

# SOIL/WATER RESEARCH

## *South Dakota State University*

### 2008 Progress Report

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#### **Time of N Application for No-Till Wheat in South Dakota for 2008 (38008 and 42008)**

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#### **Introduction**

Application of nitrogen (N) for wheat production in South Dakota has historically occurred in the spring. Winter wheat producers will typically wait until potential winter injury has been assessed before applying nitrogen in late winter or early spring. Spring wheat producers would generally wait until just prior or after planting.

No-till wheat production has increased dramatically in the last 10 – 15 years, especially in Western and Central areas of South Dakota. Time savings, better equipment and herbicides have been major drivers in this change. Urea is the primary N source used by South Dakota producers. It is economical, and can be handled easily and safely. However, application of urea to a soil/residue surface (without tillage) can lead to potential N volatilization (N gas loss).

High temperatures, low precipitation, and heavy residue conditions can lead to estimated losses of 25 to 35% of the applied N under worst case scenarios. One management tool to limit potential N volatilization is time of N application. Applying urea in the early spring when the probability for low temperatures and higher rainfall are highest should limit potential gaseous N loss. However, a number of producers wanting to decrease spring workloads and take advantage of lower urea prices will apply urea in late-fall. Late winter (Feb.-Mar.) application has also been used by some producers when snow conditions allow field access. Effectiveness of urea when applied to frozen soils or upon snow is still a question. Much producer interest has been shown in delaying at least part of the nitrogen until after tillering. With N prices at record highs, increasing N efficiency is a necessity to maintain profitability in wheat production.

#### **Objective**

Determine time to apply nitrogen for most efficient N utilization for no-till winter and spring wheat production.

## Materials and Methods

Location	Location	
	Cresbard	Sturgis
Wheat type	Spring	Winter
N Application Timing Trts.		
Planting = P	4-18-08	9-20-07
Late Fall = LF	11-8-07	12-17-07
Winter = W	na	1-24-08*
Early Spring = ES	2-27-08*	4-3-08
Sub-Surface = SS	4-18-08	9-20-07
Feekes 5.5 = F5	6-13-08	na
Foliar N application rate	30 lbs N/a	na
Foliar N application timing	7-11-08 (Feekes 10.8)	na
Variety	Traverse	Expedition
N Rates	0 at P and SS 50 at LF,P,ES,SS,F5 100, 150, and 200 at P	0 at P and SS 50 at P, LF, W, ES 100, 150 at P
N Sources	urea and ammonium nitrate (AMN)	
Replications	4	
Split plot design (RCBD)	Main block = N timing, Split = N source and rate	
Statistics	SAS, ANOVA	

note: Environmentally Sensitive Nitrogen (ESN) used at Sturgis only.

\* applied on snow (Cresbard 3-4 inches, Sturgis 1-2 inches)

## Results and Discussion

**N Rate:** Carryover soil nitrogen was low at each site, Cresbard (52 lbs NO<sub>3</sub>-N/a) and Sturgis (28 lbs NO<sub>3</sub>-N/a). Applied N significantly increased grain yield at Sturgis and Cresbard (Tables 1 and 5). Maximum yield was attained with 50 and 100 lbs N/a at Cresbard and Sturgis, respectively.

**N Timing:** The time of nitrogen application had a significant influence on grain yield at Cresbard ( $Pr > F = 0.02$ ) and somewhat at Sturgis ( $Pr > F = 0.11$ ) (Tables 2 and 6). At Cresbard, applying N at F5 (Feekes 5.5) significantly reduced yield (Table 2) and was probably associated with dry surface soil

conditions that made the N positionally unavailable. In addition, the application was late, as the first node was 3-4 inches above ground. Post N application work has shown that applications should be applied before jointing. At Sturgis, the late fall (LF) and winter (W) application timings had reduced yields.

**N Source:** Nitrogen source significantly influenced grain yield at Cresbard (Table 2) but not at Sturgis (Table 6). The urea N source, applied at the early spring timing at Cresbard had 3-4 inches of snow ground cover and had significantly lower yield when compared to AMN (Table 6). All other urea and AMN comparison yields were very

similar. There are differences between urea and AMN yields at Sturgis but no trend in the data could explain these differences (Table 6). Possible volatilization of N may have existed at the early spring application at both Cresbard and Sturgis. However, volatilization loss was not high enough to quantify with the sensitivity of the studies.

