Influence of Late Nitrogen Applications on Corn Grain Yield on a Mississippi River Alluvial Clay in Northeast Louisiana

H.J. "Rick" Mascagni, Jr. and Bubba Bell

Introduction

Nitrogen (N) fertilization is a critical cultural practice required for producing maximum corn yield. Many factors, including soil type and cropping system, determine optimum N rates. Nitrogen is typically knifed-in soon after the crop has emerged and an adequate stand established. After fertilization, uncontrollable factors such as excessive or lack of rainfall, may produce soil conditions conducive to N fertilizer loss through denitrification and/or inefficient plant N uptake. Sometimes N applications are delayed or omitted due to inclement weather. While at other times, growers apply the recommended N rate for an expected yield potential; however, as the crop develops yield potential may be higher than expected and additional N may be required. In each of the above situations the question arises, can N applications as late as reproductive growth stages be effective? The objective of this trial was to evaluate late N applications on a Mississippi River alluvial clay.

Procedures

A field experiment was conducted in 2006 on Sharkey silty clay at the Northeast Research Station near St. Joseph to evaluate the influence of N rate and timing on corn yield and N fertilizer use efficiency (NFUE). Early-season N (ESN) rates were injected at about the two-leaf growth stage as 32% URAN solution at N rates of 0, 150, 180, 210, 240, and 270 lb/acre. Late-season N (LSN) was broadcast at early tassel as ammonium nitrate at rates of 0 and 60 lb/acre for each ESN rate, except for the no-N control, resulting in a total of 11 treatments. Late N at tassel emergence was applied on June 6, 2006. Irrigation (furrow) was also evaluated. Using the Arkansas Irrigation Scheduler, irrigations were triggered whenever the soil moisture deficit reached 1.5-inches. Pioneer brand (PB) 33R81 was planted on March 16 at a seeding rate of approximately 30,000 seed/acre. The LSN was watered-in soon after application in the irrigated clay trial; however, rainfall was needed to activate late N in the non-irrigated trial. Cultural practices as recommended by the LSU AgCenter were followed.

The experimental design was a randomized complete block with four replications for both the non-irrigated and irrigated trials on the Sharkey soil. Grain yield, leaf N, kernel-N concentration, kernel-N uptake, and NFUE were measured. Grain yield was determined by machine harvest from the two middle rows of four-row plots and reported at 15.5% moisture. Yield components, ears/acre, kernel weight (g/100 kernels), and ear size (kernels/ear) were also determined from the two middle rows. Twelve ear-leave samples were collected from the two center rows at two dates, early tassel emergence (June 6) and post tassel (June 15). Total N was determined in the ear leaves and kernels by the LSU AgCenter's Soil and Plant Testing Lab. Kernel-N uptake (lb N/acre) was calculated by multiplying kernel-N concentration by grain yield. NFUE was calculated using the following formula: (kernel-N uptake for a given N rate – kernel-N uptake for the no-N control) / N rate. Calculations for kernel-N uptake and NFUE are based on dry weight. Statistical analyses were performed using the GLM procedure of SAS at probability level of 0.10.

Results and Discussion

Rainfall was well below normal in June, with total June rainfall totaling only 0.38 inches (Table 1). There were six irrigations beginning on June 6 and terminating on August 14.

The influence of N rate and N fertilizer timing on ear leaf in non-irrigated and irrigated corn is shown in Table 2. At tassel emergence there was a significant increase in leaf N in the ESN rates up to 210 lb N/acre in both non-irrigated and irrigated trials. Similarly for the post-tassel sampling date, leaf-N increased up to 210 lb N/acre in the non-irrigated trial and 240 lb N/acre in the irrigated trial. Late N increased leaf N in both the non-irrigated and irrigated trials. The published critical levels of leaf N at tassel emergence is 2.9-3.0%.

