Report – Analysis of 2016 Adapt-N Yields

Introduction

Forty-seven field-scale replicated strip trials to evaluate Adapt-N were completed in 2016. The trials followed the protocol required by the NutrientStar program.

Field Methods

Most trials had 4 replications and 4 rates of N: 100, 150, 200 and 250 pounds N/acre. A few trials had higher rates of N but maintained a 50-pound difference between the rates.

Most trials were corn after beans. Eight trials had a history of manure applications, and those trials were trials: 04-003, 04-004, 07-013, 09-003, 09-005, 13-013, 14-017, 18-001.

The N rates were established at the time of sidedressing with most trials applying 40 to 80 pounds of N/acre before planting. The sidedressing occurred between the V2 and V4 stage of growth in most trials.

UAN was applied for a majority of the N on almost all trials. Seventeen trials had anhydrous applied as the primary source of N. The fields that received anhydrous as the primary source of N were: 01-294, 02-002, 03-007, 03-128, 04-003, 05-015, 05-016, 05-017, 07-013, 10-011, 10-012, 10-013, 14-018, 16-006, 16-018, 16-019, 16-020.

The farmer total N rate and the Adapt-N total N rate for each trial was recorded.

Data Analysis

The linear (L), quadratic (Q) and quadratic-plateau (QP) models were used to describe the relationship between yield and N rate at each trial. The QP model failed to converge for several trials and at other trials did not describe the relationship better than the Q model based on adjusted R^2, P, and AIC values. For these reasons, the QP model information will not be reported.

The trials were divided into three categories for further analysis. Category 1 trials included those where both the Q and L models were not significant. These results indicate that a response to N at these trials occurred at less than the lowest N rate of 100 pounds per acre. Category 2 trials included those where there was a significant quadratic response ($P < 0.10$) to N, and the agronomic optimal N rate (AONR) was equal to or less than the highest N rate applied. Category 3 trials included those where the Q model was significant ($P < 0.10$), and the calculated AONR was greater than the highest N rate applied, or the Q model was not significant, but the L model was significant. These results indicate that the response to N occurred at a rate greater than the highest N rate applied.

The AONR and economic optimal N rate (EONR) were calculated for each trial using the Q model. Confidence intervals (95%) were calculated for the AONRs (Jaynes, 2011).

The partial factor productivity for the Adapt-N rate compared with the Farmer rate was calculated for the trials where there was a significant quadratic response to N within the rates of N applied in the field (Category 2 trials). Partial Factor Productivity is defined as the yield divided by applied N rate expressed as the pound of grain harvested per pound of N applied. Calculation of the percentage change in NUE at individual trials was calculated as: (NUE for Adapt-N - NUE Farmer treatment)/NUE Farmer treatment X 100.

The loss in $/acre from the EONR was calculated for Adapt N and Farmer rates, and the loss in $/acre from the Farmer rate was calculated for the Adapt-N rate. For those trials where the response to N was less than the lowest rate applied (100 lbs/acre) at the trial, the loss in $/acre was calculated for an N rate of 0 pounds/acre and 100 pounds/acre for the Adapt-N rate and the Farmer rate. This allows bracketing the loss in extra cost of N fertilizer for the Adapt-N rate and the Farmer rate at trials where the EONR was less than 100 pounds/acre.

Results

Trials with N response less than lowest N rate (100 lbs/acre)

At 15 (32%) of the 47 trials the Q model had a P value greater than 0.10 and an AIC value within 2 units of the L model. These trials also had a P value greater than 0.10 for the L model (Table 2). This indicates the AONR is less than the lowest N rate (100 lbs/acre) applied in the trial. Graphs of the yield vs N rate also showed these trials had no response to N.

Trials with N response between applied N rates (100 to 250 lbs/acre)

At 22 (47%) of the 47 trials, the Q model showed a significant (0.10) response to N and the AONR was between the four rates of N applied at each trial. See table 2 below for information about these trials.

Trials with N response greater than the highest N rate (250 lbs/acre)

At 10 (21%) of the 47 trials, the N response was greater than the highest N rate applied in the trial (Table 3). At 8 of the trials the Q model was significant (<0.10), and the AONR was greater than the highest rate applied at the trial. At two to the trials the Q model was not significant (>0.10), and the L model was significant (<0.10). This indicates the response to N was greater than the highest N rate (250 lbs/acre) applied at most trials. To obtain an estimate of how well the farmers and Adapt-N predicted the N rate, the N rate and yield at 250 pounds of N were compared with the results from the Adapt-N and Farmer rates of N.

