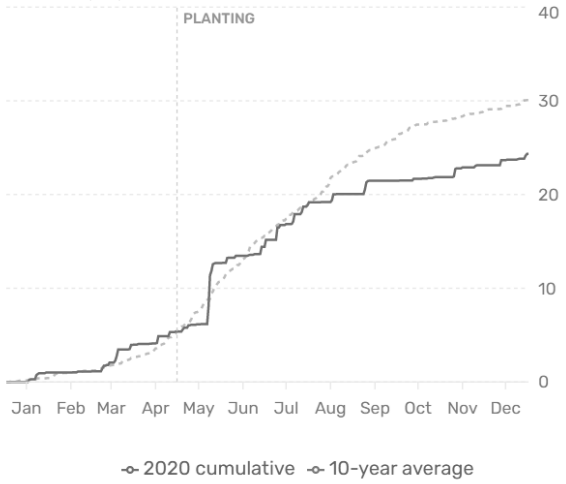
Sensor-Based Nitrogen Fertigation Management

Study ID: 0817081202001
County: Hamilton
Soil Type: Crete silt loam 0-1% slope; Hastings silt loam 0-1% slope; Hastings silt loam 1-3% slope
Planting Date: 4/30/20
Harvest Date: 11/2/20
Seeding Rate: 32,000
Row Spacing (in): 30
Hybrid: Pioneer® P1370Q
Reps: 4
Previous Crop: Corn
Tillage: Ridge-Till
Herbicides: ***Pre:*** 12 oz/ac Verdict®, 0.50 pt/ac Talus™ HC, 1 qt/ac ALTRA-V™ 4L, and 24 oz/ac Mountaineer® 6 MAX on 4/21/20 ***Post:*** 16 oz/ac Armezon® PRO, 1 qt/ac ALTRA-V™ 4L, and 32 oz/ac Mountaineer® 6 MAX on 6/11/20
Seed Treatment: Maxim® Quattro, Lumiflex™, Lumiante™, L-2012R, Lumivia™, Lumisure™, Lumialza™
Foliar Insecticides: 5 oz/ac Hero® on 7/18/20
Foliar Fungicides: 6.8 oz/ac Aproach® Prima, 4 oz/ac Spire™ 500 EC on 7/18/20
Note: Hail on 6/3 when corn was at V3. High winds on 7/8 led to stalk snap. Adjustment was 33.8% loss. Generally less damage in the study area.
Irrigation: Pivot, Total: 10.3"
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	6.5	7.0	3.9	5.9	11	11	286	2239	351	36	16	7	5	70	17	1
Full-Season	6.5	6.9	3.8	6.0	15	11	296	2304	339	31	17	11	5	68	16	1
Constrained	6.5	6.9	3.7	5.6	11	9	277	2225	337	34	17	10	4	68	17	1

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 64 lb/ac N as 11-52-0 on April 9, 35.5 lb/ac N as 32% UAN on April 22 with a high-clearance applicator, 5.8 lb/ac N as 10-34-0 on April 30 with planting, and 35.5 lb/ac N as 32% UAN through each fertigation on June 17, June 24, and July 8. Total N application was 212 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 105 lb/ac N (from pre-plant and at planting applications). All sensor-based fertigation applications were made at a rate of 30 lb/ac N. Sensor-based fertigation with 32%

UAN was triggered on five dates: three of four replications received N on June 24, one replication received N on July 8, one replication received N on July 13, two replications received N on July 22, and one replication received N on July 28. The total N application was 165 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 105 lb/ac N (from pre-plant and at planting applications). The grower's management was followed to apply 35.5 lb/ac N through each fertigation on June 17 and 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 176 lb/ac N.