The influence on N management on corn grain yields in non-irrigated and irrigated corn is shown in Table 3. Grain yields ranged from 38.9 to 155.5 bu/acre in the non-irrigated trial and 41.1 to 206.2 bu/acre in the irrigated trial. Optimum ESN rates were 180 to 210 lb N/acre for non-irrigated corn and 210 to 240 lb N/acre for irrigated corn. Rainfall did not occur for three to four weeks after LSN applications, so not unexpectedly, there was little affect of LSN in the non-irrigated trial. The relatively low yield potential may have also contributed to the lack of yield response to late N applications. When corn was irrigated, LSN increased grain yields, particularly at the lower ESN rates. Grain yield increases by late N for the 150, 180, 210, and 240 ESN rates were 30.6, 15.7, 8.9, and 4.1 bu/acre, respectively. The large response to supplemental N for the 270 lb/acre ESN rate was not expected. When comparing grain yield response for equivalent N rates, there was very small differences. For example, when a total of 210 lb N/acre was applied grain yields were 184.6 bu/acre for the single application at the early seedling stage and 177.9 bu/acre when the 210 lb/acre was split between early season and tassel. The response to late N in the irrigated trial was primarily due to higher kernel weight (Table 4). Nitrogen applied at tassel increased kernel weight for each of the ESN rates. Averaged across ESN rates, average kernel weights were 33.2 g/100 kernels when no late N was applied and 34.7 g/100 kernels when late N was applied.

The influence of applied N on kernel N, kernel-N uptake, and NFUE is shown in Table 5. Averaged across N fertilizer timings, kernel-N uptake was 82.2 and 101.7 lb N/acre for the non-irrigated and irrigated trials, respectively. NFUE was much higher under irrigated compared to non-irrigated management, 36.6 versus 28.0%. The NFUE is a rough estimate of the percentage of N fertilizer taken up by the plant, which suggests that the fertilizer N uptake efficiency is much higher under irrigated conditions. Generally, late N decreased NFUE for each of the ESN rates. It's very important that you compare equivalent N rates (total N applied). Splitting the N between early season and tassel did not increase NFUE. For example, NFUE for 210 lb N/acre applied in one application at early season was 39.3% compared to 35.2% for the split applications, early and late season. Similar to late N grain yield responses, kernel-N uptake was increased by late N only under irrigated conditions.

In summary, 2006 findings suggest that N fertilizer may be beneficial when applied as late as tassel emergence, if the corn crop is suffering from N deficiency. Plant monitoring techniques such as infrared technology, chlorophyll meters (SPAD meters), and N status of the plant are being evaluated and will be correlated with grain yield responses.

Table 1. Rainfall received at St. Joseph, 2006

Month	Rainfall
	inches
March	5.11
April	3.49
May	5.09
June	0.38
July	4.62
August	4.10

Table 2 . Influence of early- and late-season N rates on ear-leaf N at two sample dates in non-irrigated and irrigated (irr) corn on Sharkey silty clay at St. Joseph, 2006.

		Total N	Tassel**		Post-tassel	
Early N	Late N	applied	Non-irr	Irr	Non-irr	Irr
---------------lb/acre------------			---------------------%--------------------------			
0*	-	0	1.62	1.50	1.49	1.33
150	0	150	2.85	2.61	2.10	1.92
150	60	210	-	-	2.37	2.13
180	0	180	3.03	2.74	2.39	2.24
180	60	240	-	-	2.48	2.46
210	0	210	3.26	3.02	2.70	2.63
210	60	270	-	-	2.73	2.50
240	0	240	3.27	3.08	2.60	2.65
240	60	300	-	-	2.67	2.83
270	0	270	3.26	3.06	2.79	2.62
270	60	330	-	-	2.81	2.82
Averages:			2.88	2.67	2.47	2.37
LSD (0.10):			**-**	**-**	**0.12**	**0.12**
Early N averages:						
150			2.85	2.61	2.24	2.03
180			3.03	2.74	2.44	2.35
210			3.26	3.02	2.72	2.57
240			3.27	3.08	2.64	2.74
270			3.26	3.06	2.80	2.72
LSD (0.10):			**0.18**	**0.19**	**.10**	**0.12**
Late N averages:						
0			-	-	2.52	2.41
60			-	-	2.61	2.55
LSD (0.10):			-	-	**0.06**	**0.08**

*Data for the no-N controls were not included in the averages or statistical analyses.

**Tassel and post-tassel leaf samples were collected on June 6 and June 15, respectively

Table 3 . Influence of early- and late-season N rates on grain yield in non-irrigated and irrigated corn on Sharkey silty clay at St. Joseph, 2006.

Early N	Late N	Total N applied	Grain yield Non-irrigated	Grain yield Irrigated
---------	lb/acre	---------	bu/acre	---------
0*	-	0	38.9	41.1
150	0	150	124.9	147.3
150	60	210	135.3	177.9
180	0	180	142.1	176.1
180	60	240	130.5	191.8
210	0	210	155.5	184.6
210	60	270	142.5	193.5
240	0	240	146.6	199.0
240	60	300	142.8	203.1
270	0	270	143.8	185.2
270	60	330	141.2	206.2
Averages:			131.3	173.3
LSD (0.10):			**NS**	**NS**
Early N averages:				
150			130.1	162.6
180			136.3	184.0
210			149.0	189.1
240			144.7	201.1
270			142.5	195.7
LSD (0.10):			**NS**	**19.8**
Late N averages:				
0			142.6	178.4
60			138.5	194.5
LSD (0.10):			**NS**	**19.8**

*Data for the no-N controls were not included in the averages or statistical analyses.

