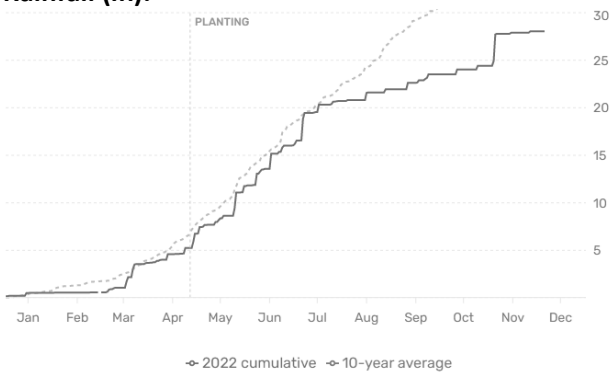
Determining Economically Optimum Nitrogen Rate on Corn

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):

			OM LOI	Melich-III P	Nitrate – N	Bray P1	Sulfate-S	-------Melich III-------				CEC	Sand	Silt	Clay
	pH	BpH	%	ppm	ppm N	ppm	ppm S	K	Ca	Mg	Na	me/100g	(%)	(%)	(%)
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.

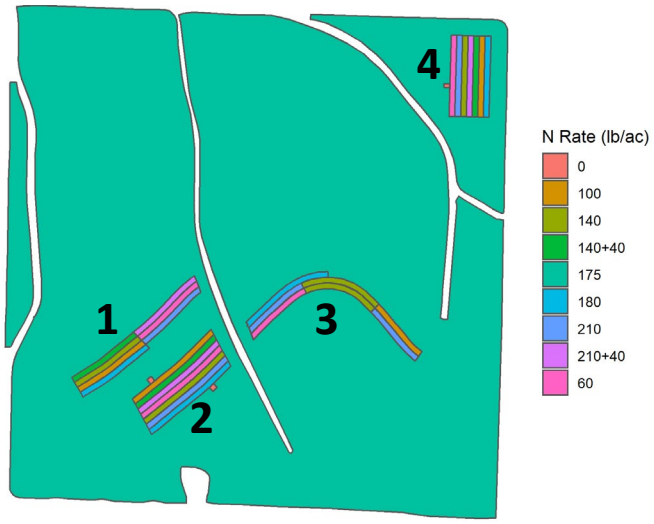


Figure 1. Nitrogen treatment map showing N rates applied with anhydrous ammonia. Treatments with sidedress application of 40 lb N/ac are indicated with "+40". Zones are numbered (1, 2, 3, and 4).

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).

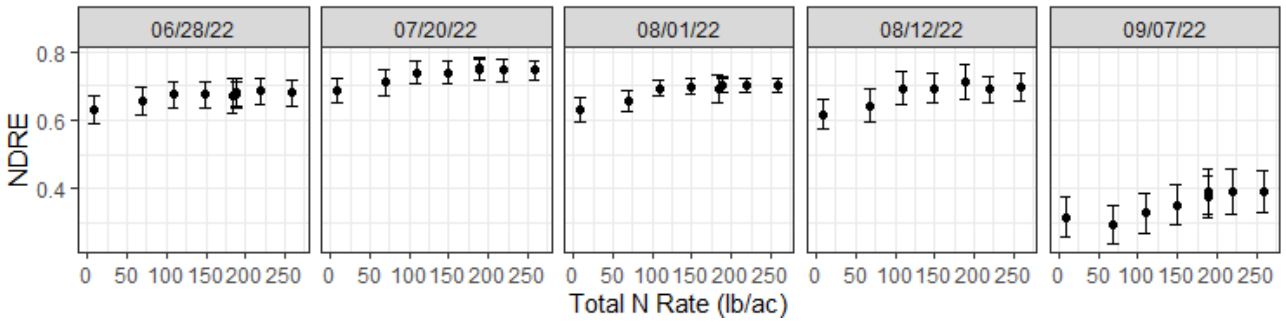


Figure 2. NDRE mean and standard deviation bars by total N applied for five imagery dates.

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.

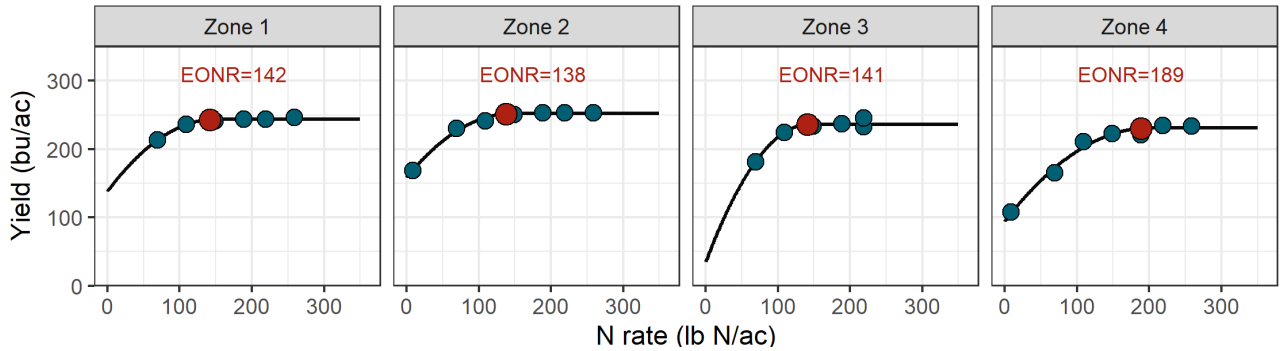


Figure 3. Corn yield by N rate for pre-plant N treatments. Economic optimum N rate is indicated with a red dot. Corn price is $6.57/bu and N fertilizer price is $0.45/lb.

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.