ENHANCED NITROGEN FOR HARD WHEAT YIELD AND PROTEIN

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ABSTRACT

Field studies with enhanced nitrogen fertilizers were conducted at the Parma R & E Center during the 2007, 2008, and 2009 seasons on a Greenleaf silt loam to improve protein of furrow irrigated hard white spring wheat (var "Otis"). Enhanced preplant dry N (ESN, SuperU), jointing or boot stage foliar N (NFusion, Nitamin 30L) or topdressed dry N (Agrotain treated urea) were compared to conventional topdressed dry urea or foliar uran N at variable N rates, generally 30 and 60 lb N/A. Preplant basal N as urea (100 lb N/A) was applied uniformly to all plots receiving enhanced N products. The N applied in addition to the basal N affected yield in only one of three years, had little or no effect on test weight or plant height, and seldom increased protein or grain N content, except for boot stage topdressed urea at the 60 lb N/A rate. While preplant enhanced dry N fertilizers may be more convenient, neither these or foliar enhanced N fertilizers for this furrow irrigated system were as consistently effective as conventional topdressed urea N for increasing protein.

INTRODUCTION

High protein hard wheat is difficult to produce under irrigation without intensive N management. Late season N applications are common on highly productive irrigated hard wheat for enhancing protein. The challenge for furrow irrigated production is that urea N topdressed, without successful incorporation with timely rain or sprinklers, can be more susceptible to volatile N losses. Furthermore, the late season N rate required to boost protein to acceptable levels in highly productive wheat can cause appreciable leaf burn when applied to foliage at rates above 30 lb/A. While there is information on the response of hard spring wheat to foliar urea or uran solutions applied to the foliage, there is limited data on the response to more recently developed "enhanced" solutions or dry N fertilizers designed to improve N availability as compared to conventional fertilizers. The primary focus of this study was the protein enhancement to be gained with these enhanced N fertilizers relative to more conventional means of enhancing wheat protein.

METHODS

To improve protein of furrow irrigated hard white spring wheat (var "Otis"), field studies were conducted at the Parma R & E Center during the 2007, 2008, and 2009 seasons on a Greenleaf silt loam. All studies received basal N as urea applied preplant at the rate of 100 lb N/A. Enhanced preplant dry (ESN, SuperU), and later foliar (Coron, NFusion, Nitamin 30L) or topdressed dry N (Agrotain treated urea) were compared to conventional boot stage topdressed dry urea or foliar uran N. Rates for the comparisons ranged from 7.5 to 60 lb N/A, generally 30 and 60 lb N/A (Tables 2-4). Preplant basal N (100 lb N/A) was broadcast preplant as urea and incorporated with a 5 foot disk and harrow. Preplant treatments of ESN (2007, 2008, 2009) and SuperU (2008, 2009) at 30 and 60 lb N rates were also incorporated with basal urea. All post emergence treatments were applied at the boot stage except for Nitamin 30L applied at jointing in 2008 and 2009. Not all treatments were included in all years. Treatments were arranged in a randomized complete block with four replications. Otis was planted with a small plot grain drill in seven rows with 7" spacings. Individual plots were 5' by 25'. Dry treatments were applied by hand but foliar N was applied with a hand held wand and CO2 pressurized containers using a spray volume of 35 gal/A.

Preplant residual NO_3-N in the first and second foot respectively measured 30 and 15 ppm in fall 2006, 10 and 10 ppm in fall 2007, and 15 and 21 ppm in 2009. Topdressed dry fertilizers were not incorporated with rain before a subsequent furrow irrigation three days later in 2007 and 2009, and four days later in 2008 (Table 1). Beyond the first subsequent irrigation, the greatest potential for volatile N loss was likely in 2008 when only 0.08" occurred for the remainder of the month. Furrow irrigation was scheduled generally weekly after the boot stage.

Foliar leaf burn after solution N was applied was estimated within a week of the application. Plant height was measured at the dough stage. Grain yield was measured from 20' of the plot after trimming 2.5' from each plot end. Test weight and protein (NIR) were measured on the harvested grain samples. Grain N content was calculated from the yield and protein measures. Means were separated with a protected LSD at the 10% probability level.