Table 4. Influence of early- and late-season N rates on yield components, ears/acre,kernel weight, and kernels/ear, in non-irrigated and irrigated (irr) corn on Sharkey silty clay at St. Joseph, 2006.

Early N	Late N	Total N applied	Ears		Kernel weight		Kernels	
			Non-irr	Irr	Non-irr	Irr	Non-irr	Irr
----------------lb/acre---------------			no/acre		g/100		no/ear	
0*	-	0	30,850	30,680	28.2	27.8	114	123
150	0	150	29,510	29,590	29.7	31.2	364	406
150	60	210	29,760	32,020	31.3	32.5	371	439
180	0	180	29,680	31,770	32.3	31.4	375	451
180	60	240	30,680	30,770	30.1	33.8	357	469
210	0	210	28,990	29,760	32.3	33.8	413	467
210	60	270	29,990	32,020	31.3	34.4	388	446
240	0	240	31,060	30,100	29.1	34.9	418	483
240	60	300	28,920	28,760	31.5	36.0	381	499
270	0	270	29,510	30,180	29.3	34.7	367	449
270	60	330	30,600	30,430	29.6	36.6	368	471
Averages:			29,870	30,540	30.7	33.9	380	458
LSD (0.10):			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Early N averages:								
150			29,640	30,810	30.5	31.9	368	423
180			30,180	31,270	31.2	32.6	366	460
210			29,490	30,890	31.8	34.1	401	457
240			29,990	29,430	30.3	35.5	400	491
270			30,060	29,430	29.5	35.7	368	460
LSD (0.10):			**NS**	**NS**	**NS**	**1.5**	**NS**	**35**
Late N averages:								
0			29,750	30,280	30.5	33.2	387	451
60			29,990	30,800	30.8	34.7	373	465
LSD (0.10):			**NS**	**NS**	**NS**	**0.9**	**NS**	**NS**

*Data for the no-N controls were not included in the averages or statistical analyses.

Table 5. Influence of early- and late-season N rates on kernel N, kernel-N uptake and N fertilizer use efficiency (NFUE) in non-irrigated and irrigated (irr) corn on Sharkey silty clay at St. Joseph, 2006.

		Total	Kernel N		Kernel-N uptake		NFUE	
Early N	Late N	N applied	Non-irr	Irr	Non-irr	Irr	Non-irr	Irr
----------------lb/acre--------------			%		lb/acre		%	
0*	-	0	1.27	1.13	23.6	22.5	-	-
150	0	150	1.26	1.13	74.3	78.6	33.8	37.3
150	60	210	1.33	1.15	84.8	96.4	29.1	35.2
180	0	180	1.33	1.11	89.6	93.0	36.7	39.1
180	60	240	1.41	1.14	86.0	103.7	26.0	33.8
210	0	210	1.36	1.20	99.5	105.0	36.2	39.3
210	60	270	1.40	1.29	94.0	118.3	26.1	35.5
240	0	240	1.35	1.34	92.5	126.9	28.9	43.5
240	60	300	1.37	1.38	91.8	132.2	22.7	36.6
270	0	270	1.39	1.27	82.6	111.0	21.8	32.7
270	60	330	1.39	1.35	85.2	131.3	18.6	32.9
Averages:			1.35	1.23	82.2	101.7	28.0	36.6
LSD (0.10):			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Early N averages:								
150			1.30	1.14	79.6	87.5	31.5	36.3
180			1.37	1.13	87.8	98.4	31.4	36.5
210			1.38	1.25	96.8	111.7	31.2	37.4
240			1.36	1.36	92.2	129.6	25.8	40.1
270			1.39	1.31	83.9	121.2	20.2	32.8
LSD (0.10):			**NS**	**0.09**	**NS**	**18.8**	**NS**	**NS**
Late N averages:								
0			1.34	1.21	87.7	102.9	31.5	38.4
60			1.38	1.26	88.4	116.4	24.5	34.8
LSD (0.10):			**0.03**	**0.05**	**NS**	**8.6**	**2.8**	**3.6**

*Data for the no-N controls were not included in the averages or statistical analyses.