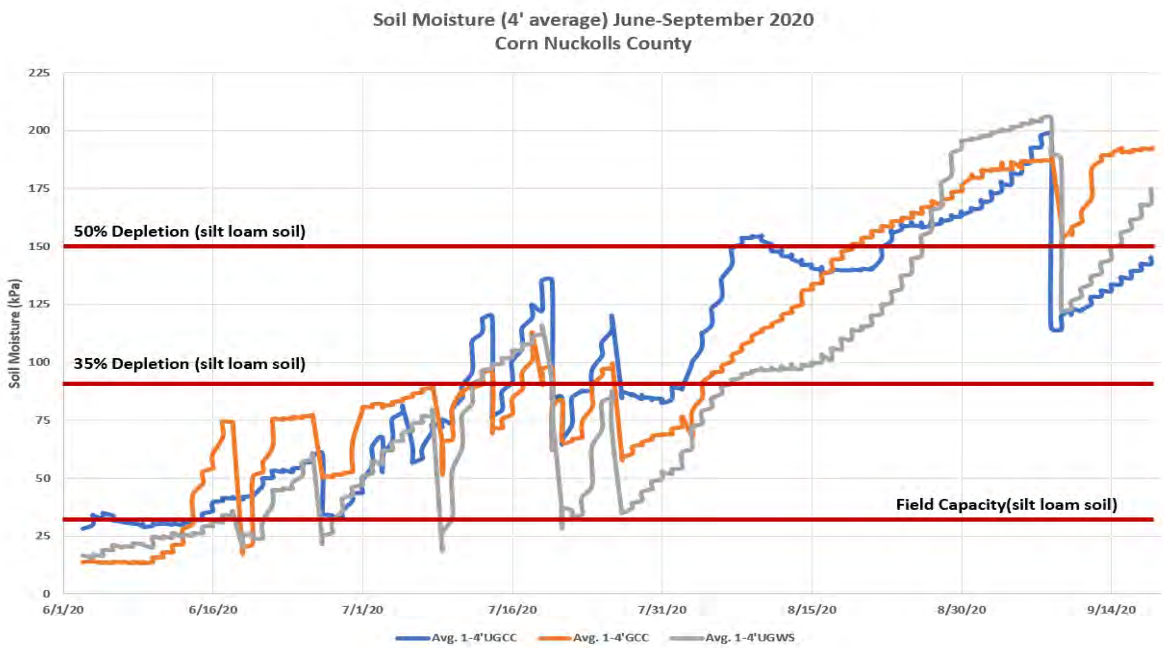


Figure 3. Soil moisture depletion for June-September 2020 corn in Nuckolls County. All treatments began the season with soil moisture at or above field capacity. The ungrazed cover crop (UGCC) and grazed cover crop (GCC) treatments reached 50% depletion by mid-August with the ungrazed wheat stubble (UGWS) 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	60.1 A	215 B
Cover Crop/Stubble—Grazed	18,000 A	0 A	13.6 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.

Year 5 (2021 Soybeans)

Following corn harvest, no cover crops were planted. In the previously established grazed cover crop treatment, cattle grazed on the corn stalks. The two previously established non-grazed treatments remained non-grazed. Soybean were planted in 15” row spacing on May 5, 2021, across all treatments. The variety was Pioneer® 25A04 and the rate was 140,000 seeds/ac. This location had good rain in 2021, so there was no moisture stress observed across treatments as was observed in 2018. The soybeans were harvested on September 21 and 22, 2021. There were no significant difference in the stand count, moisture, or soybean yield in 2021.

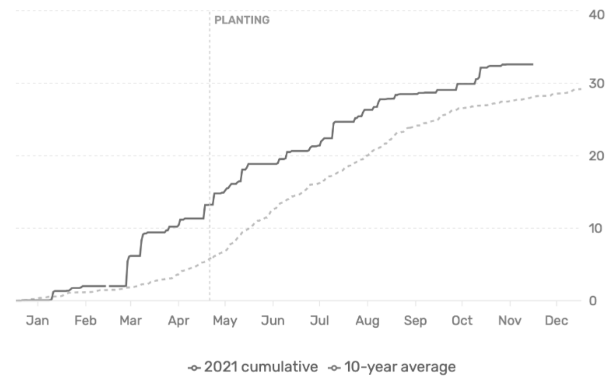


Table 8. 2021 soybean yield results.

	Stand Count (plants/ac)	Moisture (%)	Soybean Yield (bu/ac)†
Cover Crop—Non-grazed	109,333 A*	10.4 A	63 A
Cover Crop/Stubble—Grazed	103,333 A	10.4 A	67 A
Stubble—Non-grazed	112,000 A	10.4 A	66 A
P-Value	0.498	0.756	0.200

*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.

Year 6 (2022 Wheat and Warm-Season Cover Crop)

Following soybean harvest in September of 2021, Wesley wheat was planted on October 3, 2021, at a seeding rate of 120 lb/ac and row spacing of 7.5”. The field received 80 lb N/ac as a spring topdress application. The wheat experienced a dry winter and spring followed by a May 22, 2022, frost. Wheat was short and only around ankle high at flag leaf. Wheat was harvested on July 7, 2022, and yield and grain moisture were recorded. For the 2022 wheat crop, there was no difference in harvest stand counts, stalk rot, grain moisture, test weight, or yield (Table 9). A warm-season cover crop was planted on August 3, 2022, with 9.4 lb/ac forage soybeans, 4.7 lb/ac German millet, 6.25 lb/ac sorghum-sudangrass, and 2.5 lb/ac radish. The cover crop winter-killed. In December 2022, 57 head of heifers grazed the 9.6-acre grazed cover crop area for 12 days for a total of 684 grazing days. Economics for the total system are described below and shown in Table 10.