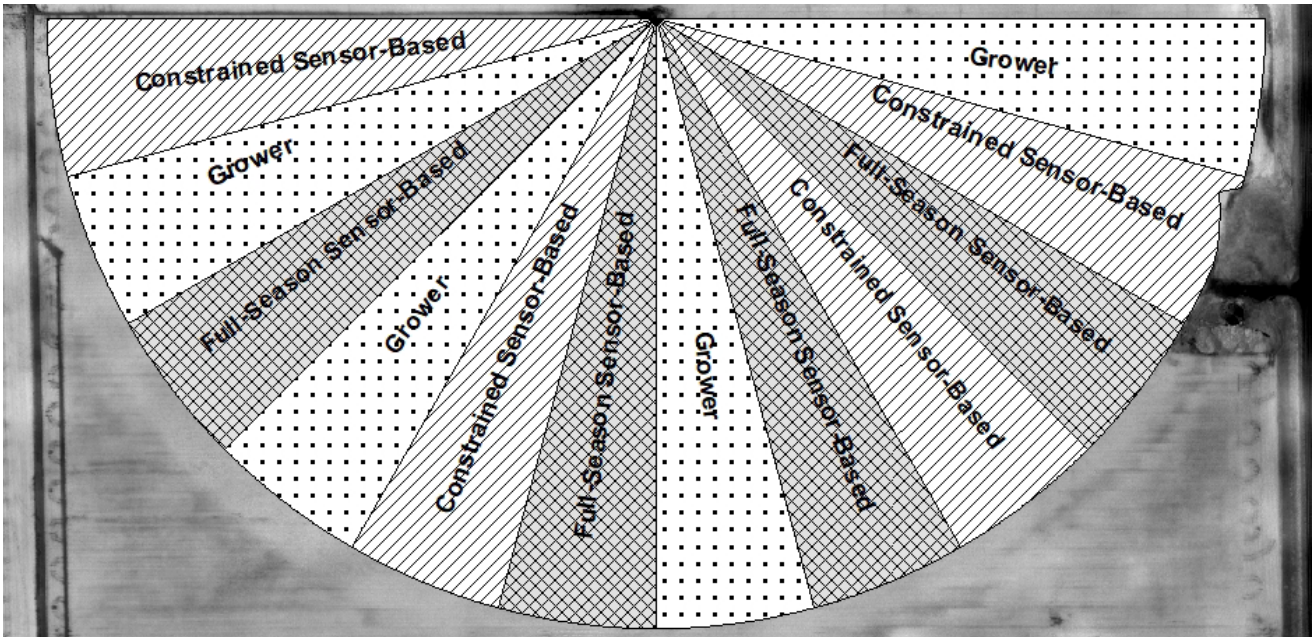


Figure 1. Experiment layout showing four replications of three treatments arranged in sectors.

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‡ ($/ac)	NO_3-N ppm N$^{\Psi}$ 0-8"	NO_3-N ppm N 8-24"
Grower	212 A*	15.5 A	235 A	62 B	0.90 A	738.66 A	3.3 A	8.0 A
Constrained	176 B	15.4 A	226 B	72 AB	0.78 B	719.43 A	3.7 A	8.9 A
Full-Season	165 B	15.0 A	221 B	76 A	0.75 B	709.31 A	3.2 A	7.9 A
P-Value	0.004	0.256	0.020	0.028	0.014	0.117	0.687	0.955

*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 November 2020.

Summary:

- At this site, the constrained sensor-based management approach applied 36 lb/ac less N than the grower's N management, whereas the full-season sensor-based management approach applied 47 lb/ac less N than the grower's management.
- Yield was 10-14 bu/ac lower for the sensor-based approaches compared to the grower's N management approach.
- Both sensor-based approaches resulted in greater nitrogen use efficiency as measured by lb of N per bu of grain.
- There was no statistical difference in marginal net return between the sensor-based approaches and the grower's N management.
- Imagery collected from this site did not appear to show insufficiency until the reproductive growth stages, indicating that yield loss may have occurred during grain fill and also suggesting that fertigation applications past R2 might be beneficial.
- Satellite imagery with only the NDVI index available was used to direct the first fertigation of the year on this site due to high winds, which inhibited UAV flight. This only impacted the full-season sensor-based management treatment, which had no sectors receive N, while all treatment sectors for the grower and constrained sensor-based management received 30 lb N.
- A significant rain event in early May could have caused significant N leaching that would have compounded the effects of a delayed early season fertigation.
- In general, results from this site further indicate the yield risk associated with full-season sensor-based fertigation management in its current form.
- Results from this site further indicate that sensor-based fertigation management leads to improved N use efficiency versus typical grower management.
- There were no statistically significant differences in residual soil nitrate or change in soil nitrate from fall to spring between the three treatments, though the two sensor-based treatments led to larger numerical reductions in soil nitrate from spring to fall.

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