SLOW RELEASE N FOR IRRIGATED HARD RED SPRING WHEAT YIELD AND PROTEIN

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ABSTRACT

Producing furrow irrigated hard red wheat with acceptable protein is challenging because of limited N management options for increasing protein. Slow release N has potential for improving N use efficiency in furrow irrigated hard wheat by avoiding the effects of excessive early season N yet providing later N for protein enhancement. A two year study (2005 and 2006) was conducted at Parma, ID to evaluate different N rates (120, 180 and 240 lb/A) of ESN and dry urea preplant N sources for furrow irrigated hard red spring wheat. Grain yield decreased in the absence of lodging with both preplant N sources when applied N exceeded 120 lb/A in 2005, possibly due to exacerbated stripe rust. With no stripe rust the following year, yield increased with higher ESN N but not with urea N, for reasons that are not clear. Preplant ESN was more productive than urea in both years at the highest N rates and protein with ESN matched the protein of wheat topdressed with 60 lb urea N/A at heading in one of the two years. At optimum N rates for each year, ESN provided greater economic returns than urea provided the price difference was only $.11 per pound of N.

INTRODUCTION

Producing high yielding irrigated hard spring wheat with acceptable protein has been challenging for producers despite their efforts to manage available N for protein enhancement. Both higher fertilizer N rates and split applications are used by growers but even these measures often result in protein concentrations that result in low protein price discounts. Furrow irrigated producers are especially frustrated because late season top-dressed fertilizer N does not appear to be used as effectively for protein enhancement as the N which can be fully incorporated with overhead sprinkler irrigation.

Furthermore, to avoid later application costs, some try to provide all the N preplant that is necessary for both yield and protein, which increases the risk of lodging and lower yields from excessive N during vegetative growth. A single pre-plant broadcast fertilizer N that could match or increase the effectiveness of later topdressed N (1) could reduce application costs, and (2) reduce N losses from volatilization, leaching, and denitrification.

Broadcast and incorporated polymer coated urea may have potential for delaying early season N availability yet provide adequate late season N for yield and protein enhancement. ESN is a polymer coated urea currently marketed for grain crops in the Midwest. The diffusion of water through the polymer coating is temperature dependent. Water passing through the polymer solubilizes the urea core enabling it to diffuse into soil where it can be used by plants.

OBJECTIVE

The objective of this study was to evaluate ESN as a preplant broadcast and incorporated N source for furrow irrigated hard red spring wheat.

METHODS

A research trial conducted at the Parma R & E Center in 2005 and 2006 involved preplant urea and ESN N sources at various N rates (120, 180 , and 240 lb/A) for its effectiveness in furrow irrigated hard red spring wheat. A delayed application of urea at heading (60% of the total) was also evaluated. Treatments were arranged in a randomized complete block with four replications and are shown in tables 1 and 2.

Preplant nitrate-N in the first foot measured 35 ppm in 2005 and 21 ppm in 2006. The previous crop was dry beans that received 50 lb N/A preplant. Preplant fertilizer treatments were applied March 30, 2005 and February 21, 2006 and incorporated with a Triple K (narrow spring toothed harrow). Subsequent rainfall after the incorporation occurred 4 days later in 2005 (0.27") and 8 days later in 2006 (0.26"). Jerome hard red spring wheat was planted March 30, 2005 and February 28, 2006. Jerome was chosen in part because of its high yield potential and a tendency to have lower protein. The trials were furrow irrigated as needed and harvested August 5, 2005 and July 27, 2006.

Chlorophyll meter (SPAD) readings were collected just prior to the top-dressed urea N application. Plant heights, yield, test weight and protein were measured. Total grain protein N was calculated from the grain yield and protein data. Apparent N recovery was calculated in 2006 based on the difference in grain N of fertilized and unfertilized wheat relative to the N applied.

RESULTS

Yields differed appreciably in the two years of study. Yields were limited in 2005 by stripe rust (*Puccinia striiformis*) and possibly by a later planting than in 2006. Stripe rust was not present in 2006 and lodging occurred at higher N rates but did not appear to affect yield.

Yields with broadcast preplant urea and ESN were significantly reduced with the higher N in 2005. Yield was significantly higher with ESN than with urea. Why yield decreased in 2005 with high N is not clear. There was no lodging in 2005. It's possible that high N exacerbated stripe rust severity but that was not obvious from visual inspection. Delaying until heading the application of 60 lb urea N/A of the 240 lb rate tended to ameliorate excessive urea N effects.

The yield response to higher N in 2006 differed for the two N sources. Yield with preplant urea was unaffected by N rates above 120 lb/A, but yield with ESN increased. Yield at the 120 rate did not differ significantly for the two N sources. Yield tended to increase at the 180 lb N rate the more ESN was substituted for urea. As in 2005, delaying the application of 60 lb of urea N until heading ameliorated some of the excessive preplant urea N effects.

Protein in 2005 with lower yields ranged narrowly from 13.9 to 14.9% with N rates of 120 to 240 lb N/A, and with higher yields in 2006 from 11.2 to 13.1%. The results in 2006 show the difficulty in producing high yields of furrow irrigated hard wheat with acceptable protein despite higher N rates than are required to maximize yield.

Protein increased with higher N rates in both years, and for urea was consistently higher when 60 lb N/A of the urea N was top-dressed at heading. Protein at the 180 N rate was higher the greater the substitution of preplant ESN for urea in 2006. While protein for the two preplant N sources did not differ in 2005, protein was consistently higher for preplant ESN than for preplant urea in 2006, despite the higher yields for ESN. Protein with preplant ESN did not consistently match the protein of wheat receiving a delayed top-dress of urea N in 2005, but protein in 2006 with preplant ESN did not differ from the split applied urea.