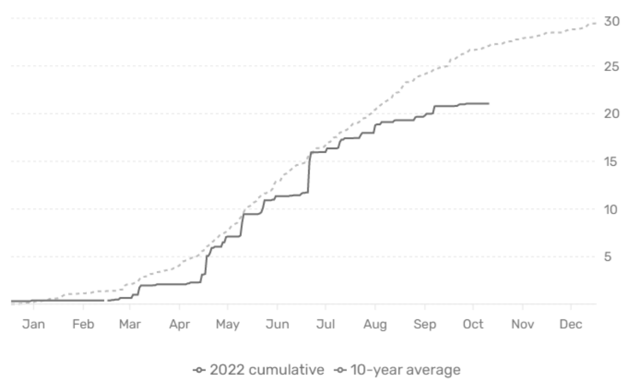


Table 9. 2022 wheat yield results.

	Test Weight (lb/bu)	Moisture (%)	Wheat Yield (bu/ac)†
Cover Crop – Non-grazed	56.6 A	8.9 A	68 A
Cover Crop/Stubble – Grazed	56.7 A	9.0 A	67 A
Stubble – Non-grazed	56.8 A	8.9 A	69 A
P-Value	0.752	0.262	0.861

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

Summary:

- For the 2022 wheat crop, there were no differences in test weight, moisture, or yield between the three treatments.
- The field was planted to a warm-season cover crop following wheat harvest. The goal is to have six additional years of this study with two cycles of warm-season cover crops to determine any economic impacts of warm-season vs. cool-season cover crops in this crop/livestock system.

Multi-Year Economic Analysis (2016 cover crop to 2022 cover 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. University of Nebraksa Lincoln (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 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. Nine bulls grazed the cover crop for 23 days. However, only 8.7 AUM were available, which was less than the 19.0 AUM in 2016 due to the wet fall, late planting, and minimal growth.

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 were 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.

2021 Soybean: The inputs were the same for the soybeans planted into all the previous treatments. UNL Budget 58 (EC872, 2021 Nebraska Crop Budgets, revised Nov. 2020) was used, which states a $410.69 total cost. A market year average price of $11.80/bu soybean was used.

2022 Wheat: The inputs were the same for the wheat planted into all the previous treatments. UNL Budget 76 (EC872, 2022 Nebraska Crop Budgets, revised Nov. 2021) was the closest available to these production practices. It stated a $299.40/ac total cost. A market year average price of $9.58/bu was used.

2022 Cover Crop: Cost for spraying the wheat stubble was $22.32 ($9/ac application and $13.32/ac herbicide cost). Costs for the non-grazed cover crop treatments were $47.11/ac ($29.11/ac for seed and $18/ac for drilling). Costs for grazed cover crop treatments were $72.11/ac ($47.11/ac for the cover crop seed and planting, $5/ac for fencing, and $20.00/ac for water). Water cost was calculated based on hauling water (12 water trips at $16/trip, which included cost of water). Costs for the grazed cover crop treatments equaled $23.62/AUM ($47.11/ac x 9.6 ac = $452.26. $452.26/19.15 AUM from what was grazed = $23.62/AUM.). The value of the grazed cover crop treatment was estimated to be $86.13/ac (based on rental rates of $53/pair/month [1.25 AUMS] or $42.40/AUM). The value was determined by considering 57 head of heifers grazed a 9.6 ac area for 12 days resulting in 684 grazing days. Because heifers were grazed rather than cows, the AUM was calculated to be 19.15. Factoring in the value of the grazing, the grazed cover crop treatment had an overall value of $14.02/ac ($86.13-$72.11 = $14.02).

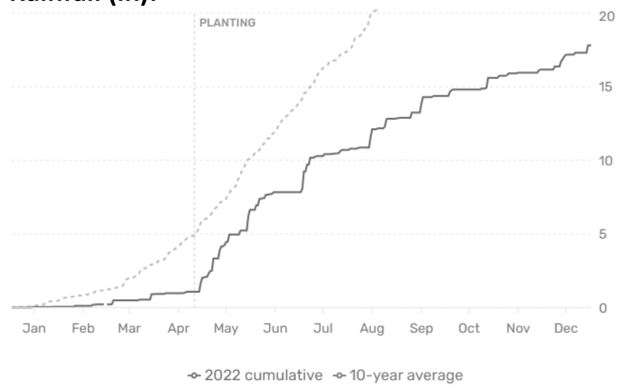
Table 10. Six crop year economic analysis summary of this study, presented in $/ac.

	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	$302.55	$332.71	$352.04	**$1216.33**
Cover Crop/Stubble—Grazed	$20.80	$311.06	$379.91	$342.46	**$1326.88**
Stubble—Non-grazed	-$18.00	$344.67	$368.11	$361.62	**$1390.39**
	2022 Cover	**2023 Corn**	**2024 Soy**	**2024 Wheat**	**9-Year Total**
Cover Crop—Non-grazed	-$47.11	*TBD*	*TBD*	*TBD*	*$1169.22*
Cover Crop/Stubble—Grazed	$14.02	*TBD*	*TBD*	*TBD*	*$1340.90*
Stubble—Non-grazed	-$22.32	*TBD*	*TBD*	*TBD*	*$1368.07*

Evaluating the Impact of 30" versus 60" Corn Row Spacing for Cover Crop

Study ID: 1406107202201
County: Knox
Soil Type: Crofton-Nora complex 6-11% slopes, eroded; Moody silty clay loam 2-6% slopes
Planting Date: 4/25/22
Harvest Date: 10/7/22
Row Spacing (in): 30
Hybrid: DEKALB® DKC59-82 VT2RIB
Reps: 6
Previous Crop: Grazed cover crop mix
Tillage: No-till

Irrigation: None
Rainfall (in):



Introduction: Wider corn row spacing may provide a better opportunity for establishment and growth of cover crops. This study compared two spacings. The two treatments were:

1) corn planted at 30" row spacing and a population of 24,000 seeds/ac (8.7" between seeds in the row)

2) corn planted at 60" row spacing and a population of 22,500 seeds/ac (4.6" between seeds in the row).