Table 1. Furrow irrigation and rainfall relative to the boot stage N applications each year.

Boot Stage N	Irrigation	Subsequent Rainfall
May 30, 2007	June 2	June 6, 0.05" June 10, 0.78"
June 5, 2008	June 9	June 11, 0.08"
May 29, 2009	June 1	June 3, 0.05" June 5, 0.25" June 6, 0.16" June 7, 0.68"

RESULTS AND DISCUSSION

There was considerable variability in the agronomic measurements in 2007. Wheat yield for enhanced N fertilizers did not differ from the basal N application in 2007 or 2009. Most N treatments increased grain yield slightly compared to the basal N in 2008. Yield with topdressed dry urea was as good or better than foliar or dry enhanced N fertilizers.

Leaf burn occurred with foliar N in 2007 especially at the higher N rate, but was not an issue in other years. Leaf burn was as high as 80% for Nitamin 30L at the 60 lb rate and lowest for Coron (43%).

Test weight and plant height were not appreciably affected by N treatments. We did not anticipate much effect on yield, test weight, or height given the preplant residual N and basal N application.

The N applied primarily for protein enhancement, beyond the basal urea rate, with few exceptions (urea topdressed at the 60 lb rate) did not increase grain protein to levels that differed significantly from the basal urea applied. Preplant incorporated ESN and SuperU with basal urea were as effective for protein enhancement as any foliar N applied during vegetative growth but did not always equal the protein from boot stage topdressed urea. No enhanced N fertilizer was more effective than conventional N sources, dry or foliar, for increasing protein in this furrow irrigated system. Grain N was also surprisingly little affected by the additional N during the three years.

For protein enhancement, under the conditions of this furrow irrigated study, alternative or enhanced N sources provided no advantage over topdressing conventional urea at the boot stage. The basal N rate may have masked enhanced N treatment effects and minimized the protein response to higher N. The protein increase with late season N is limited the higher the previously available N. The results reflect the challenge of producing furrow irrigated hard wheat with acceptable protein.

Available preplant residual N was 180, 80, and 144 lb/A in 2007, 2008, and 2009 respectively, with corresponding protein using only basal N of 13.4, 11.8 and 12.2%, and the corresponding available N (lb/A of residual plus basal N) to protein ratios of 3.0, 1.8, and 2.5. If acceptable protein for hard white spring wheat is 12.5%, protein was acceptable with basal N only in 2007. No enhanced fertilizer N came closer to 12.5% than urea topdressed at the boot stage, despite conditions in early June (urea surface applied with the soil surface wetted from an advancing wetting front) that could have promoted urea N volatilization. Consequently, given their greater expense, unless there are offsetting cost savings from more convenient applications, there is little justification for using these enhanced N alternatives for increasing protein in furrow irrigated hard wheat production.

ACKNOWLEDGEMENT

These studies were conducted with support from the Idaho Wheat Commission as well as the companies providing the materials for study.

Table 2. Nitrogen sources for enhancing protein of furrow irrigated hard white spring wheat. Parma, 2007.

Basal N 100lb N/A	Additional N for protein			Yield	Protein	Test Wt	Height	Grain N
	Source	Timing	N Rate					
			lb/A	bu/A	%	lb/bu	in	lb/A
Urea	--	--	--	93.0	13.4	60.9	44.6	133
Urea	Dry ESN	Preplant	30	92.6	13.7	60.9	44.0	135
Urea	Dry ESN	Preplant	60	91.0	14.2	60.4	44.9	138
Urea	Coron	Boot	30	92.6	14.1	61.2	43.5	141
Urea	Coron	Boot	60	88.1	13.9	60.7	42.7	129
Urea	Foliar	Boot	30	85.1	13.4	60.9	44.0	122
Urea	Foliar	Boot	60	80.2	13.9	60.9	42.5	123
Urea	Foliar Uran	Boot	30	95.1	13.4	61.6	43.9	136
Urea	Foliar Uran	Boot	60	88.3	14.0	60.1	43.2	132
Urea	Dry Urea	Boot	30	101.1	13.9	61.4	44.3	149
Urea	Dry Urea	Boot	60	99.5	13.9	61.6	45.6	146
	$LSD_{0.10}$			17	0.6	1.2	2.1	26
	CV			15.3	3.8	1.6	4.0	16

Table 3. Nitrogen sources for enhancing protein of furrow irrigated hard white spring wheat. Parma, 2008.