**N Placement:** Possible immobilization of N in residue did not seem to be a problem at either site because the sub-surface and surface broadcast placements of N produced similar yields (Tables 3 and 7). There was a trend for yield improvement with sub-surface urea and AMN application at Cresbard because the  $P > F$  statistic was nearing a significant level (80% confidence). ESN did not significantly influence grain yield when compared to urea or AMN at Sturgis (Table 7).

**Protein:** Nitrogen rate significantly influenced both spring and winter wheat grain protein (Tables 9 and 10). However, the effects were opposite between the sites. Increase N rate increased spring wheat grain protein while decreasing winter wheat protein. With the spring wheat, N was non-limiting beyond the 50 lb. N/a rate which provided extra N to increase grain protein levels. In contrast, increasing N rates, lowered grain protein levels at Sturgis. The winter wheat grain yield

responded to the incremental increase in soil applied N, resulting in less N available for grain protein partition at the higher N rates. Foliar application of N on spring wheat plots further increased spring wheat grain protein (Table 9). It is speculated that foliar N application on the winter wheat would have greatly increased grain protein.

**Precipitation:** For both sites, precipitation frequency increases as we move from late fall to planting (Tables 4 and 8).

**Summary:** Soil applied N increased wheat grain yield at each site. Grain yield was maximized with 50 and 100 lbs N/a for the spring and winter wheat, respectively. The spring wheat site had 50 lbs NO<sub>3</sub>-N/a residual N while the winter wheat site had 28. Grain yield was significantly reduced by applied N at the Feeke's 5.5 (F5.5) stage for spring wheat and the late fall (LF) and winter (W) applications for winter wheat. Dry soil conditions at the spring wheat site during the F5.5 stage kept applied N at the soil surface mostly unavailable for the wheat plant root systems. Grain protein positively responded to increased N rate and foliar application at the spring wheat site.

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Table 1. Nitrogen rate influence on spring wheat grain yield near Cresbard SD, in 2008.

N rate lbs/a	Grain Yield bu/a
0	40.7
50	47.2
100	45.1
150	45.2
200	44.7
Pr>F	0.44
LSD(.10)	NS
CV %	10.6
Orthogonal No N vs N (Pr>F)	0.07

sunflower was previous crop  
 lbs NO<sub>3</sub>-N/a = 52 lbs/a sampled before planting  
 N applied at planting (4-18-08)

Table 2. Influence of N source and N application timing on spring wheat grain yield at Cresbard SD, in 2008.

Time of N Application	N Source		N Source Statistics for each N timing	
	Ammonium Nitrate	Urea	Pr>F	CV
	----- bu/a -----			
Late Fall	47.3 a	47.9 a	0.50	2.2
Early Spring	44.6 a	41.2 b	0.01	2.1
Planting	47.2 a	45.7 a	0.15	2.4
5 Leaf Stage	39.9 b	40.2 b	0.75	2.2
Pr>F	0.03	0.02		
LSD(.05)	4.0	3.9		
CV %	6.8	6.7		
other Statistics:				
N Source (S)	0.04			
N Timing (T)	0.02			
S x T	0.02			

N rate = 50 lbs N/a

Means with similar lower case letter are not significantly different within a comparison column.

Table 3. Influence of tillage and N application position on spring wheat grain yield at Cresbard SD, in 2008.

N Application Method	N Rate and Source		
	0	50 Urea	50 AMN
Surface Broadcast <sup>A</sup>	40.7	45.7	47.2
Sub-Surface	41.1	50.7	49.8
LSD <sub>(.10)</sub>	NS	NS	NS
Pr>F	0.94	0.21	0.22

AMN = ammonium nitrate

<sup>A</sup> broadcast applied after planting

<sup>B</sup> Applied with drill (7 inch spacings, 2-3 inch depth) before planting.

NS = non-significant

Table 4. Precipitation frequency summary at the spring wheat N timing site near Cresbard SD, in 2008.

