Enhancement Of Nitrogen Fertilizer Efficiency For Corn Production On Mississippi River Alluvial Soils

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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, how late can N fertilizer be applied and be effective? The objective of this trial was to evaluate the timing of supplemental N applications on Mississippi River alluvial soils.

Procedures

Field experiments were conducted in 2008, 2009, and 2010 on Commerce silt loam and Sharkey clay at LSU AgCenter's Northeast Research Station near St. Joseph to evaluate the influence of N rate and timing on corn yield and N fertilizer use efficiency (NFUE). Conventional tillage was used in the Commerce study and a stale-seedbed tillage system was used in the Sharkey study. Early-season N rates (ESN) were injected at about the two-leaf growth stage as 30-0-0-2 solution at N rates of 0, 150, 180, 210, and 240 lb/acre on Commerce and 0, 180, 210, 240, and 270 lb/acre on Sharkey. Additionally, supplemental N rates were applied at about the 8-leaf, 12-leaf, and early silk growth stages at rates of 30 and 60 lb N/acre. The 8-leaf application was knifed-in, while the two later side-dress applications were applied by hand using a syringe simulating a dribble application. Furrow irrigation was also evaluated on Sharkey clay. Using the Arkansas Irrigation Scheduler, irrigations were triggered whenever the soil moisture deficit reached 1.5-inches. Planting dates for DynaGro DG58P59 were: March 28, 2008 (on Commerce and Sharkey); March 23, 2009 (Commerce) and April 17, 2009 (replant) (Sharkey); and April 1, 2010 (Commerce and Sharkey). Final harvest populations were about 30,000 plants/acre. Cotton was the previous crop in each trial. Cultural practices as recommended by the LSU AgCenter were followed.

The experimental design was a randomized complete block (RCB) with four replications for both the non-irrigated and irrigated trials on Sharkey and five replications for trial on Commerce. Grain yield and yield components were measured. Grain yield was determined by machine harvest of the two middle rows of four-row plots and reported at 15.5% moisture. NFUE was determined using seed N. Remote sensing data, Greenseeker and SPAD meter readings, were determined at multiple growth stages. This report focuses on yield response to N treatments. Statistical analyses were performed using the GLM procedure of SAS at probability level of 0.10.

Results

Commerce silt loam: Yield responses to N treatments on the Commerce silt loam are presented in Table 1. Optimum ESN rate was between 180 and 210 lb/acre in 2008 and 180 lb/acre in 2009. The lower N requirement in 2009 was partly due to the very high residual-N carryover, with the no-N control plots yielding 93.6 bu/acre (see footnote below Table 1). Each year yields were increased at each timing by the supplemental N rates, more so for the 60 lb/acre rate. Yield responses were greater for the 8-leaf and 12-leaf growth stage applications compared to early- silk applications. However, there was generally no advantage to the supplemental N rate when comparing the equivalent N rate applied once early in the season (2-leaf growth stage).

Sharkey clay: Higher yields and greater responses occurred on the irrigated plots (Table 2). Optimum N rates were about 210 lb/acre on the non-irrigated plots in 2008, 2009, and 2010 and irrigated plots in 2008 and between 240 and 270 lb/acre in the irrigated plots in 2009 and 2010. Similar to the Commerce study, yields were increased at each timing by the supplemental N rates, more so for the 60 lb/acre rate. However in this study, yield responses were similar across the different timings. In 2009, the supplemental N application was greater than the equivalent N rate applied early season, especially for the 8-leaf supplemental application. The 8-leaf 240 lb N/acre application (180 + 60 lb N/acre) yielded as well as the ESN rate of 270 lb/acre.

These studies indicate that supplemental N applications as late as early silk may increase yield. However, these applications may not be as effective as applications applied earlier in the season. Δ

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Table 1. Influence of N rate and time of application on corn yield on Commerce silt loam at St. Joseph for three years.

ESN rate[1]	Time of N application			2008	2009	2010
	8-leaf	12-leaf	Early silk			
lb N/a	lb N/a			bu/a[2]		
150	-	-	-	174.9	140.6	113.6
150	30	-	-	185.2	148.2	127.9
150	60	-	-	191.7	154.4	136.8
150	-	30	-	187.5	146.6	120.4
150	-	60	-	191.0	152.1	130.3
150	-	-	30	176.6	149.8	110.2
150	-	-	60	187.5	151.6	117.9
180	-	-	-	187.2	148.7	117.6
210	-	-	-	193.2	152.1	141.3
240	-	-	-	197.4	154.7	136.6
Average				186.3	149.9	107.1
LSD (0.10)				6.2	9.8	8.6

1Applied at about the 2-leaf growth stage.

2For the no-N control, yields were 21.2 bu/a in 2008, 93.6 bu/a in 2009, and 16.2 bu/a in 2010.

Table 2. Influence of N rate and time of application on corn yield in non-irrigated and irrigated plots on Sharkey clay at St. Joseph for three years.

ESN rate[1]	Time of N application			2008		2009		2010	
	8-leaf	12-leaf	Early silk	Non-irr	Irr	Non-irr	Irr	Non-irr	Irr
lb N/a	lb N/a			bu/a[2]					
180	-	-	-	162.7	189.5	93.2	127.6	43.3	129.7
180	30	-	-	169.3	191.1	106.1	155.4	51.2	140.7
180	60	-	-	167.0	195.0	100.8	167.9	56.6	148.2
180	-	30	-	167.4	196.0	99.7	142.3	40.3	143.2
180	-	60	-	166.1	203.0	101.8	156.3	52.4	142.7
180	-	-	30	160.9	191.8	94.3	147.5	47.7	133.8
180	-	-	60	169.1	194.0	94.4	152.0	48.8	140.3
210	-	-	-	165.1	194.1	108.1	143.1	47.1	138.7
240	-	-	-	166.4	202.8	106.0	147.3	52.3	149.1
270	-	-	-	170.7	194.5	108.4	163.5	51.0	157.7
Average				167.3	194.9	101.3	150.3	45.7	129.8
LSD (0.10)				NS	7.7	6.8	6.2	10.2	7.8

1Applied at about the 2-leaf growth stage.

2For the no-N control, yields were 12.1 bu/a in non-irrigated and 20.3 bu/a in irrigated plots in 2008, 15.6 in non-irrigated and 22.3 bu/a in irrigated plots in 2009, and 1.4 bu/a in non-irrigated and 3.9 bu/a in irrigated plots in 2010.