Cover crops were planted in only the 60" row spacing treatment on June 18, 2022. The cover crop was a mix of Iron & Clay cowpea, Dixie crimson clover, sunn hemp, Centurion annual ryegrass, Nitro radish, impact forage collards, Trophy rapeseed, Mancan buckwheat, pie pumpkins, and decorative gourd mix.

The study was not randomized. One field-length strip of 30” row spacing was planted next to one field-length strip of 60” row spacing. At harvest, the strips were sub-divided into six portions to obtain six yield replications for comparison. Stand counts, moisture, grain yield, and net return were evaluated.

Results:

	Stand Counts (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
30" Row Spacing	21,227	14.5 B*	145 A	950 A
60" Row Spacing with Cover Crop	20,356	14.9 A	128 B	775 B
P-Value	0.392	0.011	0.002	0.0002

*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 $6.57/bu corn, $40/ac cover crop seed, and $22.50/ac for cover crop drilling.

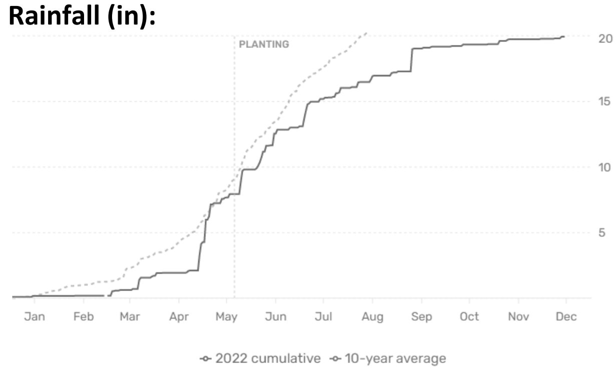
Summary:

- The 60" row spacing treatment with cover crop resulted in slightly wetter grain (0.5%), a 17 bu/ac reduction in yield, and a $175/ac reduction in net return. We cannot determine how much of the yield reduction was due to row spacing versus cover crop.
- The value of the forage was not included in the net return calculation. One test of cover crop biomass production showed that 900 to 1,000 lb/ac of forage was produced. With hay value of $175/ton, cover crop production would be equivalent to $85/ac.

CROP PROTECTION

Impact of Xyway™ LFR® Fungicide In-Furrow

Study ID: 0802185202201
County: York
Soil Type: Hord silt loam 1-3% slope; Hord silt loam 0-1% slope; Hastings silty clay loam 3-7% slopes
Planting Date: 5/20/22
Harvest Date: 10/14/22
Seeding Rate: 31,000
Row Spacing (in): 30
Hybrid: Pioneer® P1089AM LL RR2
Reps: 4
Previous Crop: Soybean
Tillage: No-till
Herbicides: ***Post:*** 80 oz/ac Resicore®, 8 oz/ac 2,4-D LV6, 22 oz/ac Roundup PowerMAX® 3, and 17 lb/100 gal AMS
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: 150 lb/ac MESZ (18 lb N/ac) applied in the fall; 185 lb N/ac as anhydrous ammonia and 3.84 gal/ac 10-34-0 (4 lb N/ac) on 4/5/22
Irrigation: None
Rainfall (in):



Introduction: This study evaluated the impact of Xyway™ LFR® fungicide applied in-furrow on corn yield. Xyway™ LFR® contains the active ingredient flutriafol and was applied at a rate of 15.2 oz/ac in-furrow with starter fertilizer. The check treatment is starter fertilizer with no Xyway™ LFR®. The treatments were arranged in a randomized complete block design and replicated four times. The plots were 1,176 ft long and 30 ft wide.

Results:

	Early Season Stand Count (plants/ac)	Harvest Stand Count (plants/ac)	Stalk Rot (%)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	31,000 A*	30,250 A	1.88 A	12.2 A	133 B	874 A
Xyway LFR	31,250 A	30,750 A	3.75 A	12.0 A	143 A	923 A
P-Value	0.836	0.664	0.444	0.415	0.094	0.179

*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 $6.57/bu corn and $19.12/ac for Xyway™ LFR®.