N Application Timing	0.25 inch of Precipitation	
	Total	Event
	----- days* -----	
Late Fall	47	134
Winter / Early Spring	27	28
Planting	13	13
5 Leaf Stage	6	11

\* days after N application to 0.25 inch total precipitation or a single event

Table 5. Nitrogen rate influence on winter wheat grain yield at Sturgis SD, in 2008.

N Rate <sup>A</sup>	Grain Yield
	----- bu/a -----
0	25.6 b
50	40.3 a
100	44.7 a
150	44.4 a
Statistics:	
Pr>F	0.001
LSD <sub>(.10)</sub>	4.5
CV%	8.9

<sup>A</sup> ammonium nitrate surface applied at planting.  
Soil NO<sub>3</sub>-N = 28 lbs/a

Table 6. Influence of N source and N application timing on winter wheat grain yield at Sturgis SD, in 2008.

Time of N Application	N Source		N Source Statistics for N timing	
	Ammonium Nitrate	Urea	Pr>F	CV
	----- bu/a -----			
Sub	38.8	36.7	0.20	4.6
Planting	37.9	39.1	0.59	7.3
Late Fall	35.4	35.3	0.95	11.5
Winter	34.8	37.3	0.19	6.0
Early Spring	40.3	38.7	0.09	2.3
Pr>F	0.18	0.24		
LSD(.05)	NS	NS		
CV %	9.0	6.6		
other Statistics:				
N Source (S)	0.97			
N Timing (T)	0.11			
S x T	0.44			

N rate = 50 lbs N/a

Means with similar lower case letter are not significantly different within a comparison column.

Table 7. Influence of tillage and N application position on winter wheat grain yield at Sturgis SD, in 2008.

N Application Method	N Rate and Source			Pr>F
	50 ESN	50 Urea	50 AMN	
	----- bu/a -----			
Surface Broadcast <sup>A</sup>	38.2	39.1	37.9	0.72
Sub-Surface	38.4	36.7	38.8	0.52
LSD <sub>(.10)</sub>	NS	NS	NS	
Pr>F	0.91	0.21	0.73	

AMN = ammonium nitrate

<sup>A</sup> broadcast applied after planting

<sup>B</sup> Applied with drill (7 inch spacings, 2-3 inch depth) before planting.

NS = non-significant

Table 8. Precipitation frequency summary at the spring wheat N timing site near Sturgis SD, in 2008.

N Application Timing	0.25 inch of Precipitation	
	Total	Event
	----- days* -----	
Planting	17	135
Late Fall	33	50
Winter	14	14
Early Spring	8	8

\* days after N application to 0.25 inch total precipitation or a single event

Table 9. Influence of N rate and Foliar N application on spring wheat grain protein near Cresbard SD in 2008.

N rate lbs/a	Foliar <sup>A</sup>		Pr>F <sup>B</sup>	CV %
	No ----- % <sup>C</sup> -----	Yes		
0	12.4 b	13.9 c	yes	4.4
50	12.8 b	13.6 c	no	4.2
100	14.8 a	15.2 b	yes	0.5
150	15.2 a	15.9 ab	yes	1.5
200	15.7 a	16.5 a	yes	1.5
Pr>F <sup>B</sup>	yes	yes		
CV %	6.2	5.2		

Overall Statistics

Foliar (F)	0.001
N Rate (NR)	0.001
F X NR	0.109

<sup>A</sup> 30 lbs N/a as 10 gpa UAN (28-0-0) and 10 gpa water applied at Feekes 10.8 (post-pollination)

<sup>B</sup> A "no" is where Pr.F is > than 0.10

<sup>C</sup> adjusted to 13% grain moisture.

Table 10. Influence of N rate on winter wheat grain protein at Sturgis SD, in 2008.

N rate <sup>A</sup> lbs/a	Grain Protein <sup>B</sup> %
0	11.9 a
50	11.5 ab
100	11.3 b
150	10.7 c
LSD <sub>(.10)</sub>	0.5
Pr>F	0.02
CV%	3.5

<sup>A</sup> applied as ammonium nitrate at planting

<sup>B</sup> adjusted to 13% grain moisture