Active Sensor Strategies for In-season Application of Urea in Corn

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A Preface

Addition of N fertilizer during the mid-vegetative corn (*Zea Mays* L.) stage is being used in Iowa to protect yield potential. The objective of this experiment was to compare pre-plant and in-season N application strategies, and evaluate N use efficiency and grain yield of sensor-based N rate application.

B Methods

The experiment was conducted at ISU Research and Demonstration Farms in 2012 and 2013. The prior crop at each site was soybean [*Glycine max* (L.) Merr.]. The active canopy sensor used was the Holland Scientific, Crop Circle ACS-210. In-season N application was conducted during the V10 corn stage.

The pre-plant (PP-N) application was urea fertilizer broadcast applied and incorporated or banded UAN before planting (0 to 280 kg N ha^{-1} in 56 kg increments). The pre-plant plus sensor (PP+S-N) application was the PP-N rates (0 to 280 kg N ha^{-1} in 56 kg increments) plus broadcast urea at the V10 growth stage (in-season N rates determined by the sensor). The split N strategy (SNS) was 84 kg N ha^{-1} PP-N plus broadcast urea at the V10 growth stage with in-season N rates determined by the sensor (84 kg N ha^{-1} rate minimum). The rescue N strategy (RNS) was 168 kg N ha^{-1} PP-N plus broadcast urea at the V10 growth stage with in-season N rates determined by the sensor (no rate minimum). The PP-N 168 kg N ha^{-1} was compared with both SNS and RNS. Corn was harvested with a plot combine and corrected to 15.5% moisture content. Additionally, a published sensor-based N study from Iowa in 2009 (normal year) and 2010 (wet year) was evaluated in-conjunction with this study, 2012-2013 (dry years).

Table 1. Characterization of normal (2009), wet (2010) and dry years (2012 and 2013).

	SDD†	GGD‡			Precipitation§		
Year	Observed	Observed	Climate Ave.	Rel.	Observed	Climate Ave.	Rel.
	base 86	-------- base 50 --------		%	--------- cm ---------		%
2009	31	2786	3102	90	56	62	90
2010	91	3416	3102	110	107	62	172
2012	376	3160	3069	103	48	61	79
2013	192	3064	3091	99	55	61	91
Mean	284	3112	3080	101	52	61	85

† Stress Degree Days (SSD) is ((daily max. temp. + 86° F)/ 2) – 86° F.
‡ Growing Degree Days (GGD) is ((daily max temp + daily min temp)/2) – 50° F.
§ Precipitation calculated as total rainfall from Apr. 15 through Oct. 15 each year. The Climate Ave. is from 1951-present.

Table 2. Sensor-Based N rates across different pre-plant N rates and N strategies, 2012 and 2013.

	Sensor-Based N Rate†		
PP-N	2012	2013	Mean
	kg N ha^{-1}		
0	144	214	179
56	95	147	121
112	91	101	96
168	73	111	92
224	60	100	80
280	56	93	75
Mean	87	128	

	N Strategies Sensor-Based N Rate‡				
	RNS	SNS	RNS	SNS	Mean
84	-	87	-	127	107
168	63	-	87	-	75

† Sensor-based N was calibrated using a virtual reference (highest observed sensor index value) at each location.
‡ Rescue N Strategy (RNS); Split N Strategy (SNS).

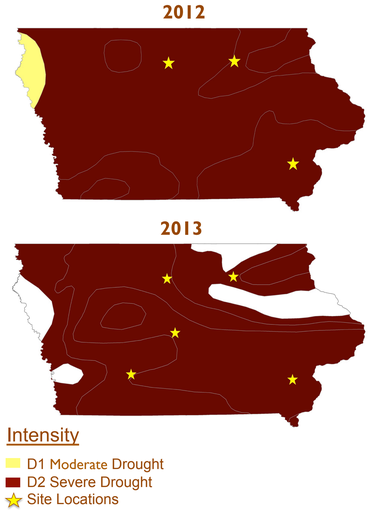

Fig. 1. Iowa Drought (Average of Weekly Monitor Maps (Apr. 15 – Oct. 15)

Map Created by Daniel Barker, Assistant Scientist, Iowa State University.
Data utilized from U.S. Drought Monitor: National Drought Monitor Center, United States Department of Agriculture, and National Oceanic and Atmospheric Administration.

