Determining Economically Optimum Nitrogen Rate on Corn

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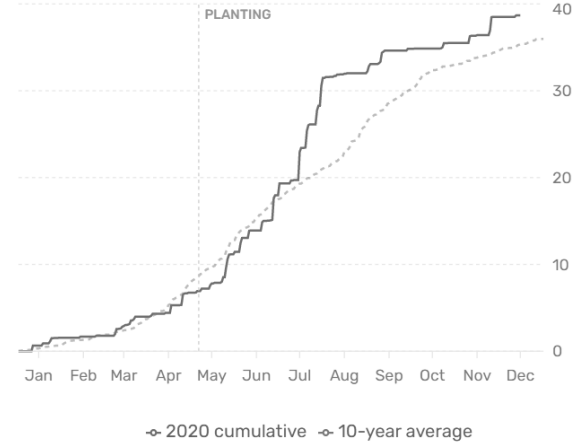**Row Spacing (in):** 30
Hybrid: Pioneer® P1197
Reps: 6
Previous Crop: Soybean
Tillage: No-Till / Strip-Till

Irrigation: None
Rainfall (in):

-○- 2020 cumulative -○- 10-year average

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

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

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

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

Yield monitor data were collected at the end of the growing season and post-processed to remove errors with Yield Editor software from the USDA. Additionally, yield data points that correspond to areas where the fertilizer application rate was more than 15% above or below the target rate were eliminated. Yield response to nitrogen and the economic optimum N rate (EONR) were calculated (Figure 3).
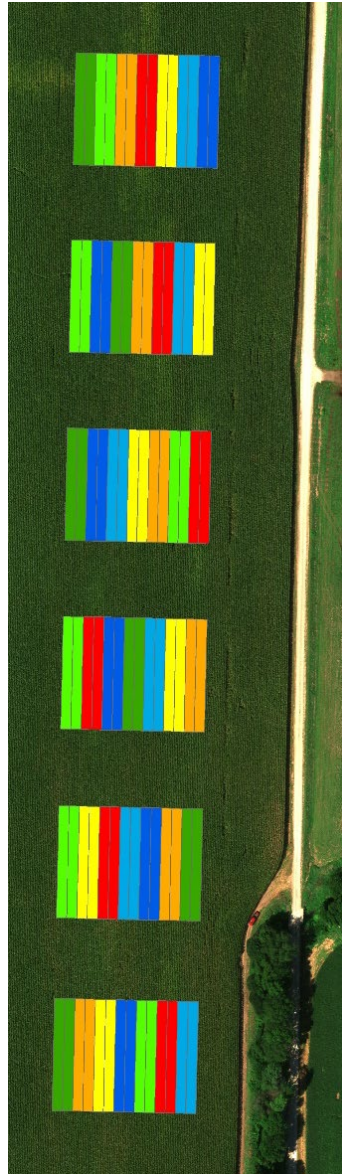
Figure 1. Nitrogen treatment map showing N rate applied with 11-52-0 and anhydrous ammonia. Treatments with sidedress application of 30 lb/ac N are indicated with "+30".

Results:

