Influence Of Nitrogen Rate And Timing Of Application On Corn Yield On Mississippi River Alluvial Soils

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Nitrogen (N) fertilization is a critical component of cultural practices required for producing maximum corn yield. Many factors, including soil type and tillage systems, determine optimum N rates. Nitrogen is typically knifed-in soon after the crop has emerged and an adequate stand established. After fertilization application, 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 these trials was to evaluated late N applications on two Mississippi River alluvial soils.

Field experiments were initiated in 2006 and 2007 on Commerce silt loam and 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). Irrigation was also evaluated in the clay trial. Early-season N (ESN) was injected at about the two-leaf growth stage as 32% URAN solution at N rates of 0, 150, 180, 210, 240, and 270 lb/a on silty clay and 0, 120, 150, 180, 210 and 240 lb/a on silt loam. Late-season N (LSN) was broadcast at early tassel as ammonium nitrate at rates of 0 and 60 lb/a. Rainfall was needed to activate the LSN treatments in both the non-irrigated clay trial and silt loam trial, while the LSN was watered-in soon after application in the irrigated clay trial. The late N application was also watered-in the day after application in the non-irrigated Sharkey trial in 2007. Unfortunately, rainfall did not occur for three to four weeks after LSN applications in both years, so, not unexpectedly, there was little affect of LSN in any of the non-irrigated trials. Yields were lower in 2006 in trials that were not irrigated due to an extremely dry May and June (less than 0.5 inches of rainfall) (Tables 1 and 3).

On the silty clay, optimum ESN rate for both years was about 180 and 210 lb/a for the non-irrigated and irrigated trials, respectively (Table 1). In 2006, grain yields for the ESN rates at 150 and 180 lb/a were increased 21 and 9%, respectively, by LSN in the irrigated clay trial. In 2007, the largest increases due to late N occurred for the 0 and 150 lb/a N rates. Late N had much less affect at the higher ESN rates. In 2006, there did not appear to be an advantage in splitting the N between early season and tassel emergence. For example when a total of 210 lb N/a was applied, yields were similar regardless if N was applied in a single application or split between early season and tassel emergence. However in 2006, yields tended to be higher with the split, which may have been due to high July rainfall. Rainfall in July totaled over 16-inches, producing conditions conducive to denitrification and inefficient nutrient uptake. The influence of treatments on seed N and NFUE in 2006 is shown in Table 2. Nitrogen analyses for the 2007 seed samples are being conducted and data will be presented.

Optimum ESN rate for silt loam was between 180 and 210 lb/a in 2006 and 120 lb/a in 2006. Late N did not significantly affect yield either year due, in part, to little rainfall and lack of late fertilizer N activation during the month of June. The influence of treatments on seed N and NFUE in 2005 is shown in Table 4. NFUE data for 2007 will also be presented. Average NFUE was slightly higher on the silt loam compared to the irrigated clay trial.

These findings indicate that N fertilizer applications as late as tassel emergence may increase corn yield, if the plant is N deficient. The efficacy of split N applications depends on factors such as climatic conditions. Plant monitoring, using remote sensing techniques (Greenseeker and SPAD meter), along with tissue analyses will also be discussed. Δ

Table 1 . Influence of early- (two to three-leaf stage) and late-season N rates (tassel) on grain yield of non-irrigated and irrigated corn on Sharkey silty clay at St. Joseph, 2006 and 2007.

Early-N rate	Late -N rate	Total N applied	2006 Non-irrigated	2006 Irrigated	2007 Non-irrigated	2007 Irrigated
lb/a	lb/a	lb/a	bu/a		bu/a	
0	0	0	38.9	41.1	14.9	25.0
0	60	60	-	-	35.6	55.0
150	0	150	124.9	147.3	116.4	157.1
150	60	210	135.3	177.9	124.6	189.2
180	0	180	142.1	176.1	125.3	185.3
180	60	240	130.5	191.8	124.3	191.1
210	0	210	155.5	184.6	128.2	200.1
210	60	270	142.5	193.5	117.8	207.1
240	0	240	146.6	199.0	126.4	210.0
240	60	300	142.8	203.1	114.9	212.3
270	0	270	143.8	185.2	124.9	204.1
270	60	330	141.2	206.2	118.0	213.1
LSD (0.10):						
Early-season N			NS[1]	19.8	8.3	7.8
Late N			NS	7.2	NS	3.9
Early N x Late N			NS	NS	11.8	11.0

[1]NS=Non-significant at the 0.10 probability level.

Table 2. Influence of early- and late-season N rates on seed N concentration, seed N and N fertilizer use efficiency (NFUE) of non-irrigated and irrigated corn on Sharkey silty clay at St. Joseph, 2006.

Early N	Late N	Total N applied	Seed N conc Non-irr	Seed N conc Irr	Seed N Non-irr	Seed N Irr	NFUE[1] Non-irr	NFUE[1] Irr
lb/a	lb/a	lb/a	%		lb/a		%	
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
0	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
LSD (0.10):								
Early N			NS[2]	0.09	NS	18.8	NS	NS
Late N			0.03	0.05	NS	8.6	2.8	3.6
Early N x Late N			NS	NS	NS	NS	NS	NS

[1]NFUE=Nitrogen fertilizer uptake efficiency, [seed N for N rate – seed N for check/ N rate] x 100
[2]NS=Non-significant at the 0.10 probability level.

Table 3. Influence of early-season and late-season N rates on grain yield on Commerce silt loam at St. Joseph, 2006 and 2007.

Early - N rate	Late- N rate	Total N applied	2006	2007
lb/a	lb/a	lb/a	bu/a	
0	0	0	20.0	26.4
0	60	60	-	32.3
120	0	120	108.3	123.1
120	60	180	119.7	129.7
150	0	150	142.7	128.5
150	60	210	153.9	133.9
180	0	180	164.0	133.9
180	60	240	164.5	118.8
210	0	210	175.8	123.2
210	60	270	170.3	127.7
240	0	240	171.9	121.8
240	60	300	176.2	136.7
LSD (0.10):				
Early N			13.9	11.4
Late N			NS[1]	NS
Early x Late			NS	NS

[1]NS=Non-significant at the 0.10 probability level.

Table 4. Influence of early-season and late-season N rates on grain yield, seed N concentration, seed N and N fertilizer use efficiency (NFUE) on Commerce silt loam at St. Joseph, 2006

Early N	Late N	Total N applied	Seed N conc	Seed N	NFUE[1]
lb/a	lb/a	lb/a	%	lb/a	%
0	-	-	1.05	9.9	-
120	0	120	1.07	55.0	37.5
120	60	180	1.15	66.0	31.1
150	0	150	1.22	82.2	48.2
150	60	210	1.26	91.5	38.8
180	0	180	1.25	97.4	48.6
180	60	240	1.31	102.2	38.5
210	0	210	1.34	111.9	48.5
210	60	270	1.39	111.5	37.6
240	0	240	1.35	109.4	41.4
240	60	300	1.38	115.2	35.1
LSD (0.10):					
Early N			0.06	10.3	5.8
Late N			0.02	3.4	1.8
Early x Late			NS[2]	NS	NS

[1]NFUE=Nitrogen fertilizer uptake efficiency, [seed N for N rate – seed N for check/ N rate] x 100
[2]NS=Non-significant at the 0.10 probability level.