Final Progress Report to the Nebraska Wheat Board
FY 2010 Funding Cycle

Project Title: Improved Nitrogen Management for High Quality White Wheat

Project Year/Time Period: Continuing Project, Year 5 of 5 Years (FY06-FY10)

PRINCIPAL INVESTIGATOR:
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PROJECT DESCRIPTION:

Hard white winter wheat acreage has the potential to increase in Nebraska and expand rapidly depending on market factors. While most Nebraska wheat is grown under dryland conditions, more wheat is being irrigated because of declining water resources in many areas. There is limited information on nitrogen (N) management for irrigated wheat in Nebraska (red or white). Irrigated wheat production is dramatically different from dryland production because of improved water availability and yield potential. To enhance yields and manage protein, more detailed information on N rates and timing is required for irrigated wheat. The objective of this work is to investigate intensive N management for hard white wheat to determine effects on yield and protein.

Specific Objectives.

1. Determine optimum N rates and timing to achieve specific yield and protein content goals for irrigated white wheat based on soil nitrate-N and organic matter levels.
2. Determine N rate and timing effects on selected crop parameters (test weight, harvest index, moisture, and baking quality).

PROCEDURES:

A factorial arrangement of N rate (60, 100, 140 lb N/a) and three timing regimes (all preplant, 1/3 at planting 2/3 at jointing, or 1/4 at planting, ½ jointing and 1/4 at boot) are being used. At the PHREC site plots also include 3 irrigation levels (4, 8, 12 inches).

PROGRESS:

Research was conducted from 2006 through 2010. Soil test information is shown in Table 1. The 2006 plots were at the High Plains Ag Lab (HPAL) at Sidney, at Scottsbluff (PHREC) and near Alliance. The Scottsbluff site included 3 irrigation levels: low (4"), limited (8") and full (12"). Antelope white winter wheat was planted at all 2006 locations except Alliance where Lakin was included. Planting dates were 9/23/2005 for Alliance and Sidney and 9/26/2005 at Scottsbluff. All these dates are somewhat later than optimum for maximum yield potential, but

wheat followed dry beans at 2 locations (Alliance and Scottsbluff), so yields are representative of predominate cropping systems where irrigated wheat will be planted in the panhandle.

Plots in 2007 were at the same three panhandle locations plus three sites were added in West Central NE: WCREC at North Platte and two sites between Imperial and Brandon, NE. Planting dates were 10/3/2006 for Alliance, 9/27/2007 for Sidney and 9/14/2006 at Scottsbluff with variety Antelope. North Platte wheat was planted 10/16/2006, Hajek site 9/29/2006 and Krajewski on 10/31/2006 all with Agripro NuDakota. Several of these dates are later than optimum for maximum yield potential, but wheat followed dry beans at 3 locations (Alliance, Hajek, Krajewski), so yields should be representative of cropping systems where irrigated wheat is planted after dry beans (late) in western NE.

In 2008 plots were at the same three panhandle locations plus one site on a producer's field near Sidney and one site in West Central. Planting dates were 10/1/2007 for Alliance, 9/19/2008 for Sidney and 9/14/2007 at Scottsbluff using Antelope. Imperial was planted 10/7/2007 with Agripro NuDakota. Several of these dates were later than optimum for maximum yield potential, but wheat followed dry beans at Alliance and Imperial. Residual nitrate at Alliance and Sidney in 2006 were much higher than desired, but Scottsbluff was low enough for a good N response. Residual nitrate levels in 2007 were high at four of the six locations, but site selection was limited.

For 2009, plots were at three panhandle locations plus one site at WCREC. Planting dates were Alliance: 9/25/2008; Sidney: 9/18/2008; Scottsbluff: 9/26/2008; and North Platte: 9/28/2008. Antelope white wheat was used at all locations. The residual nitrate at Alliance, Sidney and North Platte was low enough to ensure good N response whereas Scottsbluff was high enough that no N response was likely.

In 2010, plots were at three panhandle locations and one site at WCREC. Planting dates were Alliance: 9/28/2009; Sidney: 10/01/2009; Scottsbluff: 9/17/2; North Platte: 9/29/10. Residual nitrate was very low at Sidney and North Platte and low at Alliance. The Scottsbluff residual nitrate was high but the higher nitrate levels were at deeper depths.

Table 1. Soil test information for sites 2006 through 2010.

