

CORN YIELD RESPONSE TO NITROGEN RATE AND TIMING IN MICHIGAN

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Improving our understanding of the factors affecting corn yield and yield response to N fertilizer in Michigan is important to providing efficient and profitable N recommendations. To address this issue, several corn N-response trials were initiated for the 2007 growing season. The specific objectives of these trials were to i) evaluate corn grain yield response to N rate and timing (time of application) in Michigan growing conditions, and ii) develop a N response database for soils and growing conditions common to Michigan. A total of 16 trials were initiated in spring 2007. However, due to droughty conditions throughout much of Michigan during the latter part of the summer, data collected from 5 sites was determined non-representative and was discarded from the data pool. Thus, 11 study locations were evaluated including 3 sites on MSU research farms and 8 sites located on producer fields. Experimental sites were located in a manner that provided a representation of the major soil associations common to Michigan corn production (Figure 1). Treatments consisted of iterations of N fertilizer (urea preplant-incorporated, ammonium nitrate, and/or 28% UAN sidedress injected depending on site) and were replicated 3 to 4 times (Table 1). At the research farm sites, soil samples were collected preplant (0-6" and 0-3' in 1' increments), pre-sidedress (0-12"), and post-harvest (0-6" and 0-3' in 1' increments). Plant growth evaluation included stand counts; V6 and R1 tissue sampling; chlorophyll meter and GreenSeeker optical sensor measurements at V6, V8, V10, and R1; end-of-season stalk sampling; grain yield and grain N analysis. Grain yields were determined via hand-harvesting, plot combine, or combine yield monitor depending on the site.

Selected preplant soil test data for several sites are provided in Table 2. These results provide evidence that soil nutrients other than N at these sites were non yield-limiting. Analysis of soil samples at other sites is pending. Plant tissue analyses and Minolta SPAD relative chlorophyll readings will be evaluated to differentiate trends in relation to N rate and timing and among each other. Remote sensing (NDVI) data collected at the research farm sites throughout the year with the GreenSeeker sensor will be evaluated and added to a regional database, where multiple universities and industry are developing algorithms for using these data to develop N recommendations and improved N management.

Table 3 shows the response of corn to N rate at individual sites and provides a comparison of different approaches for determining the optimum N rate to apply (N rate based on maximum agronomic yield vs. economic optimum yield). Tables 4 and 5 provide a statistical comparison (based on Fisher's LSD) among the various N treatments at each site. *With the exception of Ingham SbC, 120 lb N/ac or less, regardless of application time, was sufficient to obtain maximum corn yield. At Ingham SbC, 160 lb/ac was required to achieve maximum yield.*

The EONR was less than the YONR at all sites and resulted in only slight reductions in crop yield. *When compared with the YONR and the EONR, the current MSU N recommendation suggested 32 and 55 additional lbs N/ac, respectively, averaged across all sites and based on the maximum yield achieved at the sites.* Based on these results, the EONR provided the maximum return on the fertilizer N investment at these sites in 2007.

Data collected from 2007 will be pooled with results from this study in 2006 as well as data collected from other recent MI N response trials. The North Central Regional Approach to N-Rate guidelines will then be applied to this collective data pool to develop a revised N-rate guideline (recommendation) for Michigan. Efficient use of N fertilizer for corn production is essential to maximizing economic return for the producer and minimizing adverse environmental effects. Improvement of the Michigan corn N recommendation will require collection of additional N response data due to the lack of this data from recent Michigan research studies. Additional data collection will be essential to improving the accuracy of the new N guidelines.

Table 1. Nitrogen fertilizer treatments at study locations in 2007†.

Ingham‡, Saginaw Branch, Hillsdale	Ingham(M), Tuscola(1,2)	Berrien	Saginaw1, St. Clair
----- lb N/ac -----			
Control	Control	Control	Control
20 (pp UR)	40 (pp UR)	40 (pp AN)	40 (sd UAN)
40 (pp UR)	80 (pp UR)	80 (pp AN)	80 (sd UAN)
80 (pp UR)	120 (pp UR)	120 (pp AN)	120 (sd UAN)
120 (pp UR)	160 (pp UR)	160 (pp AN)	160 (sd UAN)
160 (pp UR)	200 (pp UR)	200 (pp AN)	200 (sd UAN)
200 (pp UR)	160 (sd UAN)		
160 (sd UAN)			
80 (20pl, 60sd)			
120 (20pl, 100sd)			
160 (20pl, 140sd)			

† pp UR: urea (46-0-0) applied preplant and incorporated

sd UAN: 28% urea ammonium nitrate solution applied sidedress, injected

pl: urea applied as 2x2 starter at planting

pp AN: ammonium nitrate (34-0-0) surface-applied preplant

‡ 20 lb N/ac rate at Branch site only; Four replications at all sites except St. Clair and Saginaw1 (3 reps each)

Table 2. Preplant soil test data (0-6" sample) for sites used in the N response studies in 2007. Information for other sites not available at time of report.