Table 1. The fit, significance, and slope for linear regression between nitrogen (N) rate and yield, total N recommended by Adapt-N, total N chosen by farmer, and the loss for the Adapt-N and Farmer rates if the EONR was 0 or 100 pounds N/acre for 15 of 47 fields where linear regression was not significant (P=0.10) for N rates between 100, 150, 200 and 250 pounds per acre.

Field	Linear regression fit, slope and significance	Adapt-N rate	Farmer rate	Adapt-N loss if 0 or 100 lbs N is EONR[1]	Farmer N rate loss if 0 or 100 lbs N is EONR[1]	Manure[2] Rate
		lbs N /acre		$/acre		lbs N /acre
03-008	R^2= 0.0004, S= -0.0016, P= 0.94	118	221	47 (7)	88 (48)	-
03-128	R^2= 0.01677, S= -0.02551, P= 0.6326	141	266	56(16)	106(66)	-
05-014	R^2=0.2263, S= 0.04393, P= 0.118	161	206	64(24)	82(42)	-
08-003	R^2=0.02179, S= 0.03943, P= 0.5854	216	286	86(46)	114(74)	-
09-003*	R^2= 0.1589, S =0.02374, P= 0.1262	87	102	35(-5)	41(1)	90
09-005	R^2= 0.07165, S= -0.02126, P= 0.3162	155	120	62(22)	48(8)	-
10-011	R^2= 0.09409, S= 0.1339, P= 0.2479	135	150	54(14)	60(20)	-
10-013	R^2= 0.1307, S= -0.0592, P= 0.1688	140	230	56(16)	92(52)	-
12-003	R^2= 0.1123, S= 0.02650, P= 0.2044	190	170	76(36)	68(28)	-
13-013*	R^2= 0.005753, S= 0.01185, P= 0.7801	164	126	66(26)	50(10)	64.4
13-120	R^2= 0.0005054, S=-0.004419, P= 0.9341	159	154	64(24)	62(22)	-
14-017*	R^2= 0.07523, S= 0.02215, P= 0.3039	65	180	26(-14)	72(32)	50
16-018	R^2= 0.09656, S= 0.05396, P= 0.2414	80	215	32(-8)	86(46)	-
16-019	R^2= 0.171, S= 0.05563, P= 0.1114	55	215	22(-18)	86(46)	-
16-020	R^2= 0.03964, S= 0.01720, P= 0.4598	117	227	47(7)	91(51)	-
						-
Mean		132	191	53(13)	76(36)	-
90% CI				45-61 (5-21)	67-86 (27-46)	-
[1]= values in parenthesis are for the 100 lb N rate; S = slope.						
[2] = manure N is expected N availability based on analysis or book values.						

Table 2. Quadratic regression parameters for fit and significance for nitrogen (N) rate and yield, economically optimal N rate (EONR) calculated from the regression, agronomic optimal N rate (AONR) N rate recommended by Adapt-N program, the Adapt-N loss from the farmer rate, and the loss from EONR for Adapt-N and Farmer rate, and change in partial factor productivity between the Adapt-N rate and farmer rate for 20 of 47 fields where there was a significant response to N between rates of 100, 150, 200 and 250 pounds per acre.