Location	pH	OM	Olsen P	ppm NO3-N			# NO3-N
				0-8"	8-24"	24-48"	in 4 feet
Alliance06	7.0	2.1%	29	20.4	10.1	4.6	130
Sidney06	7.8	2.2%	48	17.2	15.3	18.5	240
Scottsbluff06	8.2	1.2%	12	0.6	1.8	5.3	50
Alliance07	7.3	1.8%	25	12.1	7.2	4.9	120
Sidney07	8.0	2.0%	79	10.9	19.0	36.1	370
Scottsbluff07	7.6	1.4%	17	12.6	9.4	16.1	190
Hajek07	6.3	1.8%	15	15.1	4.3	5.0	110
Krajewski07	7.1	1.9%	6*	13.7	25.9	8.4	224
North Platte07	7.3	2.4%	14	6.2	3.8	2.5	55
Alliance08	7.1	1.9%	18	12.1	2.0	3.5	60
Imperial08	7.6	1.9%	9	13.2	4.1	3.5	86
Scottsbluff08	8.1	1.5%	11*	17.6	5.5	9.5	187
Sidney08	6.8	2.6%	18	13.3	3.8	11.4	132
Alliance09	7.3	2.3%	29	11.4	8.6	4.1	97
Scottsbluff09	8.3	1.6%	12	11.6	18.6	18.7	250
Sidney09	7.0	2.0%	13	11.7	4.5	3.9	72
North Platte09	7.5	1.7%	5*	9.0	5.6	2.0	63
Alliance10	7.2	2.2%	24	15.3	2.0	1.3	55
Scottsbluff10	8.2	1.7%	14*	6.2	2.9	28.1	237
Sidney10	7.6	2.3%	38	1.0	0.6	1.2	15
North Platte10	7.6	1.8%	58	5.5	2.0	1.6	39

*50 lbs phosphate added to plot area due to low soil P.

The 2006 data showed a slight N response at Alliance and Scottsbluff 12 inch irrigation levels (Table 2). Yield levels were very good at Alliance and Scottsbluff but were lower than expected at Sidney, due to later planting date, poor emergence and stand.

Table 2. 2006 irrigated white wheat grain yields.

		Alliance	Alliance	PREC-4"	PREC-8"	PREC-12"	Sidney
Variety		Antelope	Lakin	Antelope	Antelope	Antelope	Antelope
N Rate and Timing		----------Bushels/acre ----------					
0	Preplant*	83	85	77	88	90	66
30	Preplant	--	--	81	--	--	--
60	Preplant	91	90	82	83	87	72
100	Preplant	90	90	85	88	97	69
140	Preplant	76	75	--	80	100	66
30	1/4p-1/2j-1/4b	--	--	83	--	--	--
60	1/4p-1/2j-1/4b	82	93	85	94	99	66
100	1/4p-1/2j-1/4b	82	89	85	83	100	67
140	1/4p-1/2j-1/4b	78	90	--	77	98	65
30	1/3p-2/3b	--	--	84	--	--	--
60	1/3p-2/3b	81	92	85	90	99	68
100	1/3p-2/3b	83	80	87	90	96	66
140	1/3p-2/3b	69	85	--	95	95	67

*Preplant = all N applied broadcast preplant; 1/4p-1/2j-1/4b = N application with one-fourth preplant, one half at jointing and the remaining one-fourth at boot stage; 1/3p-2/3b = one-third preplant and 2/3 at jointing.

The 2007 data showed a slight N response at Alliance and Scottsbluff 12 inch irrigation levels (Table 3). Yield levels were very good at Alliance and Scottsbluff but were again low at Sidney, due to the site and poor stand. There were significant N responses at WCREC and Hajek but the very late planting, poor stands and very high nitrate-N contributed to no N response at Krajewski.

Table 3. 2007 irrigated white wheat grain yields.

		PHREC			Alliance	HPAL
		4 inch	8 inch	12 inch		
Treatment	N Rate	----------Bushels/A ----------				
All Preplant	0	62	80	89	102	65
	30	58	----	----	----	----
	60	49	78	96	106	68
	100	50	74	90	111	63
	140	----	77	92	113	65
1/4P-1/2J-1/4B	30	54	----	----	----	----
	60	62	82	93	106	63
	100	59	78	99	113	64
	140	----	71	99	115	63
1/3P-2/3J	30	57	----	----	----	----
	60	59	79	96	109	62
	100	53	77	98	109	62
	140	----	77	96	115	68

White Wheat 2007 grain yield.

		Krajewski *	Hajek	North Platte
Treatment	N Rate	Bushels/A		
All Preplant	0	54	64	57
	40	49	71	67
	100	50	82	65
	160	48	89	82
1/4P-1/2J-1/4B	40	55	74	75
	100	54	87	79
	160	51	89	71
1/3P-2/3J	40	52	78	71
	100	80	87	73
	160	47	92	75

* N rates were 0, 40, 80 and 120 lb N/acre.

The 2008 data showed a slight N response at Alliance, Imperial and the Scottsbluff 12 inch irrigation level (Table 4). Yield levels were somewhat low at Alliance and Imperial. The Imperial site did not have P applied which limited yield and response when combined with the late planting date. The Sidney site produced good yields. Scottsbluff yields under full irrigation were excellent, although because of high residual nitrate (187# Table 2) there was no N response.