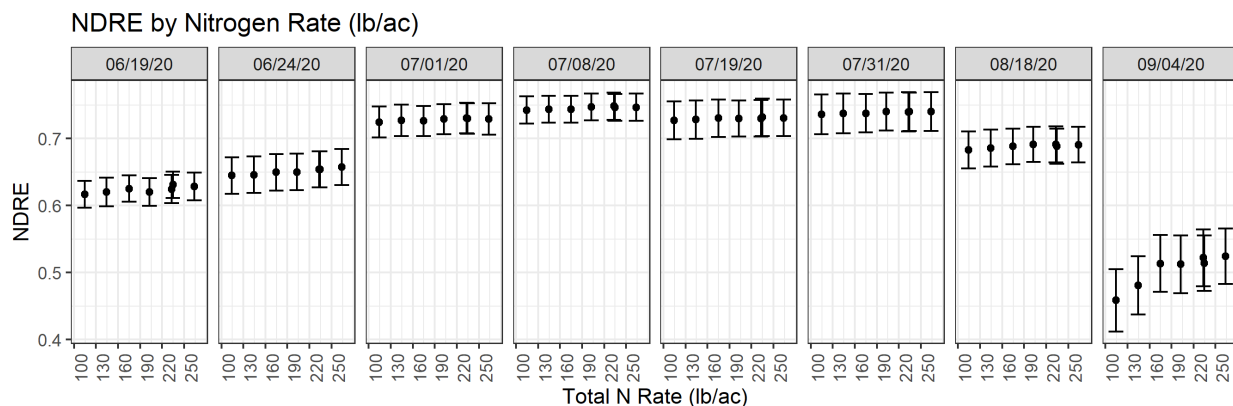|	NDRE							
	6/19/20	**6/24/20**	**7/1/20**	**7/8/20**	**7/19/20**	**7/31/20**	**8/18/20**	**9/4/20**
113 lb N/ac	0.612 C	0.642 C	0.722 C	0.742 B	0.726 C	0.734 C	0.682 C	0.457 C
143 lb N/ac	0.619 BC	0.647 BC	0.727 B	0.744 AB	0.728 BC	0.737 BC	0.686 BC	0.485 BC
173 lb N/ac	0.625 AB	0.651 AB	0.727 B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

NDRE by Nitrogen Rate (lb/ac)

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

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

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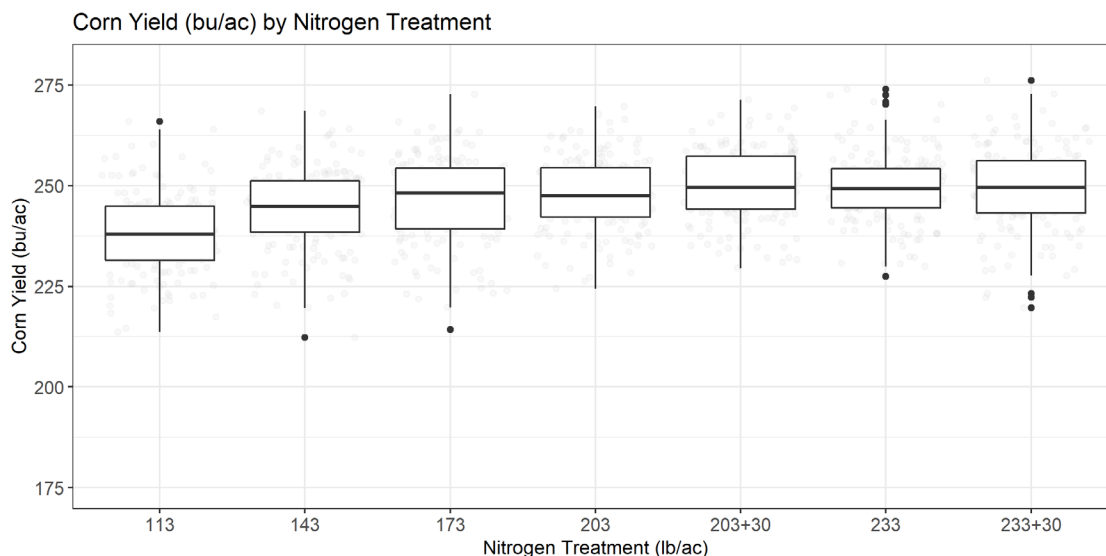

Figure 3: Corn yield by nitrogen rates. Nitrogen rates include N from 11-52-0 and from anhydrous ammonia. Treatments with sidedress application of 30 lb/ac N are indicated with "+30". The economic optimum N rate (EONR) was 157 lb/ac. In the plot, the midline is the median of the data, with the upper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

Summary:

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