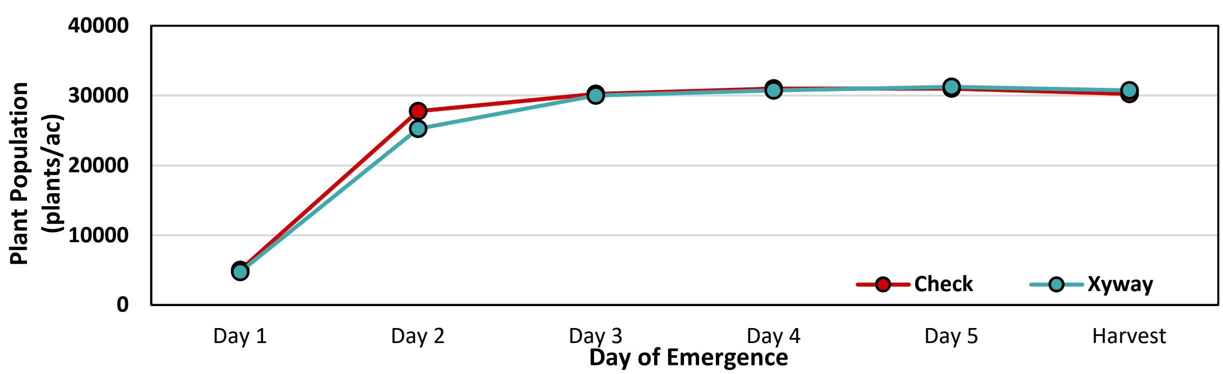


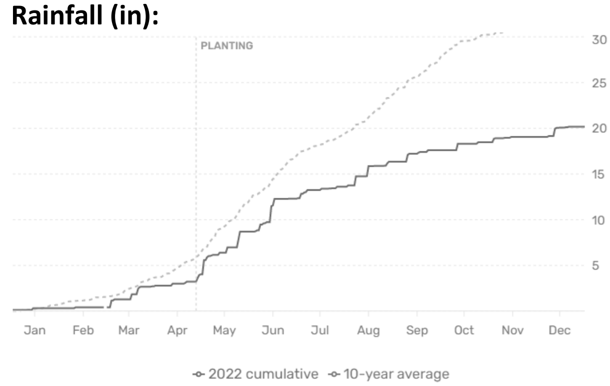
Figure 1. Stand counts for Xyway and check treatments starting on the first day of emergence through the fifth day of emergence and at harvest.

Summary:

- There were no differences in stand counts or stalk rot between the treatments evaluated. Harvest stand counts were approximately 600 plants/ac lower than early season stand counts.
- Yield was approximately 10 bu/ac higher for the Xyway™ LFR® fungicide treatment compared to the non-treated check. There were no significant differences in net return.

Evaluating ILeVO® Seed Treatment for Sudden Death Syndrome in Soybeans

Study ID: 0928155202202
County: Saunders
Soil Type: Lamo silty clay loam occasionally flooded; Muscotah silty clay loam occasionally flooded; Nodaway silty clay loam occasionally flooded
Planting Date: 4/27/22
Harvest Date: 9/22/22
Seeding Rate: 140,000
Row Spacing (in): 15
Hybrid: Pioneer® P26T23E
Reps: 8
Previous Crop: Corn
Tillage: No-till
Herbicides: ***Pre:*** 13 oz/ac Roundup PowerMAX® and 13 oz/ac 2,4-D LV6 with 21 oz/ac crop oil and 1.57 lb/ac AMS applied as burndown; 28 oz/ac Prowl® H2O, 2.5 oz/ac Valor® SX, and 4 oz/ac Glory® with 19 oz/ac crop oil
Post: 1.8 oz/ac clethodim 2EC, 23 oz/ac Enlist One®, 15.7 oz/ac Me-Too-Lachlor™, 18.5 oz/ac crop oil, and 2 lb/ac AMS
Foliar Insecticides: None
Foliar Fungicides: None
Fertilizer: None
Irrigation: None
Rainfall (in):



Introduction: Sudden death syndrome (SDS) is caused by the soil-borne fungus *Fusarium virguliforme*. 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 treatment options. Historical SDS pressure is unknown as this field was new to the operation; however, the landscape position and soils suggested there may be increased SDS susceptibility. This study evaluated:

A: Base seed treatment of LumiGEN™, EverGol®, and Gaucho®.
B: Base seed treatment plus ILeVO® (fluopyram) at a rate of 1.97 oz/140,000 seeds.
The treatments were arranged in a paired comparison design and replicated eight times. Normalized difference vegetative index (NDVI) imagery was acquired on August 25, 2022, using a senseFly eBee SQ drone equipped with a Parrot® Sequoia multispectral camera. Harvest stand counts were collected on September 19, 2022. Yield, grain moisture, and net return were evaluated.

Results:

	Harvest Stand Count (plants/ac)	NDVI	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Base Treatment	85,535 A*	0.874 A	9.5 B	55.8 A	771 A
Base Treatment + ILeVO®	84,374 A	0.877 A	9.6 A	55.2 A	754 B
P-Value	0.846	0.645	0.011	0.352	0.099

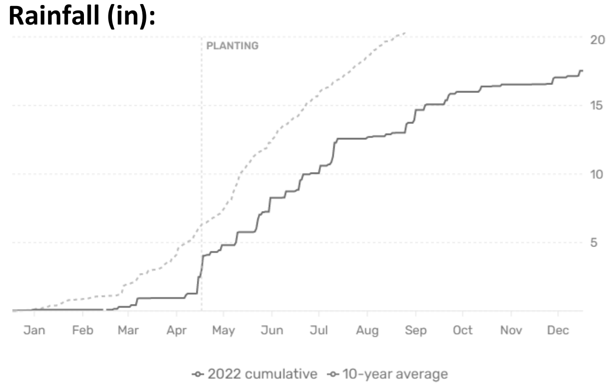
*Values with the same letter are not significantly different at a 90% confidence level.
†Yield values are from cleaned yield monitor data. Bushels per acre corrected to 13% moisture.
‡Marginal net return based on $13.97/bu soybean, $9.50/ac for the base seed treatment, and $8.00/ac for the ILeVO® seed treatment.

Summary:

- There were no differences in harvest stand counts or NDVI between the base seed treatment and the base plus ILeVO® seed treatment.
- Grain moisture was slightly wetter (0.1%) for the treatment with ILeVO®.
- The use of ILeVO® did not result in a yield increase. Incidence and severity of disease pressure in the field is unknown.
- Due to the additional treatment cost for the ILeVO® product and no yield advantage, the base treatment was $17/ac more profitable than the treatment with ILeVO®.