Table 1. Jerome hard red spring wheat response to preplant conventional urea and slow release N fertilization. Parma, 2005.

Total N applied	Preplant Urea N	Preplant ESN N	Late Urea N	Yield	Protein	Test weight	Height	SPAD	Grain N
	------------lb/A------------			bu/A	%	lb/bu	in		lb/A
120									
	120			84	13.9	61.7	34	49.1	125
		120		92	14.0	61.6	34	51.7	137
180									
	180			82	14.2	60.5	34	51.4	124
	120	60		82	14.3	60.7	33	52.2	125
	60	120		84	14.4	60.8	34	51.9	128
	0	180		87	14.4	61.2	34	50.4	132
	120		60	83	14.6	60.4	34	48.7	128
240									
	240			73	14.6	60.5	33	52.9	112
		240		83	14.6	60.5	33	51.3	128
	180		60	79	14.9	60.3	33	52.2	125
CV				8	1.9	0.7	3.3	5.2	7.6
$LSD_{.10}$				8	0.3	0.5	1.3	3.2	11.6

Table 2. Jerome hard red spring wheat response to preplant conventional urea and ESN slow release N fertilization. Parma, 2006.

Total N applied	Preplant Urea N	Preplant ESN N	Late Urea N	Yield	Protein	Test weight	Height	Lodged	SPAD	Grain N	ANR
	------------lb/A------------			bu/A	%	lb/bu	in	%		lb/A	%
0	--	--	--	79.2	8.9	61.2	32.9	0	44.1	74.9	--
120	--	--	--								
	120			113.8	11.2	62.0	36.8	8	52.2	135.6	50.6
	--	120	--	116.6	11.6	62.5	36.2	0	53.1	143.4	57.1
180											
	180	--	--	118.8	11.7	62.0	36.2	10	55.0	147.3	40.2
	120	60	--	121.2	12.2	62.4	37.8	10	54.5	156.4	45.3
	60	120	--	124.3	12.3	62.4	37.1	28	53.0	161.9	48.3
	--	180	--	129.1	12.7	62.4	37.3	38	54.9	174.0	55.1
	120	--	60	125.8	12.7	62.3	37.3	65	55.9	169.4	52.5
240											
	240	--	--	116.6	12.5	62.2	37.4	18	54.3	155.2	33.5
	--	240	--	125.2	13.0	62.2	37.4	55	55.5	172.6	40.7
	180	--	60	122.5	13.1	62.1	37.3	53	56.2	170.5	39.8
CV				4.5	3.8	0.4	2.7	112	3.8	3.0	--
$LSD_{.10}$				6.4	0.43	0.4	1.2	35	2.4	10.5	--

Grain N content also differed appreciably in the two years and depended primarily on yield. Grain N ranged from 112 to 137 lb/A in 2005 and was highest at the lowest N rate due to higher yields. Grain N ranged from 137 to 174 lb/A for the same treatments in 2006, but unlike 2005, was highest with the highest preplant N rate, particularly with a delayed N topdress. Grain N in most comparisons was greater in grain fertilized preplant with ESN than with urea. Preplant ESN grain N was consistently as high as the grain N with split applied urea.

Including a control in 2006 enabled calculation of apparent N recovery (ANR). The ANR in harvested grain of that applied in 2006 decreased as N rates increased. ANR ranged from highs of 50.6% with urea and 57.1% with ESN applied preplant for the 120 N rate to only 33.4% with urea and 40.7% with ESN at the 240 rate. Recovery estimates are conservative as they don't include N contents of chaff and stubble. The delayed urea top-dress increased the ANR for urea by 30% (40.2 vs 52.5%) for the 180 N rate over that with all preplant urea, primarily due to higher yields.

SPAD readings (heading) and plant heights (dough stage) for the two preplant N sources did not differ significantly in any year. Test weight decreased with higher N in 2005 and was occasionally higher with ESN. Lodging in 2006 increased with higher N, especially for treatments providing higher N during later growth stages, but these were also the most productive treatments. Lodging was greater with preplant ESN than preplant urea.

Preplant urea N was less effective in both years compared to slow release N at higher N rates. While we can't rule out the influence of stripe rust on the N response in 2005, N loses from leaching or volatile N losses (NH_3 from soil, denitrification, NH_3 from plants) are also possible. N losses don't explain declining yields with higher urea N in 2005 but they could help explain the minimal response to higher urea N in 2006. Leaching is not likely responsible for the minimal response since greater losses would seem to favor the higher N rates. Volatile losses from urea N that are more dependent on the rate applied are more consistent with the 2006 results of a limited yield response and low protein. For example, the 240 lb preplant urea N rate resulted in only 12.5% protein, protein barely adequate for maximizing yield. Even ESN at the highest N rate resulted in only 13% protein, a full percentage less than desired. There appears to have been significant N losses from early season available N.

Though greater volatile N losses with higher urea N may account for the minimal yield and protein response to higher urea N in 2006, physiologic N imbalance or inefficiency also can not be ruled out. However, less lodging with urea relative to ESN in 2006 suggests that excessive vegetative growth did not occur with preplant urea N.

Regardless of the mechanism, preplant slow release N was significantly more effective than urea under the different conditions of these two field trials. Further study is merited on preplant slow release N for producing high yielding furrow irrigated hard wheat with acceptable protein.

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