Table 4. 2008 irrigated white wheat grain yields.

		Alliance	Imperial	PREC-4"	PREC-8"	PREC-12"	Sidney
Variety		Antelope		Antelope	Antelope	Antelope	Antelope
N Rate and Timing		----------Bushels/acre ----------					
0	Preplant*	78	59	70	88	96	82
30	Preplant	--	--	71	--	--	--
60	Preplant	88	68	71	87	108	75
100	Preplant	85	73	69	88	107	79
140	Preplant	72	73	--	88	104	71
30	1/4p-1/2j-1/4b	--	--	71	--	--	--
60	1/4p-1/2j-1/4b	82	76	70	85	108	79
100	1/4p-1/2j-1/4b	77	74	76	88	108	78
140	1/4p-1/2j-1/4b	79	77	--	90	111	80
30	1/3p-2/3b	--	--	72	--	--	--
60	1/3p-2/3b	76	76	71	85	102	81
100	1/3p-2/3b	78	72	74	86	106	78
140	1/3p-2/3b	77	67	--	86	108	75

In 2009 the drought was broken, but the high spring moisture caused some disease problems which were not detected early enough for spraying fungicide (Table 5). The Alliance plot was lost to hail in early June. Yields at Scottsbluff were low due to disease and at Sidney hail contributed to no N response. There was a significant response to N at North Platte with maximum response near 70# N per acre.

Table 5. 2009 irrigated white wheat grain yields.

		North Platte	PREC-8"	PREC-12"	Sidney
Variety		Antelope	Antelope	Antelope	Antelope
N Rate and Timing		----------Bushels/acre ----------			
0	Preplant*	64	69	69	59
60	Preplant	79(40*)	69	67	56
100	Preplant	78(80)	77	70	60
140	Preplant	81(120)	69	70	61
60	1/4p-1/2j-1/4b	76(40)	76	73	62
100	1/4p-1/2j-1/4b	83(80)	72	67	60
140	1/4p-1/2j-1/4b	78(120)	73	73	59
60	1/3p-2/3b	73(40)	72	73	59
100	1/3p-2/3b	80(80)	69	72	58
140	1/3p-2/3b	81(120)	73	74	59

* N rates at North Platte were changed to obtain a better response.

In 2010 the early spring was cool and wet. The Alliance, Sidney and North Platte plots showed good early season N response with limited visual response at Scottsbluff. There was a significant response to N at Alliance and Sidney and response at the first N rate at Scottsbluff (Table 6). The North Platte site was not harvested due to rain which delayed harvest and caused weed growth that did not allow combining. Yield levels were good at Scottsbluff and Sidney considering the year but did not approach the 90 to 100 bushel yield goal expected. A late spring freeze and limited water reduced yield potential at Alliance but not the N response. There generally was no difference between N timings, but at report writing, the complete statistical analysis has not been completed. We also are waiting for lab results on protein. There was still a trend of lower yields from the highest preplant N rate at several locations.

Table 6. 2010 irrigated white wheat grain yields.

		Alliance	PREC	Sidney
Variety		Antelope	Antelope	Antelope
N Rate and Timing		----------Bushels/acre ----------		
0	Preplant	39	66	38
60	Preplant	56	73	65
100	Preplant	48	67	73
140	Preplant	52	68	76
60	1/4p-1/2j-1/4b	55	77	56
100	1/4p-1/2j-1/4b	53	85	70
140	1/4p-1/2j-1/4b	54	80	69
60	1/3p-2/3b	58	71	64
100	1/3p-2/3b	62	79	71
140	1/3p-2/3b	56	78	71

The significant information from the five year's of research is the importance of measuring residual N before planting. Yield levels were high at some locations, but usually a total of 180 to 200 pounds N (fertilizer N plus residual soil nitrate-N in 4 feet) maximized yields. Where there was an N response, N required was usually less than 80# N/acre. Our protein levels have been consistently high (data not shown). Further data analysis will be done to include the 2010 results especially for protein since we had good N response in 2010.

Too much N can cause problems in irrigated wheat. When all of the N was applied preplant, yields tended to be reduced at the higher N rates, especially the 140 lb rate. As N rates increased to the 140# level, regardless of application method, yields often decreased compared to the 100# N rate. This again supports the idea that testing for residual nitrate is essential in irrigated wheat production.

This work will be continued at six locations planted for 2011 (3 in the panhandle and 3 in west central) with a simpler design of 1/3 preplant N and 2/3 N applied before jointing. N rates have also been lowered to produce more defined N response relationships with N rates of 0, 30, 60, 90, 120 and 150 lbs per acre.

Acknowledgements

We sincerely appreciate the support the NE Wheat Board for this research. The data will help us develop a new N recommendation algorithm for irrigated wheat in western NE.

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