Evaluating the Impact of Nematicide Treatments in Corn

Study ID: 1413099202201
County: Kearney
Soil Type: Simeon sandy loam 0-3% slope; Valentine loamy fine sand 3-9% slopes
Planting Date: 5/1/22
Harvest Date: 10/21/22
Seeding Rate: 34,500
Row Spacing (in): 30
Hybrid: Pioneer® P1306W (conventional)
Reps: 4
Previous Crop: Corn
Tillage: Conventional + strip-till
Herbicides: ***Pre:*** 2 qt/ac FulTime® and 32 oz/ac Roundup® on 5/7/22 ***Post:*** 4 oz/ac Status® on 6/14/22; 1 lb active ingredient/ac 2,4-D LV on 7/24/22
Seed Treatment: Lumisure™ 1250
Foliar Insecticides: 6 oz/ac Steward® EC and 2 oz/ac Mustang® Maxx applied aerially on 7/16/22; 6.4 oz/ac bifenthrin applied through pivot on 7/24/22
Foliar Fungicides: 15.2 oz/ac Xyway™ applied in a 2x2 starter band on 5/1/22; 13.7 oz/ac Trivapro® applied aerially on 7/16/22
Fertilizer: 210 lb N/ac, 25 lb P/ac, 59 lb K/ac, 14 lb S/ac, and 0.3 lb Zn/ac
Note: Significant hail on 6/14/22 at the 9 to 11 leaf growth stage resulted in an estimated average of 80% defoliation and 3% stand loss.
Irrigation: Pivot, Total: 25"
Rainfall (in):



Introduction: Plant parasitic nematodes are microscopic worms that are recognized as major pests in production agriculture. In some cases, certain nematodes or high population densities can negatively impact yield. This study evaluated two nematicide treatments, Averland® FC and Counter® 20CR. Counter® 20CR was applied at 6.5 lb/ac on April 22, 2022, with strip-till at approximately 3 to 4 inches deep and Averland® FC was applied at 6 oz/ac in-furrow with the planter on May 1, 2022. Treatments were applied in field length strips with two strips of Counter® 20CR, two strips of Averland® FC, and two strips of the untreated check (Figure 1). Each strip was sub-divided into three segments to create a total of six replications of each treatment.

Figure 1. Study layout with field-length strips of Averland® FC, Counter® 20CR, and an untreated check. Strips were subdivided into three segments to create six replications. Within each segment, four sub-plots were sampled to assess nematode populations during the season and take into account the tendency of nematodes to be randomly aggregated.

Within each segment, four sub-plots were designated for collecting soil cores to assess nematode populations during the season. Therefore, there were a total of 72 subplots sampled for this field study. Subplots were flagged and marked via GPS coordinates so they could be resampled during the growing season to estimate the change in populations from planting to midseason. Soil cores were manually collected at a depth of 6-8" with a soil probe.

Initial nematode populations were assessed on April 1, 2022, just prior to planting and treatment applications. A total of six soil cores were collected at each subplot location for the initial nematode population assessment. On May 21, 2022, mid-season nematode populations were collected when plant stage development was approximately V4-V6. A total of four soil cores were collected from each subplot location for the mid-season nematode population assessment. Two sample times were completed to determine how treatments impacted nematode population densities early in the growing season. At each sampling time, individual cores collected were composited to provide enough soil sample for each respective subplot. Samples were then processed and nematodes were counted at the University of Nebraska-Lincoln Department of Plant Pathology in Lincoln. The reproduction factor (RF) was calculated by the (final population + 1)/(initial population +1) to estimate changes in nematode populations over time as an indicator of whether reproduction occurred or nematodes declined over time [RF = (Pf +1)/(Pi +1)]. Therefore, an RF number greater than 1 would indicate the nematode population is increasing, whereas an RF less than 1 would indicate the population is decreasing.

Plant parasitic nematodes can injure crops and certain nematodes can be quite damaging to corn plants. Several different types of nematodes (genera) were recovered from the soil samples including needle, stubby-root, lance, lesion, dagger, spiral, stunt, and ring nematodes. Spiral and ring nematodes are the least concerning for corn production while needle nematodes would be the most concerning as a small number of needle nematodes can cause extensive root damage to corn.

Stand counts were collected on May 21, 2022, and yield was estimated with a yield monitor. The field had significant hail damage on July 14 resulting in approximately 80% defoliation at the 9-11 leaf stage and 3% stand loss. Due to non-uniform hail damage, only replications 3 through 6 were included in the data analyses reported here as damage was more uniform in this area.

Results:

	Needle	**Stubby**	**Lance**	**Lesion**	**Dagger**	**Spiral**	**Stunt**	**Ring**
	Initial Populations (April 1, 2022)							
Check	0.1 B	14.78 A	30.3 B	255.55 A	21.01 A	225.6 A	73.09 A	271.91 A
Counter®	1.9 A	27.83 A	160.4 A	173.88 A	37.75 A	225.9 A	117 A	350.1 A
Averland® FC	0.5 B	9.77 A	58.7 B	133.08 A	23.63 A	221.4 A	102.38 A	266.46 A
CV	*90.2*	*21.74t*	*52.71*	*39.35*	*115.64*	*93.97*	*80.25*	*14.43t*
	Mid-Season Populations (June 4, 2022)							
Check	0.3 A	5.3 A	20.3 A	83.88 A	5.7 A	123.5 A	58.38 A	100.57 A
Counter®	0.6 A	7.6 A	39.3 A	58.38 A	4.58 A	68.1 A	24.13 A	71.58 A
Averland® FC	0.3 A	12.5 A	7.8 A	62.88 A	6.35 A	60.2 A	39.92 A	74.21 A
CV	*106.57*	*50.19t*	*42.2t*	*43.64*	*51.83t*	*45.71*	*53.15*	*22.26t*
	Reproduction Factor (RF)							
Check	1.125 A	0.952 B	4.345 A	0.417 A	0.552 A	9.839 A	1.306 A	2.158 A
Counter®	0.848 B	0.329 B	1.331 A	0.378 A	0.611 A	0.765 A	1.585 A	0.466 A
Averland® FC	1.058 A	3.297 A	0.525 A	0.522 A	1.505 A	0.798 A	3.597 A	2.635 A
CV	*14.15*	*64.75t*	*178.78*	*16.96t*	*44.85t*	*261.91*	*83.3t*	*161.55t*

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

[t] Data were transformed for statistical analyses, but results were back transformed in the table for easier interpretation.