Field	Regression fit and significance	EONR	AONR (CI +/- 2 SD)	Adapt-N rate	Farmer rate	Adapt-N loss from Farmer	Adapt-N loss from EONR	Farmer loss from EONR	Loss in Partial Factor Productivity	Manure Rate
		lbs N / acre				$ / acre			%	lbs N / acre
01-293	Adj. R^2 = 0.68, p <0.001	200	218 (196-288)	100	180	112	117	5	53	-
01-294	Adj. R^2 = 0.46, p <0.01	172	204 (184-267)	110	200	20	25	5	71	-
01-295	Adj. R^2 = 0.93, p <0.001	218	232 (214-259)	100	180	180	201	21	39	-
01-296	Adj. R^2 = 0.58, p < 0.01	181	207 (190-271)	100	200	47	50	3	81	-
01-297	Adj. R^2 = 0.52, p < 0.01	178	214 (193-402)	135	180	10	11	1	29	-
01-298	Adj. R^2 = 0.77, p < 0.001	176	222 (205-300)	90	170	32	33	0	74	-
01-299	Adj. R^2 = 0.51, p < 0.01	188	238 (195-549)	100	180	31	31	0	69	-
01-300	Adj. R^2 = 0.92, p < 0.001	182	232 (221-287)	110	165	19	20	1	44	-
03-007	Adj. R^2 = 0.32, p = 0.03	198	248 (194-667)	128	223	17	19	3	60	-
04-003*	Adj. R^2 = 0.53, p = 0.013	149	212 (175-745)	183	151	4	4	0	-16	200
05-016	Adj. R^2 = 0.28, p = 0.094	171	202 (180-445)	212	207	2	11	8	-2	-
05-017	Adj. R^2 = 0.27, p = 0.098	124	249 (184-631)	170	200	-6	3	9	17	-
05-018	Adj. R^2 = 0.76, p < 0.001	206	220 (199-293)	168	203	21	21	0	16	-
07-013	Adj. R^2 = 0.84, p < 0.001	258	288 (265-350)	127	272	117	118	1	63	-
09-004*	Adj. R^2 = 0.49, p < 0.01	179	211 (193-236)	207	187	4	5	0	-9	80
10-012	Adj. R^2 = 0.83, p < 0.001	204	223 (205-261)	178	203	7	7	0	11	-
14-013	Adj. R^2 = 0.66, p < 0.001	191	247 (203-590)	159	179	3	4	1	11	-
16-006	Adj. R^2 = 0.34, p = 0.025	128	228 (190-718)	70	210	-6	7	13	177	-
16-016	Adj. R^2 = 0.41, p = 0.012	197	228 (192-615)	150	230	7	14	8	46	-
16-017	Adj. R^2 = 0.83, p < 0.001	196	223 (202-254)	136	191	26	26	0	32	-
18-001*	Adj. R^2 = 0.65, p < 0.001	96	131 (103-249)	236	51	100	111	11	-79	139
19-001	Adj. R^2 = 0.85, p < 0.001	170	195 (180-255)	183	140	-5	2	7	-21	-
Mean (SD)				143 (44)	186 (40)	34 (48)	38(50)	4(5)	35 (49)	-
90% CI				-	-	16-52	19-57	2-6	17-53	-

Table 3. Quadratic regression parameters for fit and significance for nitrogen (N) rate and yield, N rate recommended by Adapt-N program, farmer rate, maximum trial rate, the Adapt-N loss from the farmer rate, and the loss from max rate for Adapt-N and Farmer rate, for 10 of 47 fields where the response to N fell outside of the rates of 100, 150, 200 and 250 pounds per acre.

Field	Regression fit and significance	AONR (CI +/- 2 SD)	Adapt-N Rate	Farmer Rate	Max Rate	Adapt-N loss from Farmer	Adapt-N loss from max rate	Farmer loss from max rate	Manure Rate
		lbs N /acre				$ / acre			lbs N /acre
02-002[1]	Adj. R2 = 0.17, p = 0.1204	220 (179-528)	178	248	250	27	-33	-6	-
03-009	Adj. R^2 = 0.84, p < 0.001	254 (216-388)	69	174	250	125	121	-4	-
03-010	Adj. R^2 = 0.89, p < 0.001	326 (251-953)	91	191	254	64	81	17	-
04-004*	Adj. R^2 = 0.31, p = 0.075	206 (111-1245)	158	118	183	5	0	-4	105
05-015	Adj. R^2 = 0.64, p < 0.01	328 (211-1159)	198	208	250	2	-4	-6	-
07-014	Adj. R^2 = 0.79, p < 0.001	272 (224-832)	153	206	250	10	15	5	-
09-001*	Adj. R^2 = 0.82, p < 0.001	271 (224-505)	160	210	255	18	6	-11	105
14-016	Adj. R^2 = 0.77, p < 0.001	271 (222-611)	83	203	256	112	108	-4	-
14-018	Adj. R^2 = 0.43, p < 0.01	279 (200-984)	125	200	250	-2	-14	-12	-
15-002[1]	Adj. R^2 = 0.14, p = 0.1461	221 (177-669)	135	240	250	14	-19	-5	-
Means (SD)			135 (40)	200 (34)	245 (21)	38 (44)	26 (53)	-3 (8)	-
90% CI			-	-	-	10-65	-6-58	-8-2	-

References

Jaynes, D. B. (2011). Confidence bands for measured economically optimal nitrogen rates. *Precision agriculture*, *12*(2), 196-213.