Location	pH	Organic Matter	Bray-1 P	K
		%	----- lb/ac -----	
Berrien	7.0	2.1	31	149
Ingham CC	7.2	2.9	73	157
Ingham SbC	6.9	2.9	120	151
Saginaw	8.0	2.9	67	354

Table 3. Corn yield response to N fertilizer rate at study locations in Michigan, 2007. Data were fit to yield response curves to determine optimum yield and N rates.

Location	Previous Crop	Max. Yield	MSU N Rec.	Yield Opt. N Rate	MSU N Rec. - Opt. N Rate	Max. Econ. Yield	Econ. Opt. N Rate (EONR)	MSU N Rec. - EONR
		bu/ac	----- lbs N/ac -----			bu/ac	---- lbs N/ac ----	
Saginaw BB	D	189	210	129	81	188	116	94
Berrien	S	145	140	150	-10	143	124	16
Branch	S	130	120	99	21	129	79	41
Ingham CC	C	140	163	114	49	139	103	60
Ingham CS	S	174	180	160	20	174	160	20
Hillsdale	S	175	181	119	62	174	109	72
Ingham M	S	109	91	122	-31	107	85	7
Saginaw	WCC	186	161	35	126	186	33	128
St. Clair	S	155	154	117	37	155	117	37
Tuscola1	S	127	116	123	-7	126	105	11
Tuscola2	S	132	123	115	8	132	115	8

Previous Crop = D:dry edible bean, S:soybean, WCC:wheat/clover cover, C:corn

Max. Yield = Maximum yield observed at location, determined by fitting yield response curves.

MSU N Rec. = MSU's N recommendation for a yield goal equal to the observed maximum yield, adjusted for previous crop N credit (Sb: 30, Db:20, WCC:30+0.5(%stand).

Yield Opt. N Rate = The yield-optimizing N rate equals the amount of N required to achieve the max. yield.

MSU N Rec. - Opt. N Rate = The current MSU N recommendation minus the optimum N rate. Negative values indicate that the current MSU recommendation would have resulted in an under-application of N for max. yields. Note that sites with negative values had max yield below typical yield goals for their areas – higher yield goal would have resulted in higher MSU N recommendations.

Max. Econ. Yield = the maximum economic yield as determined by a 1:10 corn to N price ratio (eg. \$3.00/bu and \$0.30 /lb N); corn yield times corn price minus cost of N

Econ. Opt. N Rate (EONR) = Economic optimum N rate is the amount of N required for maximum economic yield.

MSU N Rec. - EONR = Provides a comparison of the current MSU N recommendation and the EONR.

Table 4. Corn yield response to N fertilizer rate and time of application at study locations in Michigan, 2007. Mean separations determined by Fisher's LSD at the 0.1 probability level.

Treatment	Saginaw	Ingham SbC	Ingham CC	Branch†	Hillsdale
lb/ac	----- bu/ac -----				
0	126d	111d	77c	105	95d
20	-	-	-	113	-
40	158c	129c	113b	121	146c
80	181b	137bc	134ab	-	172a
120	187ab	140bc	139a	132	183a
160	185ab	164a	137a	-	142c
200	194a	153ab	142a	127	151bc
160 sd	190ab	157a	117b	130	170ab
80 sp	179b	139bc	121ab	131	165abc
120 sp	178b	152ab	131ab	136	172a
160 sp	189ab	151ab	133ab	136	163abc
Mean	177	143	124	126	156
Prev. Crop‡	DB	SB	C	SB	SB

† No significant difference in yield among N treatments at the Branch site

‡ DB, dry bean; SB, soybean; C, corn

Table 5. Corn yield response to N fertilizer rate and time of application at on-farm locations in Michigan, 2007. Fertilizer applied as 28% UAN at ~V6, except Van Buren (preplant broadcast 34-0-0). Mean separations determined by Fisher's LSD.

Treatment	Berrien	Ingham(M)	Saginaw1	St. Clair	Tuscola1	Tuscola2
lb/ac	----- bu/ac -----					
0	99c	90a	157b	86d	84c	56c
40	124b	96a	190a	114c	112b	103b
80	136ab	111a	179a	132b	118b	104b
120	138ab	106a	187a	151a	134a	125ab
160	146a	114a	188a	158a	117b	138a
200	146a	105a	186a	-	133a	133a
Mean	131	104	181	128	116	110
Prev. Crop†	SB	SB	WW	SB	SB	SB

† SB, soybean; WW, winter wheat/clover cover

Figure 1. Corn N-response study locations in 2007. Solid stars denote locations used in data analysis, non-solid stars denote sites that were excluded due to drought effects.