	Early Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
Check	34,125 B*	12.5 A	241 A	1,580 A
Counter®	34,750 A	12.9 A	237 A	1,539 A
Averland® FC	34,500 AB	12.8 A	235 A	1,532 A
P-Value	0.058	0.456	0.431	0.248

*Values within a coloumn 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 $6.57/bu corn, $18/ac for Counter® 20CR, and $10/ac for Averland® FC.

Summary:

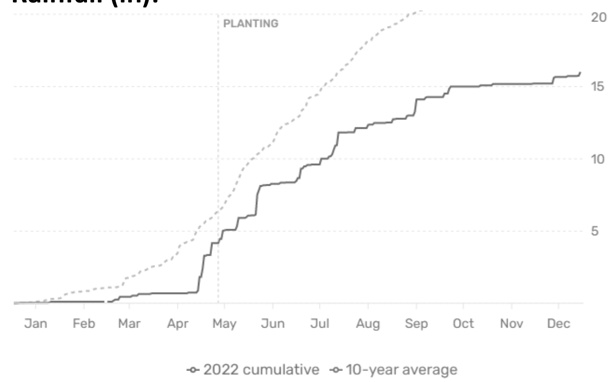
- This field location has several high impact nematodes types, including some at high population densities which could be expected to impact plant health.
- The naturally patchy distribution of nematodes across this field was high in the beginning of the season for species such as needle and lance and complicated analyses of nematode data.
- The reproduction (RF) of the needle nematode species was significiantly reduced by the Counter® 20CR treatment compared to the untreated check and the Averland® FC. The reproduction of the stubby-root nematodes was significantly reduced in the check and Counter® 20CR treatments compared to the Averland® FC. The RF did not vary by treatment for the other nematode species.
- The untreated check had a 625 plants/acre lower stand count compared to the Counter® 20CR.
- There were no differences in grain moisture, corn yield, or net return between the treatments.

EQUIPMENT

Impact of Strip-Till vs No-Till Before Planting into Cover Crops

Study ID: 1402047202202
County: Dawson
Soil Type: Cozad silt loam 0-1% slope; Hall silt loam 0-1% slope
Planting Date: 5/11/22
Harvest Date: 10/20/22 & 10/24/22
Seeding Rate: 34,000
Row Spacing (in): 36
Hybrid: Hoegemeyer® 8235
Reps: 5
Previous Crop: Corn silage
Tillage: No-till / Strip-till
Herbicides: ***Pre:*** 4 oz/ac DiFlexx®, 10 oz/ac Verdict®, 1 pt/ac atrazine 4L, 16 oz/ac Destiny® HC, 28 oz/ac Cornerstone® 5 Plus, 3 oz/ac InterLock®, 32 oz/ac Class Act® NG®, 21 oz/ac CENTURO®, and 2.6 oz/ac ANVOL® nitrogen stabilizer on 5/14/22
Seed Treatment: Pivot Bio PROVEN® 40

Fertilizer: 20 gal/ac as 32% UAN on 5/14/22; 3 rounds of fertigation totaling 50 lb N/ac with 32% UAN
Irrigation: Pivot, Total: 24"
Rainfall (in):



Baseline Soil Samples, 0-8" (January 2022):

	pH	OM LOI %	Melich-lll P ppm	Nitrate – N ppm N	Sulfate-S ppm S	-------Melich lll------- K	Ca	Mg	Na	CEC me/100g
Sample 1	7.4	2.4	99	12.2	28	608	3290	463	80	22

Introduction: This study evaluated the impact of strip-till versus no-till before planting corn into green cover crop. A wheat cover crop was planted on September 10, 2021, at 50 lb/ac. The producer was interested in determining if the strip-till pass was necessary, or if his planter would have sufficient downforce pressure to cut through heavy cover crop residue without a strip-till operation. The strip-till operation occurred on May 7, 2022, to establish five strip-till strips and five no-till strips. The strip-till unit was an Orthman 1tRIPr® 12R36 with shanks and rolling baskets set to 8" deep. Corn was planted on May 11, 2022. The planter was a John Deere® 1725C with ExactEmerge™ row units and a central seed hopper. The planter has an automatic hydraulic downforce system and pneumatic row cleaners. The cover crop was approximately 20-24" tall at the time of termination on May 14, 2022. Stand counts, grain 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)
No-Till	30,933 A*	30,000 A	22.4 A	250 A	1,640 A
Strip-Till	32,200 A	30,000 A	21.1 B	255 A	1,646 A
P-Value	0.159	1	0.003	0.229	0.837

*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 $6.57/bu corn and $30/ac for strip-till operation.

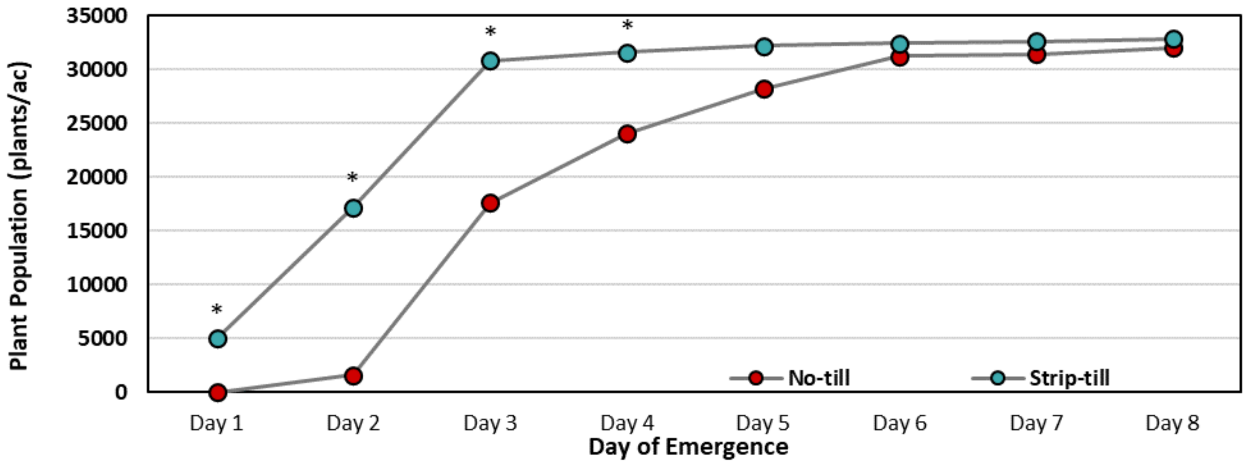


Figure 1. Stand counts for strip-till and no-till treatments starting on the first day of emergence through the eighth day of emergence. Asterisks indicate statistically significant differences in stand count.

