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

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Introduction

Nitrogen (N) fertilization is a critical cultural practice required for producing maximum corn yield. Many factors, including soil type and crop management systems, 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 evaluated late N applications on a Mississippi River alluvial clay.

Procedures

A field experiment was conducted in 2007 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, resulting in a total of 12 treatments. Late N at tassel emergence was applied on May 31, 2007. Irrigation (furrow) was also evaluated. Using the Arkansas Irrigation Scheduler, irrigations were triggered whenever the soil moisture deficit reached 1.5-inches. A furrow-irrigation was applied soon after the late application in both the non-irrigated and irrigated trials to activate the fertilizer. Pioneer brand (PB) 33R81 was planted on March 16 at a seeding rate of approximately 30,000 seed/acre. 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 seed), 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 early tassel (May 31). 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 in March through June was below the norm, ranging from 0.53 inches in June to 3.33 inches in April (Table 1). There were seven furrow irrigations beginning May 18 and terminating on June 29.

Influence of ESN rates on ear leaf N is shown in Table 2. Leaf N ranged from 1.17 to 3.01% in the non-irrigated trial and 1.19 to 3.32% in the irrigated trial. Averaged across rates, average leaf N was 2.50 and 2.81 for the non-irrigated and irrigated trials, respectively. Published critical N levels at tassel emergence is 2.9-3.0%.

Influence of N management on grain yield in non-irrigated and irrigated corn is shown in Table 3. In the non-irrigated trial, average grain yields ranged from 25.3 to 124.8 bu/acre with the optimum ESN rate about 150 to 180 lb/acre. Late N was activated with a furrow irrigation immediately after application; however, supplemental N did not influence grain yield. The lack of response to late N may have been due, in part, to the relatively low yield potentials.

In the irrigated trial, average grain yields ranged from 40.0 to 211.2 bu/acre with the optimum ESN rate about 180 to 210 lb/acre (Table 3). Supplemental N increased grain yields with the greatest responses at the lower ESN rates. When 150 lb/acre of N was applied early, the additional 60 lb N/acre applied at tassel increased grain yield by 32.1 bu/acre, 157.1 to 189.2 bu/acre. When comparing equivalent rates, the single application at early season had slightly higher grain yields than the split application, early and late season. For the 210 lb/acre N rate, grain yields were 200.1 bu/acre for the single ESN rate compared to 189.2 bu/acre for the split application at early and late season. Grain yield responses to ESN was primarily related to ear size, while responses to LSN were more related to kernel weight (Table 4).

The influence of N management on kernel N, kernel-N uptake, and NFUE is shown in Table 5. Kernel N and kernel-N uptake were increased by ESN and LSN in both non-irrigated and irrigated trials. Kernel-N uptake for the ESN averages ranged from 11.5 to 79.3 lb/acre in the non-irrigated trials and 16.8 to 128.2 lb/acre in the irrigated trials. LSN averages ranged from 62.7 to 66.4 lb/acre for the non-irrigated trials and 90.9 to 103.3 lb/acre in the irrigated trials. NFUE was much higher in the irrigated versus non-irrigated trials, suggesting that irrigation improves N fertilizer uptake efficiency. When comparing NFUE for equivalent N rates, NFUE was greater for the single application. For the 210 lb/acre N rate in the irrigated trial, NFUE was 49.3 and 42.0% for the single and split applications, respectively. Differences in NFUE was much less in the non-irrigated study. Averaged across ESN rates, NFUE was 46.2% when no late N was applied and 40.6% when the 60 lb N/acre rate was applied.

In summary, supplemental N applications as late as tassel emergence increased corn grain yields, if the crop was N deficient. Monitoring of the plant using infrared

sensing, chlorophyll measurements (SPAD meter), and total N is being evaluated and will be correlated with grain yield responses.

Table 1. Rainfall received at St. Joseph, 2007

Month	Rainfall
	Inches
March	1.30
April	3.33
May	1.80
June	0.53
July	16.03
August	3.55

Table 2 . Influence of early- and late-season N rates on ear-leaf N at tassel emergence in non-irrigated and irrigated corn on Sharkey silty clay at St. Joseph, 2007.

Early N	Non-irrigated	Irrigated
lb/acre	----------%----------	
0	1.17	1.19
150	2.72	2.82
180	2.63	3.12
210	2.92	3.25
240	2.96	3.32
270	3.01	3.31
Average:	2.50	2.81
LSD (0.10):	0.24	0.31

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, 2007.

