SLOW RELEASE NITROGEN SOURCE AND TIMING FOR IRRIGATED WINTER WHEAT

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ABSTRACT

Information is lacking on the effectiveness of polymer coated urea for irrigated winter wheat. Field studies with Stephens winter wheat were conducted for the 2006, 2007 and 2008 seasons on a Greenleaf silt loam at the UI Parma R & E Center. Nitrogen (N) timing (preplant broadcast, late fall top-dress, and late winter top-dress), N rate (60, 120, 180 lb N/A), and N source (urea, polymer coated urea as ESN®, and a 50-50 mixture) were factorially combined in a randomized complete block design with four replications. An untreated control was included for calculation of Apparent N Recovery. Year effects were highly significant and affected the response to N rate for most parameters measured. Nitrogen at the higher rates increased yield in all years but 2006. Timing of N effects were insignificant for most parameters but there were significant N timing x N source interactions for yield, height, SPAD, grain N, and ANR. ESN® was the more effective early fall preplant application for yield and ANR but urea was the more effective late winter top-dress. Fall preplant ESN® N yielded as well and was utilized as much as late winter topdressed N. Test weight and protein were higher for ESN® than for urea regardless of timing or N rate.

INTRODUCTION

Previous research indicates that late winter top-dressed urea N is more effective than early fall preplant incorporated urea for winter wheat in 2 out of 3 years, due either to less leaching, denitrification, or immobilization. While preplant urea is occasionally as effective as late winter top-dressed urea, it is seldom more effective. In part because of this research, the current NRCS Code 590 Standard discourages early fall preplant applied N unless the N can be maintained in the ammonium form during winter, the period of maximum precipitation and nitrate leaching potential. High rates of urea have reduced grain yield in the absence of lodging or disease.

Despite the relative effectiveness of winter top-dressed urea N, this N fertilizer is subject to volatile losses when it hydrolyzes at the soil surface. Ammonia emissions from all sources will be increasingly scrutinized due to their relation to PM2.5 particulates and air quality.

Preplant N incorporated was historically favored by the industry and growers as it helped distribute the workload in addition to minimizing volatile N losses from the soil surface. There is need for a preplant N fertilizer that can be incorporated without the limitations of conventional dry N sources (immobilization; rapid nitrification and subsequent leaching or denitrification; phytotoxicity). ESN, a polymer coated urea and controlled release fertilizer has potential for significantly delaying N release and reducing immobilization, nitrification, phytotoxicity and excessive growth. Information is needed on the relative performance of ESN and urea dry fertilizers for both preplant and later top-dressed applications to furrow irrigated winter wheat.

METHODS

Irrigated winter wheat trials at Parma with Stephens soft white winter wheat were conducted for three years (2006-08) to evaluate N sources (urea, ESN®, and a 50% mix of each) at three N rates (60, 120, and 240 lb N /A) and timing (preplant incorporated, and either late fall or late winter top-dressed). An untreated control was also included to allow the calculation of Apparent N Recovery (ANR), taken as the grain N difference between a treatment and the control divided by the N rate used. Treatments were arranged in a randomized complete block with four replications. Dates for treatments, cultural practices, and other information is given in Table 1. The wheat was planted in all years at the rate of 100 lb/A. Weed control was gained with labeled broadleaf herbicides. The trial was furrow irrigated as needed using 30" spaced furrows. Chlorophyll meter (SPAD) readings were collected at late vegetative stage (between heading and flowering). Plant height was measured from five plants, and lodging visually estimated. Grain was harvested with a small plot combine from plot centers (5'x20') for the yield estimate. Both test weight and protein (NIR) were measured on harvested subsamples. Total grain N was calculated from the grain yield and protein data, using 5.7 as the factor for converting percent protein to N concentration. The data were analyzed as a 3x3x3 factorial using PROC GLM in SAS 9.2. Treatment interaction means were separated with a protected LSD at the 10% probability level.

RESULTS AND DISCUSSION

Yields were highest in 2007 (164 bu/A) and lowest in 2008 (140 bu/A). Yield increased with higher N rates (120 and 180 lb N/A) particularly in 2007 and 2008. A significant timing x source interaction for yield occurred (P>F=0.0001). ESN® was the more effective (7.6%) early fall preplant application for yield but urea was the more effective (3.3%) late winter top-dress. With late fall top-dressed N, sources did not differ in yield. Timing was more critical for urea effectiveness than for ESN®.

Plant height increased with added N and was greatest in 2006 and lowest in 2008. Plant height for the preplant applications was greater for ESN® than for urea, but the opposite occurred with late winter applications. ESN® plant height was reduced with later topdressing and was more affected by timing than urea. Lodging occurred in 2006 with higher N rates but timing and source effects were not significant.

