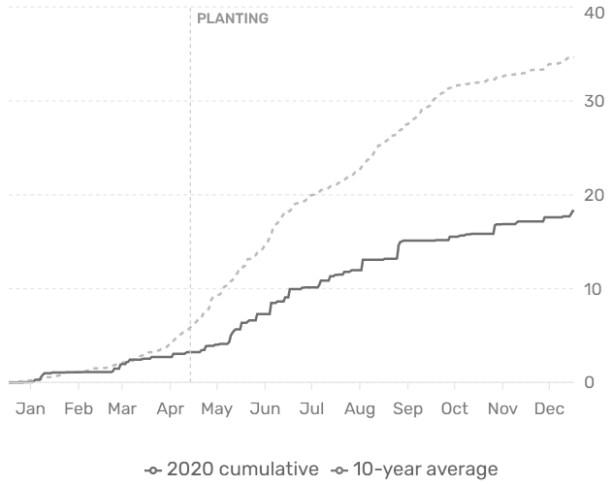
Sensor-Based Nitrogen Fertigation Management

Study ID: 0934155202002
County: Saunders
Soil Type: Yutan silty clay loam terrace, 2-6% slopes, eroded; Filbert silt loam 0-1% slope; Tomek silt loam 0-2% slope
Planting Date: 4/28/20
Harvest Date: 10/20/20
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1563AM
Reps: 4
Previous Crop: Soybean
Tillage: No-Till
Herbicides: ***Pre:*** 1 qt/ac atrazine 4L, 3.5 oz/ac Corvus®, 36 oz/ac Roundup PowerMAX® with 2 lb/ac AMS and 16 oz/ac COC on 4/28/20 ***Post:*** 1 pt/ac atrazine 4L, 3 oz/ac Laudis®, 40 oz/ac Roundup PowerMAX® with 2 lb/ac AMS and 18 oz/ac MSO on 6/4/20

Foliar Insecticides: None
Foliar Fungicides: None
Irrigation: Pivot, Total: 8.35"
Rainfall (in):



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

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

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

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

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

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

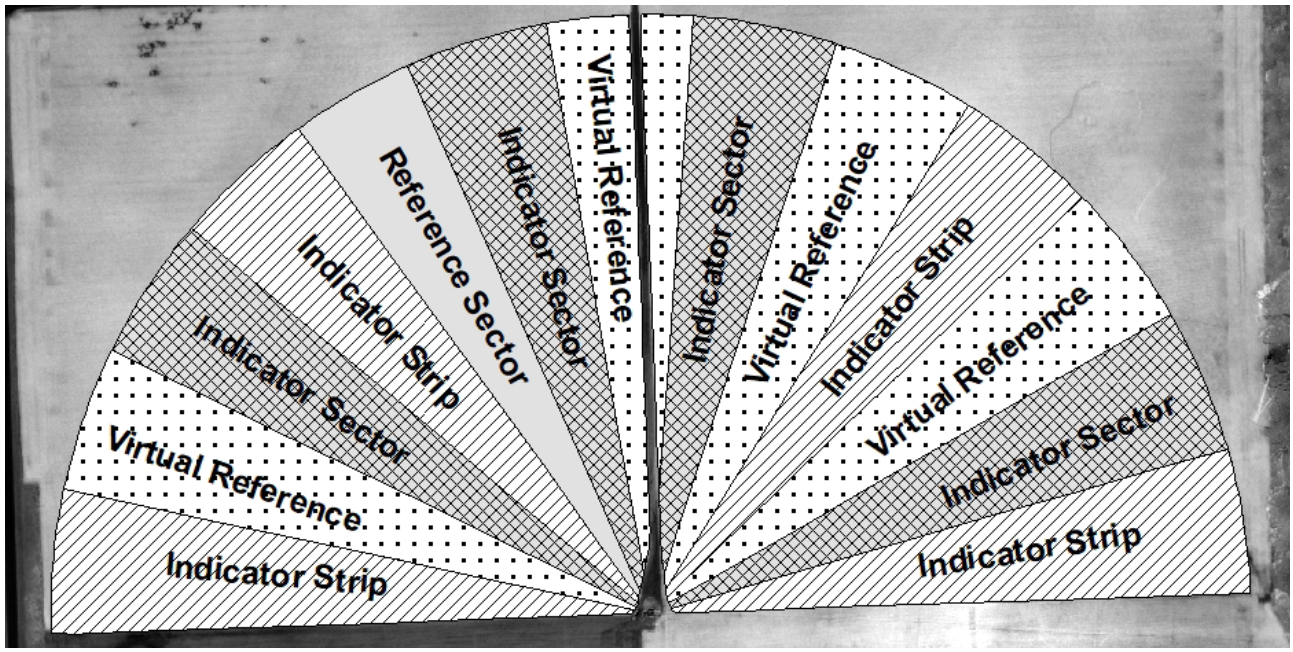


Figure 1. Experiment layout showing four replications of three treatments arranged in sectors.

Results:

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

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

Summary:

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

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