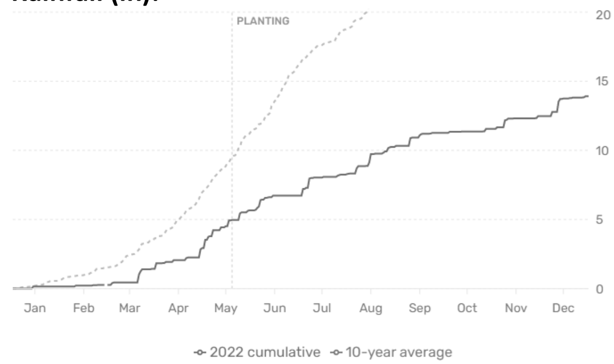
Summary:

- The strip-till treatment was faster to emerge and had higher stand counts compared to the no-till treatment through the fourth day of emergence. By the fifth day, the no-till treatment had statistically, caught up to the strip-till treatment.
- There were no differences in early or harvest stand counts between the strip-till and no-till treatments.
- Grain moisture was 1.3% wetter for the no-till treatment compared to the strip-till treatment.
- There were no statistically significant differences in yield or marginal net return between the no-till and strip-till treatments.

Impact of Planter Downforce on Corn Emergence and Yield

Study ID: 1411173202202
County: Thurston
Soil Type: Colo silty clay loam occasionally flooded; McPaul silt loam occasionally flooded
Planting Date: 5/19/22
Harvest Date: 10/20/22
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1257
Reps: 3
Previous Crop: Soybean
Tillage: No-till
Seed Treatment: None

Irrigation: None
Rainfall (in):



Introduction: Downforce pressure demands vary by field and soil type. A lighter soil with high sand content will demand less downforce because of the larger particle size and lower aggregation of soil particles. If a large amount of downforce is applied to a light soil, the gauge-wheel load can increase and create sidewall compaction, negatively impacting seedling emergence. On the other hand, in a heavier soil with high clay content, a larger amount of downforce is needed, since the soil particles are smaller and more aggregated. If the amount of downforce applied to heavier soils is too little, the gauge-wheels can lose contact impacting seeding depth and seedling emergence. Therefore, understanding the optimal downforce for each field can be beneficial. This study evaluated three downforce pressures: 100 lb, 150 lb, and 200 lb.

A 24-row John Deere® ExactEmerge™ planter was used to plant corn at 2" deep. The seeding rate was 32,000 seeds/ac, and the field was planted on May 19, 2022. The soil moisture was high at the planting date. Emergence counts were taken to determine the percent of plants that emerged in the first 48 hours, 48-96 hours, and 96+ hours after planting. Early season stand counts were collected on June 5, 2022. For each time frame, the percentage of plants emerged was calculated by dividing the plants emerged in that time frame by the total number of plants in the early season stand counts. Yield was determined by hand harvesting 20' of one row on October 22, 2022.

Results:

	% of Plants Emerged 0-48 hrs	% of Plants Emerged 48-96 hrs	% of Plants Emerged 96+ hrs	Early Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
100 lb Downforce	59 B*	28 A	13 A	31,073 A	15.5 A	153 A	1,002 A
150 lb Downforce	75 A	17 A	9 A	29,621 B	14.8 A	155 A	1,018 A
200 lb Downforce	74 AB	19 A	8 A	31,073 A	15.3 A	154 A	1,011 A
P-Value	0.076	0.174	0.428	0.059	0.671	0.974	0.974

*Values with the same letter are not significantly different at a 90% confidence level.
†Bushels per acre determined by hand harvesting and corrected to 15.5% moisture.
‡Marginal net return based on $6.57/bu corn.

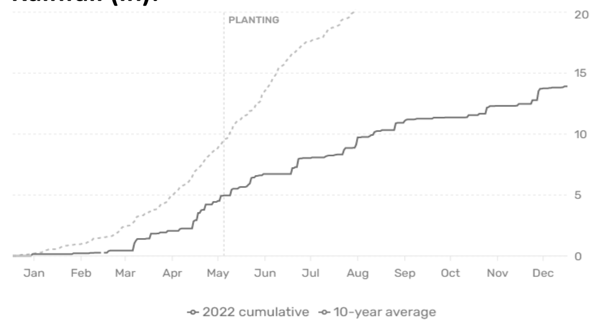
Summary:

- In the first 48 hours, the 100 lb downforce treatment had lower percent emergence compared to the 150 lb treatment. By the 48-96 hour and 96+ hour stand counts, there were no differences between the treatments in percent of plants emerged.
- Early season stand counts in June showed that the 150 lb treatment had 1,452 lower plants/ac.
- There was no difference in grain moisture, yield, or net return.

