2017 field trial execution methodology for Adapt N

2017 trial locations and number

Each year, NutrientStar conducts field trials in cornfields during the growing season on working farms to test performance of nitrogen fertilizer management models and products. In any given testing season there are approximately 20 consultants implementing 1 - 4 trials each with farmer clients in Indiana, Illinois, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin, under guidance and direction from S2, LLC[1]. Detailed field trial protocol are provided here.

During the 2017 field trial season which began in April 2017, NutrientStar planned to collect data and report results from fifty field trials on the Adapt N model. NutrientStar collected data from 45 trials. Five trials were not reported for the following reasons: one trial was abandoned because the field size would not accommodate the trial design (NST201714GK004); another trial was abandoned because reviewers could not determine the total actual nitrogen rates used by the farmer (NST201719EX002); two trials were abandoned because the nitrogen sidedress application information was not spatially registered with the yield data (NST201726FF001, NST201726FF003); and the final abandoned trial was collected with a yield monitor that had physical problems with the sensor systems (NST201720LE001).

Adapt-N model input entry process

For all trials, consultants entered the required data into the model according to the instructions provided in the Adapt-N manual and as directed by S2 with guidance originally obtained from Agronomic Technology Corporation staff.[2] Detailed field trial data are entered into an online database with naming conventions for each field to ensure anonymity of the farmer location. On occasion, S2 staff provided consultants with data entry assistance - on these occasions S2 staff entered data into the online database while conferring with the cooperating consultant via phone or email to ensure accuracy. S2 staff reviewed all data entered into the online database. If staff had questions about entered data, S2 contacted the cooperating consultant to verify accuracy and make any necessary corrections. Inconsistencies were generally minor and related to data entry error.

The NutrientStar consultants reviewed default values in the model for all fields. In some cases consultants and farmers changed the default values as the model allows based on their

[1]S-Sqared Partners, LLC. (S2) is an independent agronomic and technology consulting firm located in Northwest Ohio. Expert agronomic and technology consulting services are provided to farmers, retail fertilizer dealers and independent agronomic consultants.

[2] Agronomic Technology Corporation markets the Adapt N tool. During the first test phase for Adapt N in 2015, Greg Levow of ATC provided detailed instructions to NutrientStar field trial administrator John McGuire for accurate entry of data inputs, and for each season S2 ensured NutrientStar consultants followed the instructions.

knowledge of field characteristics such as soil type, organic matter, and rooting depth. The Adapt N model allows for more accurate field measurements or observations to be entered where known. Where there were manured fields, consultants entered manure N values according to their experience regarding manure physical composition and nitrogen availability. In very few cases, consultants changed the rooting depth value from the default value. The Adapt-N model uses the SSURGO database for soils data, which is known to provide only approximate estimates of properties like rooting depth. As a result, where local knowledge from consultants or farmers was believed to be more accurate than default values, the default values were changed.

It is worth noting that yield goal inputs influence the model's N recommendations. All the consultants and farmers in NutrientStar's trials used the recommended method in the Adapt-N manual to choose the yield goal for their trials. The recommended method is to insert the "fourth highest yield from the last five years" into the Adapt-N interface (Moebius-Clune et al., 2014).

Consultants entered all additional required and requested data inputs into the model around the date of sidedress nitrogen application. Sidedress applications occurred in most trials between the V2 and V4 growth stage with a few trials sidedressed at later growth stages. Although the Adapt-N Training Manual recommends that estimated nitrogen sidedress rates from the Adapt-N model should occur between the V6 and V12 growth stages, NutrientStar found this impossible to implement in real-world conditions. Farmers running trials for NutrientStar - like most farmers throughout the Corn Belt - typically apply sidedress N between the V2 and V4 growth stages. NutrientStar administrators suspected that trial results would not vary markedly from nitrogen sidedressed at the V4 growth stage compared with sidedressing at the V6 growth stage - which is typically a difference of 6 days - because the probability of a rainfall event with sufficient rain to cause substantial losses of N occurring in a 6-day period during that time in the growing season is small. To check this assumption, NutrientStar ran an analysis of the data in Supplemental Tables S1 and S2 from Sela et al. (2016) comparing the RTN from the 113 trials divided into three groups: trials sidedressed before the V6 growth stage, trials sidedressed from V6 to V12, and trials sidedressed after V12. The results are shown in Table 2 below. There was no difference in RTN for trials sidedressed before V6 compared with trials sidedressed from V6 to V12, which substantiated NutrientStar's assumption.

S2 staff collected yield monitor data for the field trials post-harvest. These data, along with model input data entered earlier in the season, were used to calculate each trial's resulting NUE and return to nitrogen compared with the results from the farmer's normal rate of nitrogen. Dr. Geoffrey Ecker at Arkansas Tech University and Dr. Tom Morris with University of Connecticut

perform the calculations. Using the statistical software R all trials were fit with both linear and quadratic models. The best model as defined by adjusted R^2 was used to determine yield at the farmers normal rate, the Adapt-N rate and the economic optimum nitrogen rate (EONR, $4/bu, $0.4/lb N). Trials for which neither model was statistically significant were deemed non-responsive. From this analysis, field trial results fell into three categories: those where there was no yield response between the rates of N applied in the trials (100 to 250 lbs N/acre); those where there was a significant response to N rates applied in the trials, and those where the response to N was greater than the highest N rate of 250 lbs N/acre applied in the trials.

The NutrientStar team shared the analysis of trial results with Adapt N personnel prior to posting on the NutrientStar website. The field trial results and initial assessment of NUE and return to N were also shared with the NutrientStar review panel via webinar. The review panel was satisfied with the field trial results and assessment based on those results, so the data were prepared for posting on the NutrientStar website.

Table 2. Number of trials and mean separation statistics by Tukey's honestly significant difference test for comparisons of return to nitrogen (RTN) for three categories of trials based on the growth stage of corn when nitrogen was sidedressed. (Calculation from data in Supplemental Tables S1 and S2 in Sela et al., 2016).

Category[1]	Number	Mean RTN ($/acre)	Comparison	Tukey HSD p value
A	47	52.67	A vs B	0.890 NS
B	58	53.28	A vs C	0.001
C	8	224.38	B vs C	0.001

[1]A = V4 and V5 stage of growth; B = V6 to V12 stage of growth; C = V13 to V16 stage of growth.

References

Moebius-Clune, B.N., M. Carlson, H. M. van Es, J. J. Melkonian, A. T. DeGaetano, and L. Joseph. 2014. Adapt-N Training Manual - A tool for precision N management in corn. Edition 1.0, Extension Series No. E14-1, Department of Crop and Soil Sciences, Cornell University, Ithaca, New York 14853. Available at: file:///C:/Users/Admin/Downloads/adapt-n-manual%20(2).pdf.

Sela, S., H. M. van Es, B. N. Moebius-Clune, R. Marjerison, J. Melkonian, D. Moebius-Clune, R. Schindelbeck, and S. Gomes. 2016. Adapt-N Outperforms Grower-Selected Nitrogen Rates in Northeast and Midwestern United States Strip Trials. Agron. J. 108:1726–1734.