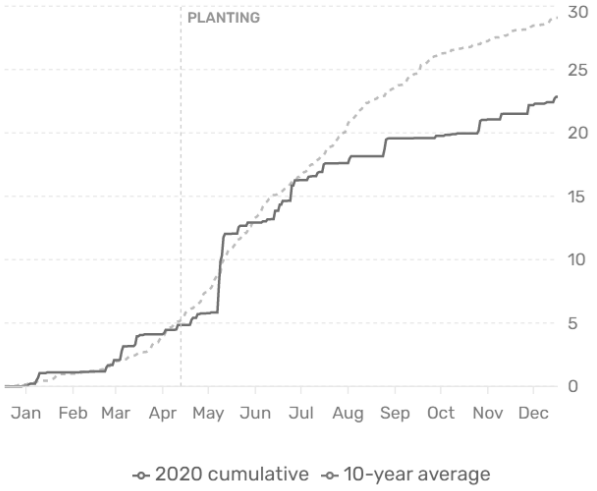
Sensor-Based Nitrogen Fertigation Management

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



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

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

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

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

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

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

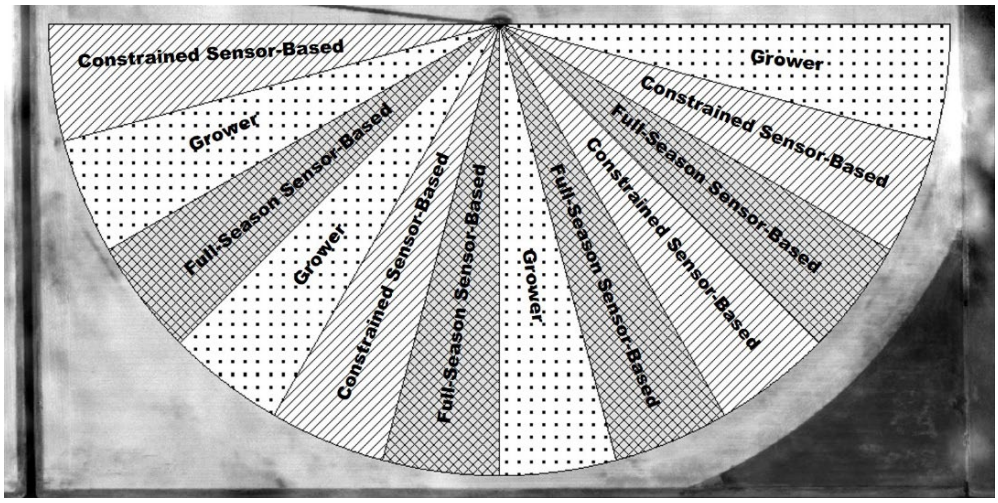


Figure 1. Experiment layout showing four replications of three treatments arranged in sectors.

Results:

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

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

Summary:

- At this site, the constrained sensor-based management approach applied 57 lb/ac less N than the grower's N management, whereas the full-season sensor-based management approach applied 17 lb/ac less N than the grower's management.
- Yield was not statistically different between the treatments. The lack of significant yield difference at this site, despite drastic numerical differences in yield, is indicative of significant yield variability within all three treatments. This suggests the experimental design may not adequately control for variability in measuring the impact of these treatments. Historical yield data (shown below) suggest underlying productivity patterns may have influenced the outcome of the trial.
- The constrained sensor-based approach resulted in the greatest nitrogen use efficiency; the constrained sensor-based approach used 0.21 fewer lb of N to produce a bushel of grain than the full-season sensor-based approach or the grower's approach.
- There was no statistical difference in marginal net return between the sensor-based approaches and the grower's N management.
- Significant wind damage, and associated weed pressure, on the higher-elevation and drastically sloping southeast portion of the field likely limited yield potential in this area. Wind damage may have also been present in other areas of the field.
- This site was the only site at which a sensor-based management treatment sector received more N than the grower treatment.
- Despite the factors that may have influenced results at this site, results from this site suggest that the constrained sensor-based management maintains efficacy for increasing N use efficiency.
- Results further suggest that full-season sensor-based management may in fact be a higher-risk implementation.
- There were no statistically significant differences in residual soil nitrate or change in soil nitrate from spring to fall between the three treatments.

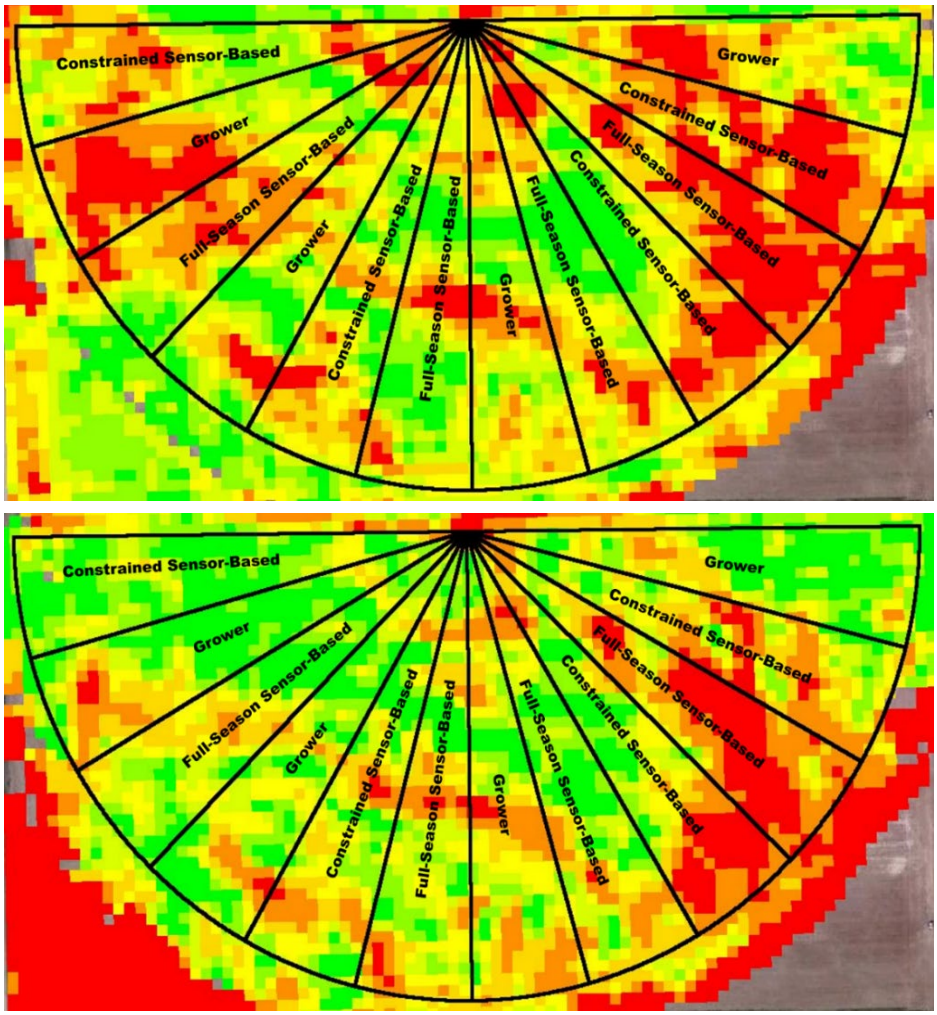


Figure 2. Gridded 2019 yield data (top) and 2020 yield data (bottom).

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