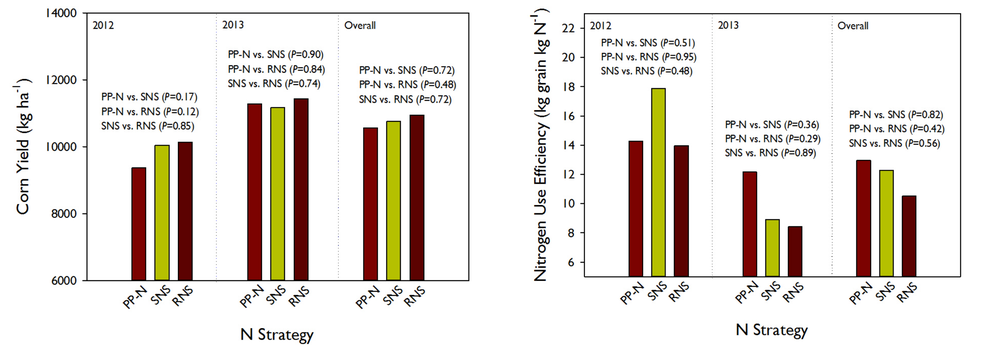

Fig. 2. Comparison of yield and NUE [(N yield – zeroN yield)/total N applied)] utilizing three N application strategies, 2012 and 2013. Statistical contrasts were made using PROC MIX.

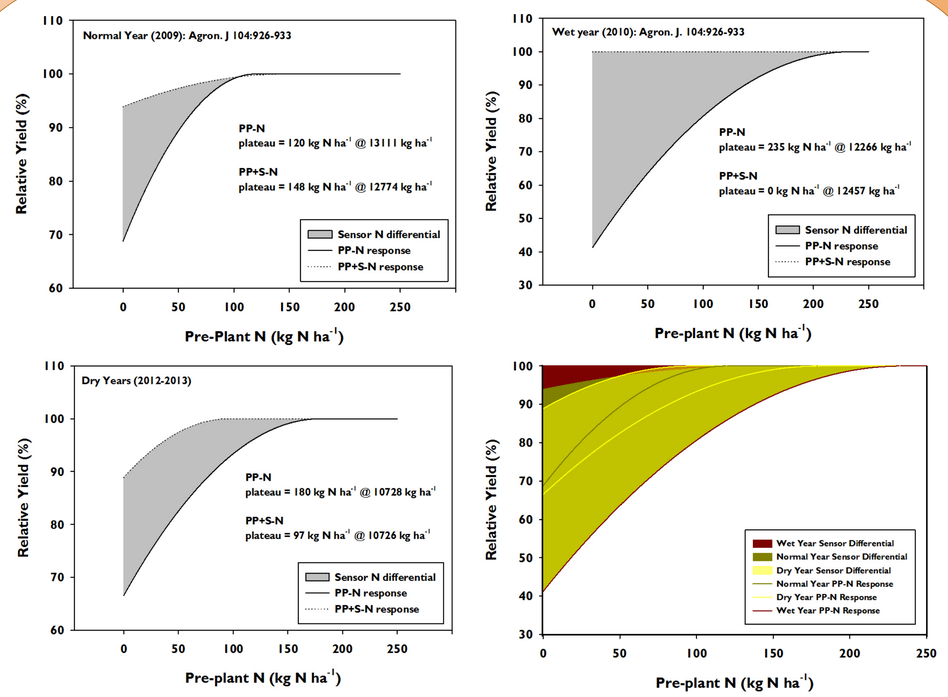

Fig. 3. Relative yield response to pre-plant N (PP-N) and PP-N with additional sensor N applied (PP+S-N). Grain yield and applied pre-plant N rate were fit to a statistically significant quadratic-plateau response model. Relative yield was calculated using the model curve yield divided by the calculated plateau yield for each strategy.

C Results

During this study, drought persisted across Iowa each year (Fig. 1), influencing in-season N treatment response and yield. In 2012 and 2013, there were 376 and 192 stress degree days, respectively (Table 1).

Corn yield and NUE were the same between the three strategies each year and overall (Fig. 2). Notably, SNS corn yields were the same as PP-N and RNS, showing yield response to sensor applied N, even in dry summer conditions. The NUE mean separations (SNS in 2012 and PP-N in 2013) were not statistically significant across sites and years, due to inconsistent/variable strategy responses at each site.

Figure 3 shows a comparison of PP-N and PP+S-N strategies across a normal year (2009), wet year (2010), and dry years (2012-13). There was positive sensor N differential in all years when limited N was applied prior to planting (minor exception at the PP-N plateau in 2009). The sensor differential becomes smaller with more applied PP-N. Plateau pre-plant N rates for the PP+S-N varied dramatically across years (0, 97, and 148 kg N ha^{-1} for wet, dry, and normal years respectively) averaging 80 kg N ha^{-1})

D Conclusions

- Drought conditions (especially after in-season N application) had a significant effect on N strategy response and yield potential during this study.
- The SNS provided more opportunity to preserve yield potential when growing conditions were uncertain.
- Across diverse years, the best PP-N rate to apply when using additional sensor-based N was approximately 80 kg N ha^{-1}.

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