NITROGEN MANAGEMENT FOR SOFT RED WINTER WHEAT

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Summary

Soft red winter wheat was grown with various rates of four N materials, ammonium sulfate, urea, urea-ammonium nitrate and ESN, for harvest years 2004 through 2007. In all studies 21 lbs N/a was applied at planting. Over these four years top wheat yields were produced with 60 or 90 lbs topdress N/a depending on year. Averaged over the four years 90 lbs N/a resulted in 1.6, 1.0 and 2.2 bu/a more yield than 60 lbs N/a for urea, UAN and ESN. This difference was neither significant nor economical. Split topdress N applications between green up and Feekes 6 improved grain yield in 1 of 2 years. Spring application of the slow release N material ESN resulted in yields equal to or better than the other N materials; urea, ammonium sulfate or UAN. In 2 of 3 years fall applied ESN resulted in grain yields comparable to the other N materials topdressed in the spring. Blending ESN with urea or ammonium sulfate resulted in comparable yields with straight ESN in 2 of the 4 years.

Introduction

With the enthusiasm for producing ethanol from corn and biodiesel from soybeans, wheat has become the forgotten field crop. However, including wheat in a corn-soybean rotation can provide some real benefits for the quality and productive of the soil. And the price of wheat now makes it an economically attractive crop. In the 1990's Dick Harwood (MSU) did considerable research evaluating the effects of wheat in rotation with corn and soybeans. Including wheat in the rotation was found to increase corn yields by at least 10 percent. In Michigan studies when wheat was followed by a cover crop, such as frost seeded red clover, corn yields were always increased by at least 15 % over continuous corn. This effect is valid for soils with low and high yield potential. The exact reasons for this enhancement in corn yield are not well understood, but are likely a combination of several effects. With increases in the price of wheat there is renewed interest in production of soft red winter wheat. Winter wheat provides the opportunity to interseed red clover for producing additional biomass and nitrogen following wheat harvest. This contributes to improvement in soil quality and provides valuable nitrogen for the following corn crop. With fertilizer N now around $1.00 per pound an N credit from a clover cover crop of 60 to 80 lbs per acre is quite valuable.

Methods and Materials

Nitrogen is a key yield determining input for the production on soft red winter wheat. Studies were conducted over a four year period to evaluate the response of soft red winter wheat to various sources and rates of nitrogen. The nitrogen carriers included ammonium sulfate (AS), urea (U), Urea-ammonium nitrate (UAN), and ESN (a polymer coated urea product of Agrium). Wheat was sown in rows 7 inches apart in early to mid-October each year at near 2 bushels per acre. At seeding 110 lbs of 19-19-19 fertilizer was applied. Plot size was 11 ft. (one drill width)

by 50 ft. At or just prior to green up the N materials were broadcast to supply 30 to 90 lbs N per acre. This was usually during the last week in March. Blends (50:50 based on lbs N) of ESN with either urea or ammonium sulfate to supply 90 lbs of N/a were also included. A no topdress N treatment was included each year. In 2004 UAN was also applied at 120 lbs N/a to give a more complete response curve. In the fall of 2004, 2005 and 2006 (for harvest years 2005, 2006 and 2007) ESN was broadcast prior to seeding the wheat. The specific treatments for each year are presented in the respective data tables. All treatments were replicated four times in a randomized complete block design. The 2005 wheat crop followed canola, and the 2004, 2006 and 2007 crops followed soybean. Harvest data (yield, test weight, grain moisture) were collected by combining a 5 foot wide by 46 foot strip of each plot.

Results and Discussion

In 2004 the Hopewell wheat was rained on several times once it was mature prior to harvest, therefore the grain test weights were very low (below 50 lb/bu) in all treatments (Table 1). Topdress application of 90 lbs N/a as urea and ammonium sulfate and 120 lbs N/a as UAN resulted in the highest grain yields. Yields were slightly lower with 60 lbs N/a and with ESN. Yields with 60 lbs N/a of all materials increased yields about 10 bushels per acre, although this was not statistically different from the control. Applying UAN at 45 lbs N/a over the top of the wheat at Feekes stage 6 caused considerable foliage injury so that yield was the same as the control. Grain moisture tended to be lowest this year with UAN applied and highest with ESN applied.

In 2005 yields of Sisson wheat were much lower than Hopewell the previous year (Table 2). April and May were quite dry. In this year the top grain yields were produced with 90 lbs N/a applied at green up as ammonium sulfate or ESN or with 100 lbs N/a as ESN applied in the fall. Although these yields were numerically greater than with 60 lbs N/a, the difference was not statistically significant. Yields with urea and UAN tended to be lower, especially at 90 lb N/a. Topdressing blends (50:50) of urea+ESN or urea+ammonium sulfate provided no benefit over individual materials. Grain moisture and test weights were variable, but no consistent relation with N rate or material was apparent.