Impact of Planter Downforce and Speed on Corn Emergence and Yield

Study ID: 1411173202201
County: Thurston
Soil Type: Colo silty clay loam occasionally flooded; McPaul silt loam occasionally flooded
Planting Date: 5/19/22
Harvest Date: 10/20/22
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1257
Reps: 4
Previous Crop: Soybean
Tillage: No-till

Seed Treatment: None
Irrigation: None
Rainfall (in):



Introduction: Planter downforce demands vary by soil type. When planting, it is important to consider how much downforce is needed to break the soil resistance and place the seeds at the right depth to ensure uniform seedling emergence. Too little downforce when planting can lead to poor seed-to-soil contact and uneven emergence, whereas too much downforce can result in sidewall compaction and delayed emergence. Planting speed can also impact seed placement and uniformity. Therefore, this study aimed to evaluate two downforce pressures, 100 lb and 200 lb, at three planting speeds, 5 mph, 6 mph, and 8.5 mph.

A 24-row John Deere® ExactEmerge™ planter was used to plant corn at 2" deep. The seeding rate was 32,000 seeds/ac, and the field was planted on May 19, 2022. The soil was fairly moist at the time of planting. Emergence counts were taken to determine the percent of plants that emerged in the first 48 hours, 48-96 hours, and 96+ hours after planting and early season stand counts were collected on June 5, 2022. For each time frame, the percentage of plants emerged was calculated by dividing the plants emerged in that time frame by the total number of plants in the early season stand counts. Yield was determined by hand harvesting 20' of one row on October 22, 2022.

Results:

	% of Plants Emerged 0-48 hrs	% of Plants Emerged 48-96 hrs	% of Plants Emerged 96+ hrs	Early Season Stand Count (plants/ac)	Moisture (%)	Yield (bu/ac)†	Marginal Net Return‡ ($/ac)
100 lb Downforce x 5 mph	75 A	18 AB	7 A	30,928 A	15.5 A	166 A	1,088 A
100 lb Downforce x 6 mph	85 A	10 B	4 A	31,363 A	14.9 A	147 A	965 A
100 lb Downforce x 8.5 mph	86 A	11 B	4 A	30,492 A	12.7 A	168 A	1,101 A
200 lb Downforce x 5 mph	81 A	13 AB	6 A	29,839 A	15.2 A	173 A	1,133 A
200 lb Downforce x 6 mph	80 A	18 AB	3 A	31,145 A	15.1 A	230 A	1,512 A
200 lb Downforce x 8.5 mph	72 A	24 A	5 A	30,492 A	16.1 A	153 A	1,007 A
P-Value	0.153	0.056	0.808	0.248	0.349	0.302	0.302

*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 $6.57/bu corn.

Summary:

- In the first 48 hours following planting, there was no statistical differences in emergence. Relative to other treatments, the 200 lb downforce at 8.5 mph tended to have lower emergence in the first 48, but higher emergence in the 48-96 hour timeframe. By the 96+ hour stand counts, there were no differences between the treatments in percent of plants emerged.
- Early season stand counts in June showed no differences in plants/ac between the treatments.
- Yields determined by hand harvesting were highly variable. There were no significant differences in grain moisture, yield, or net return.

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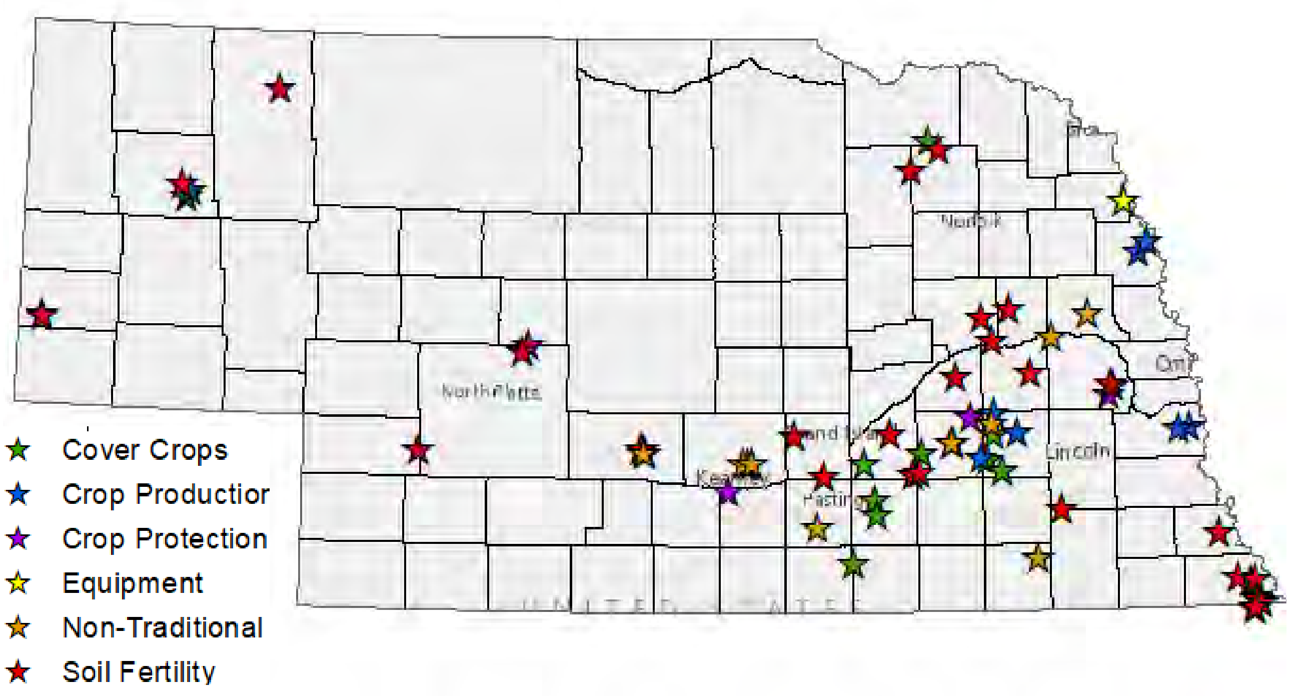
2022 STUDY LOCATIONS



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