Early N	Late N	Total N applied	Grain yield	
			Non-irrigated	Irrigated
lb/acre	lb/acre	lb/acre	----------bu/acre----------	
0	0	0	14.9	25.0
0	60	60	35.6	55.0
150	0	150	116.4	157.1
150	60	210	124.6	189.2
180	0	180	125.3	185.3
180	60	240	124.3	191.1
210	0	210	128.2	200.1
210	60	270	117.8	207.1
240	0	240	126.4	210.0
240	60	300	114.9	212.3
270	0	270	124.9	204.1
270	60	330	118.0	213.1
Averages:			105.9	170.8
LSD (0.10):			**11.9**	**11.0**
Early N averages:				
0			25.3	40.0
150			120.5	173.2
180			124.8	188.2
210			123.0	203.6
240			120.7	211.2
270			121.5	208.6
LSD (0.10):			**8.4**	**7.8**
Late N averages:				
0			106.0	163.6
60			105.9	178.0
LSD (0.10):			**NS**	**3.9**

Table 4. Influence of early- and late-season N rates on yield components, ears/acre, kernel weight, and kernels/ear, on Sharkey silty clay at St. Joseph, 2007.

			Ears		Kernel weight		Kernels	
Early N	Late N	Total N applied	Non-irr	Irr	Non-irr	Irr	Non-irr	Irr
----------lb/acre----------			no/acre		g/100		no/ear	
0	0	0	24,420	24,850	29.6	29.7	67	89
0	60	60	24,200	26,600	32.6	32.1	119	165
150	0	150	20,930	22,020	32.0	32.1	448	568
150	60	210	25,724	23,760	32.1	33.1	399	629
180	0	180	23,330	25,070	31.6	34.5	441	556
180	60	240	22,560	24,200	29.6	33.7	463	607
210	0	210	23,540	22,450	31.2	32.8	463	713
210	60	270	20,930	22,450	27.9	35.1	518	691
240	0	240	24,850	25,070	33.2	33.0	402	666
240	60	300	23,330	23,330	32.0	34.2	399	719
270	0	270	22,450	23,760	32.6	32.1	441	718
270	60	330	23,760	27,250	32.6	35.0	401	590
Average:			23,040	24,400	31.4	33.3	388	551
LSD (0.10):			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Early N averages:								
0			24,310	25,720	31.8	30.9	98	127
150			23,330	22,890	32.1	32.6	424	598
180			23,020	24,630	30.8	34.1	450	581
210			22,240	22,450	29.6	34.0	491	702
240			24,090	24,200	32.6	33.6	401	692
270			23,110	25,510	32.6	33.6	421	654
LSD (0.10):			**NS**	**NS**	**NS**	**NS**	**69**	**85**
Late N averages:								
0			23,080	24,390	31.6	32.5	385	538
60			23,000	24,420	31.3	34.1	391	564
LSD (0.10):			**NS**	**NS**	**NS**	**1.3**	**NS**	**NS**

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, 2007.

			Kernel N		Kernel-N uptake		NFUE	
Early N	Late N	Total N applied	Non-irr	Irr	Non-irr	Irr	Non-irr	Irr
----------lb/acre----------			%		lb/acre		%	
0	0	0	1.03	1.00	6.1	10.3	-	-
0	60	60	1.18	1.02	16.9	23.3	18.0	21.6
150	0	150	1.15	1.08	60.0	78.4	35.9	45.4
150	60	210	1.32	1.13	73.4	98.5	32.0	42.0
180	0	180	1.27	1.14	71.2	95.6	36.2	47.4
180	60	240	1.39	1.25	77.4	108.5	29.7	40.9
210	0	210	1.34	1.24	77.6	113.9	34.0	49.3
210	60	270	1.40	1.32	75.1	124.8	25.6	42.4
240	0	240	1.46	1.29	81.9	124.9	31.6	47.7
240	60	300	1.50	1.33	76.7	130.3	23.5	40.0
270	0	270	1.41	1.30	79.1	122.1	27.0	41.4
270	60	330	1.50	1.38	79.1	134.2	22.1	37.5
Averages:			1.33	1.21	64.5	97.1	26.3	38.0
LSD (0.10):			**NS**	**NS**	**7.7**	**NS**	**NS**	**NS**
Early N averages:								
0			1.11	1.01	11.5	16.8	-	-
150			1.24	1.11	66.7	88.5	34.0	43.7
180			1.33	1.20	74.3	102.1	33.0	44.2
210			1.37	1.28	76.4	119.4	29.8	45.9
240			1.48	1.31	79.3	127.6	27.6	43.9
270			1.46	1.34	79.1	128.2	24.6	39.5
LSD (0.10):			**0.08**	**0.07**	**5.4**	**8.2**	**0.05**	**4.4**
Late N averages:								
0			1.28	1.18	62.7	90.9	32.9	46.2
60			1.38	1.24	66.4	103.3	26.6	40.6
LSD (0.10):			**0.05**	**0.04**	**2.7**	**4.1**	**0.01**	**2.2**