In 2006 yields of Roan wheat were very good, despite severe lodging of all plots receiving 60 or more lbs N/a due to strong winds and heavy rains (Table 3). Lodging was worse in plots receiving 60 or 90 lbs N/a as ammonium sulfate or urea. Lodging was the least in wheat receiving ESN or when the topdress N was split between green up and Feekes 6. As a result of the lodging, grain yields were actually best with only 30 lbs N/a topdressed at green up for all materials, except the slow release material ESN. In this year 60 lbs N/a topdressed at green up was more than adequate. Spring applied ESN (60 or 90 lbs N/a) produced the highest yields. Blends (50:50) of ESN+urea or ESN+ Ammonium sulfate produced yields similar to ESN alone. Fall applied ESN produced yields similar to the other N materials. Splitting the N topdress between green up and Feekes 6 provided no grain yield benefit, although lodging was less. Grain moisture tended to be higher with the higher N rates. Test weights were low due to rains prior to harvest.

In 2007 the best grain yield (108 bu/a) occurred with 45 lbs N/a as urea applied at green up followed by 45 lbs N/a at Feekes 6 as ammonium sulfate. With urea the best yield occurred with 90 lbs N/a, but with all the other materials the yield topped out with 60 lbs N/a. In this year ESN incorporated prior to planting produced yields equal to spring topdressed ESN and the other N materials. Nitrogen rate or material had no effect on grain test weight or moisture.

These studies have shown that farmers looking for improved time management can applied ESN (a slow release polymer coated urea) in the fall to supply all the needed N and produce top yields. Slow release N materials provide a wider window for application in the spring prior to green up without the concern for N loss by leaching or volatilization. Split application of N between green up and Feekes 6 has potential for improving wheat yield. However, if rainfall is limited after the Feekes 6 application benefit from that N may be limited. Table 5 presents a summary of the N rates and materials common to the years of these studies. Over 3 years fall applied ESN (60 and 90 lbs N/a) resulted in the same yields as with the same rates of urea and UAN topdressed in late March. Over this same time period spring applied ESN resulted in the highest yields. For all N materials the economic optimum N rate was between 60 and 90 lbs topdress N/a. In a variety by N rate study in 2008 all four varieties responded similarly to N. Each increment of N applied resulted in an economic return on investment up to 120 lbs N/a, which was the highest rate used. This wheat followed soybeans. This response was greater than that observed in the studies from 2004 through 2007. The greater response may have been partially due to the wheat having been heavily grazed by Canadian geese in the fall so that N rate had a greater effect early spring growth and tillering.

Table 1. Soft red winter wheat (cv. Hopewell) yield, grain moisture and test weight in relation to varying nitrogen rates of several nitrogen materials. Agronomy Farm, Michigan State University, 2004.

N Material	N Rate[1]	Yield[2]	Moisture	Test Weight
	lb N/A	bu/acre	%	lb/bu
None	0	75.2	14.9	48.6
Urea	60	85.5	16.2	49.8
	90	89.4	15.7	50.5
AmSulfate	30	75.4	15.6	49.9
	60	86.6	16.0	49.7
	90	91.8	16.0	49.0
UAN	60	86.8	15.1	50.7
	90	82.5	15.3	48.5
	120	93.4	15.5	48.0
	45+45	76.6	14.4	49.7
ESN Sp	60	81.9	16.5	48.9
	90	84.5	17.1	46.0
ESN+Urea	90	83.2	16.3	47.9
	$Lsd_{.05}$	11.7	1.3	2.7
	CV	9.7	5.8	3.8

[1] N surface applied at green up. 45+45 applied at green up + Feekes 6. ESN + Urea is a 50:50 blend.

[2] Yield adjusted to 11.5% moisture.

Table 2. Soft red winter wheat (cv. Sisson) yield, grain moisture and test weight in relation to varying nitrogen rates of several nitrogen materials. Agronomy Farm, Michigan State University. 2005.

Nitrogen Material	Nitrogen Applied	Timing	Grain Yield[1]	Grain Moisture	Grain Test Wt.
	b/A		bu/A	%	lb/bu
None	0	- - -	52.7	15.8	54.7
Urea	60	Green Up	66.0	16.1	53.6
	90	Green Up	62.9	16.6	53.0
Amm. Sulfate	30	Green Up	66.0	16.5	55.0
	60	Green Up	67.5	17.8	51.3
	90	Green Up	78.3	17.1	54.0
UAN	60	Green Up	63.2	16.0	54.7
	90	Green Up	65.7	15.9	54.5
ESN	60	Fall	65.0	17.6	53.8
	80	Fall	66.8	16.8	51.7
	100	Fall	72.1	17.0	55.2
	60	Green Up	68.7	14.7	56.3
	90	Green Up	74.0	16.8	54.4
Urea + ESN	45+45(blend)	Green Up	69.0	16.7	53.6
AmS + Urea	45+45(blend)	Green Up	69.3	16.4	53.8
	$Lsd_{.10}$		13.6	3.3	1.8
	CV		17.0	5.3	9.5

[1] Yield adjusted to 11.5% moisture.