Chlorophyll meter (SPAD) readings at heading increased with N rates and there was a significant interaction for timing and source (P>F=0.0002). SPAD values for the preplant applied N sources were highest for ESN® and lowest for urea, but values were higher for urea than ESN® with late winter topdressed N. Test weight increased with N rate and was consistently higher for ESN than urea regardless of N timing.

Grain protein concentration and total grain N increased with added N. Protein was higher for ESN than urea particularly with the preplant N. Total grain N was higher for preplant ESN than preplant urea but N sources did not differ significantly when top-dressed. The ANR decreased with higher N rates and a significant timing x source interaction (P>F=0.014) indicated that the efficiency of ESN® was greater than urea as a preplant broadcast or late fall topdress application but tended to be less efficient as a late winter topdress.

The results for furrow-irrigated winter wheat over three years (higher yield, protein, grain N, and ANR) strongly suggest that preplant ESN® is the more effective N source for early fall preplant applied N as compared to urea. Despite greater potential for leaching with winter precipitation, the ANR for preplant ESN® was at least as good as with late winter topdressed urea. Consequently, it is not likely that preplant polymer coated ESN® results in more N available for leaching in winter or during the irrigation season than late winter topdressed urea, although N movement was not measured in this research. From the stand point of nutrient use efficiency, either ESN® or a similarly effective controlled release N source should be considered for preplant applications with other applied fertilizers to avoid separate applications cost if the slow release N is not prohibitively expensive.

ESN® provided little if any agronomic advantage over urea as a late fall topdress and was clearly less effective as a late winter topdress than urea. The relative ineffectiveness of ESN® as a late winter topdress is likely due to inadequate precipitation and drier soil surface conditions that limited sufficient ESN® N release during critical growth periods.

The protein results imply that ESN may be especially suited for hard winter wheat classes (or fall planted hard wheat spring genotypes) that receive premiums for higher protein. For soft winter wheat the higher protein provides no marketing advantage.

Table 1. Preplant residual N, and timing of cultural and sampling operations for the trials in each season

	2006	2007	2008
Preplant Residual NO3-N			
0-12”	10	24	21
12-24”	16	8	16
Planting date	10/18/05	9/28/06	10/9/07
Preplant broadcast N	10/17/05	9/28/06	10/9/07
Late fall topdressed N	11/15	11/13	11/13
Late winter topdressed N	2/14	2/20	3/5
Irrigation	4/26	10/9/06	4/16
	5/12	4/9/07	5/1
	5/24	4/30	5/14 5/28
	6/3	5/8	6/6
	6/12	5/24	6/12
	6/21	6/6	6/23
		6/14	6/30
		6/20	
SPAD readings	6/3	5/16	5/27
Harvest	7/21	7/19	7/29

Table 2. Irrigated winter wheat response to year and N rate. Parma, 2006-08.

Year	N Rate	Yield	Protein	Test weight	Height	SPAD	Grain N	ANR
		bu/A	%	lb/bu	in	%	lb/A	%
2006								
	60	153	10.2	59.2	38.1	51.7	166	62.0
	120	156	11.1	59.0	38.5	53.7	184	46.0
	180	154	11.4	58.5	38.9	54.6	186	31.9
2007								
	60	147	9.8	58.9	37.3	49.1	154	77.7
	120	165	10.8	59.2	37.8	52.0	190	68.7
	180	173	11.4	59.5	37.9	53.6	210	56.7
2008-								
	60	122	7.8	58.1	35.0	40.1	102	70.0
	120	144	8.9	58.9	36.2	44.5	136	63.1
	180	154	9.7	59.3	36.5	47.6	159	54.8
$LSD_{.10}$								

Table 3. Irrigated winter wheat response to N source and timing. Parma, 2006-08.

Timing	Source	Yield	Protein	Test weight	Height	SPAD	Grain N	ANR
		bu/A	%	lb/bu	in		lb/A	%
Preplant								
	Urea	145	9.8	58.9	37.4	48.7	153	47.3
	ESN	156	10.4	59.1	38.0	50.5	175	67.4
	Mixed	152	10.1	58.7	37.8	49.6	165	60.4
Late Fall								
	Urea	150	9.8	58.4	37.8	49.7	159	51.5
	ESN	151	10.2	59.3	36.6	49.6	165	59.9
	Mixed	152	10.2	58.8	37.1	48.9	167	60.5
Late Winter-								
	Urea	157	10.2	58.7	37.6	50.9	171	65.2
	ESN	152	10.4	59.4	36.4	48.8	169	60.5
	Mixed	151	10.1	59.2	37.4	50.2	165	58.4
$LSD_{.10}$								

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