Basal N 100lb N/A	Additional N for protein			Yield	Protein	Test Wt	Height	Grain N
	Source	Timing	N Rate					
			lb/A	bu/A	%	lb/bu	in	lb/A
Urea	--	--	--	99.1	11.8	63.0	40.7	124
Urea	SuperU	Preplant	30	105.9	12.0	63.3	40.9	135
Urea	SuperU	Preplant	60	109.6	12.1	62.5	41.7	141
Urea	ESN	Preplant	30	106.8	11.7	63.2	40.6	132
Urea	ESN	Preplant	60	111.9	12.1	63.4	41.0	143
Urea	Foliar Nitamin	Jointing	7.5	103.0	11.9	63.3	40.8	130
Urea	Foliar Nitamin	Jointing	15	104.6	11.7	62.9	40.9	133
Urea	Foliar NFusion	Boot	15	104.6	11.8	63.1	40.7	131
Urea	Foliar NFusion	Boot	30	104.0	12.0	62.8	40.6	133
Urea	Foliar Uran	Boot	30	106.7	11.8	63.6	40.8	134
Urea	Foliar Uran	Boot	60	115.7	12.1	63.7	41.0	149
Urea	Dry Urea	Boot	30	112.7	12.0	63.7	41.8	144
Urea	Dry Urea	Boot	60	109.8	12.4	63.7	41.3	144
Urea	Dry Agrotain	Boot	30	106.4	11.9	63.4	41.2	134
Urea	Dry Agrotain	Boot	60	108.8	12.0	63.1	41.2	139
	$LSD_{0.10}$			5.4	0.3	0.66	0.7	7
	CV			4.3	2.3	0.9	1.3	4.4

Table 4. Nitrogen sources for enhancing protein of furrow irrigated hard white spring wheat. Parma, 2009.

Basal N 100lb N/A	Additional N for protein			Yield	Protein	Test Wt	Height	Grain N
	Source	Timing	N Rate					
			lb/A	bu/A	%	lb/bu	in	lb/A
Urea	--	--	--	92.9	12.2	61.8	40.4	106
Urea	SuperU	Preplant	30	90.8	12.3	61.6	41.0	105
Urea	SuperU	Preplant	60	92.6	12.6	61.4	42.1	109
Urea	ESN	Preplant	30	95.7	12.2	61.9	41.2	109
Urea	ESN	Preplant	60	90.9	12.2	61.9	41.4	104
Urea	Foliar Nitamin	Jointing	7.5	93.4	11.9	61.7	41.4	104
Urea	Foliar Nitamin	Jointing	15	94.8	11.7	61.9	41.2	104
Urea	Foliar NFusion	Boot	15	92.8	12.0	61.7	40.4	104
Urea	Foliar NFusion	Boot	30	90.9	12.2	61.5	41.1	104
Urea	Foliar Uran	Boot	30	93.3	11.9	61.9	40.7	104
Urea	Foliar Uran	Boot	60	92.8	12.5	61.3	41.1	109
Urea	Dry Urea	Boot	30	94.0	12.6	61.9	41.2	111
Urea	Dry Urea	Boot	60	94.1	12.9	61.7	40.7	113
Urea	Dry Agrotain	Boot	30	95.8	12.5	61.9	41.2	112
Urea	Dry Agrotain	Boot	60	96.4	12.6	61.6	41.8	114
	$LSD_{0.10}$			5.3	0.4	0.5	1.2	7
	CV			4.8	3.0	0.7	2.0	5.6