Table 3. Soft red winter wheat (cv. Roan) yield, grain moisture and test weight, and lodging in relation to varying nitrogen rates of several nitrogen materials. Agronomy Farm, Michigan State University. 2006.

N Material	N Rate	Yield[1]	Moisture	Test Weight	Lodging[2]
	lb N/A	bu/A	%	lb/bu	%
Control	0	88.4	12.7	48.9	19
Am Sulfate	30	95.7	13.1	49.5	70
	60	90.8	15.9	50.5	86
	90	91.2	14.9	48.0	92
	45+45[3]	95.9	14.3	49.1	50
Urea	30	96.6	13.2	49.0	86
	60	94.9	14.3	49.8	97
	90	96.2	13.6	50.8	97
UAN	30	93.9	14.3	48.0	50
	60	88.2	14.6	50.6	77
	90	94.5	13.4	48.7	94
ESN fall	30	96.1	12.2	49.9	14
	60	93.5	14.6	50.1	82
	90	93.5	14.0	51.3	71
	120	89.5	14.8	50.3	67
ESN spring	30	93.7	12.2	49.3	22
	60	106.1	13.2	49.8	79
	90	105.7	14.1	48.6	52
ESN+AmS	90	98.3	14.9	50.5	91
ESN+Urea	90	97.2	13.7	50.4	76
	$Lsd_{.05}$	7.6	2.7	2.8	
	CV	5.7	13.5	4.0	

[1] Yield adjusted to 11.5% moisture.
[2] Lodging rating on 6/23/06.
[3] N surface applied at green up. 45+45 applied at green up + Feekes 6

Table 4. Wheat yield in relation to nitrogen material, rate and program. 2007 cv. Roan.

Nitrogen Material	Nitrogen Rate[1]	Grain Yield[2]	Grain Moisture	Test Weight
	lbs N/A	bu/A	%	lbs/bu
None	0	81.4	14.2	59.4
Urea	30	89.3	14.3	59.2
	60	91.8	14.5	59.2
	90	97.0	14.4	59.3
Ur+AS blend	30	85.5	14.2	59.3
	60	98.0	14.4	59.5
	90	98.5	14.5	59.3
Ur+AS	45+45 fks 6	108.0	14.7	59.2
UAN	30	95.1	14.3	59.3
	60	101.2	14.7	59.1
	90	100.6	15.0	58.7
ESN fall	30	84.8	14.2	59.1
	60	98.4	14.4	59.4
	90	100.8	14.5	59.4
	120	98.4	14.3	59.6
ESN spr	30	96.9	14.4	59.9
	60	95.9	14.3	60.0
	90	103.5	14.5	60.1
ESN+AS blend	90	100.8	14.5	59.4
ESN+Ur blend	90	103.7	14.6	59.4
	Lsd.05	9.0	ns	0.42
	CV (%)	6.6	0.67	2.06

[1] N surface applied at green up. 45+45 applied at green up + Feekes 6.
[2] Yield adjusted to 11.5% moisture.

Table 5. Summary of wheat yields in relation to nitrogen material, rate and program. 2004-2007. cv. 2003-4=Hopewell; 2004-5=Sisson; 2005-6 and 2006-7 =Roan.

Topdress Nitrogen Material	Topdress Nitrogen Rate[1]	Grain Yield[2]				**04-07 4 year**	**05-07 3 year**
		2004	2005	2006	2007	**Average**	
	lbs N/A	- - - - - - bu/A - - - - - -					
None	0	75.2	52.7	88.4	81.4	**74.4**	**74.1**
Urea	30			96.6	89.3		
	60	85.5	66.0	90.8	91.8	**83.5**	**82.8**
	90	89.4	62.9	91.2	97.0	**85.1**	**83.7**
Ur + AS	45+45 fks6			95.9	108.0		
UAN	30			93.9	95.1		
	60	86.8	63.2	88.2	101.2	**84.8**	**84.2**
	90	82.5	65.7	94.5	100.6	**85.8**	**86.9**
	120	93.4					
ESN fall	30			96.1	84.8		
	60		65.0	93.5	98.4		**85.6**
	90		69.4	93.5	100.8		**87.9**
	120			89.5	98.4		
ESN spr	30			93.7	96.9		
	60	81.9	68.7	106.1	95.9	**88.1**	**90.2**
	90	84.5	74.0	105.7	103.5	**91.9**	**94.4**
ESN+AS blend	90			98.3	100.8		
ESN+U blend	90	83.2	60.3	97.2			
	$Lsd_{.10}$	9.7	13.6	6.3	7.5		
	CV (%)	9.7	17.0	5.7	6.6		

[1] N surface applied at green up. 45+45 applied at green up + Feekes 6.
[2] Yield adjusted to 11.5% moisture.

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