Improving N Fertilizer Management for High Quality, High Prices and High Costs

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Background

The past couple of years have seen major change in wheat prices and production costs. Wheat prices have doubled compared to two years ago (Fig 1).

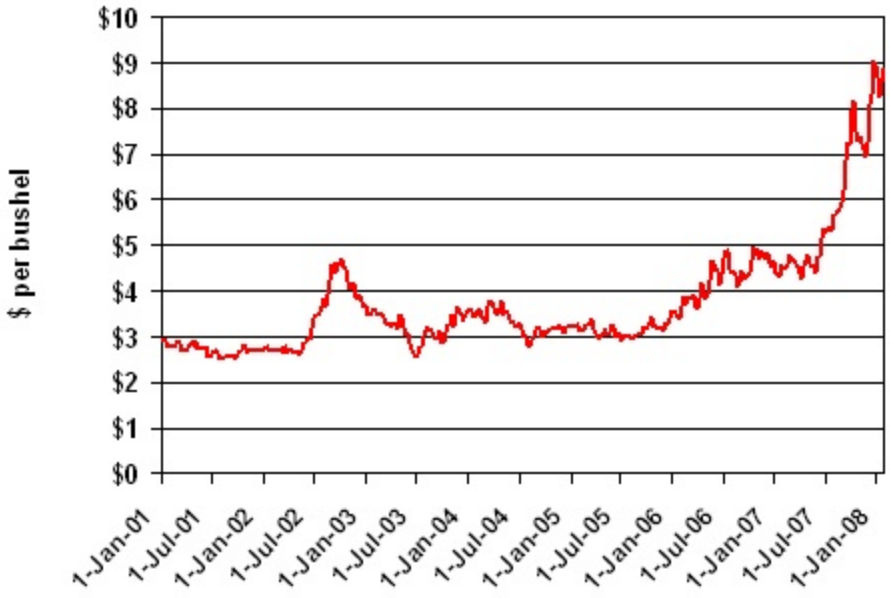

Figure 1. Winter wheat prices for western Nebraska 2001 to 2008.

Nitrogen fertilizer prices have also more than doubled in the last two years (Fig 2).

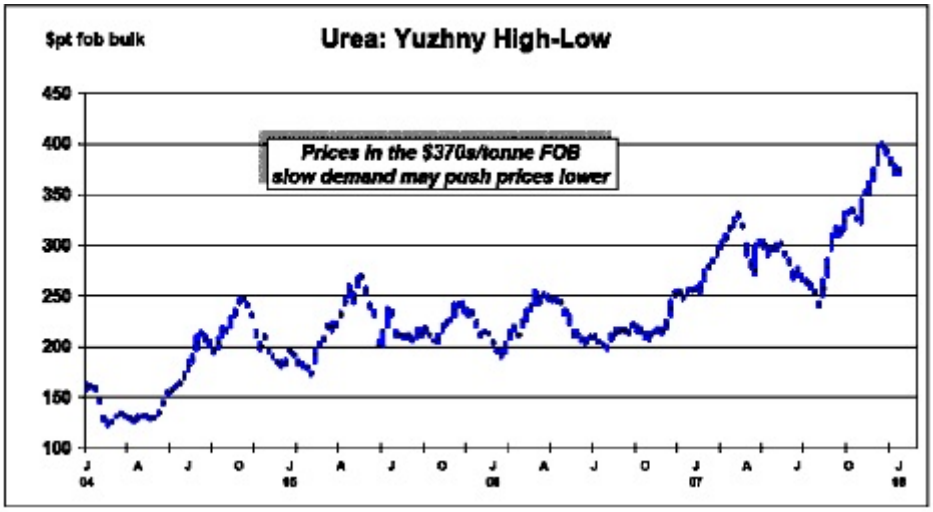

Figure 2. Urea price at Yuzhny, Ukraine 2004 to 2008 (Source: The Market).

Natural gas accounts for 80% to 90% of the cost of producing anhydrous ammonia, the base material for producing all other nitrogen fertilizers. After Hurricane Katrina in 2005, natural gas prices spiked near $15 per million BTU (MMBTU) but have returned to pre-Katrina levels around $7/MMBTU but rise with winter demand, according to the U.S. Department of Energy (http://tonto.eia.doe.gov/oog/info/ngw/ngupdate.asp).

Increases in fertilizer prices often are blamed on increasing natural gas prices, but that doesn't represent the whole story. World prices for natural gas are much lower and range from less than $1/MMBTU in parts of the Middle East to only $2-3/MMBTU in Russia.

Major reasons for increasing N costs include the closure of 25 ammonia plants in the USA since 1999 (http://www.tfi.org/publications/pricespaper.pdf), a 14% increase in world-wide demand for fertilizer mainly in China, India and Brazil (2001 to 2006), the failure of the US to build major ports and unloading facilities for liquified natural gas, a weak US dollar and high domestic demand driven primarily by ethanol mandates.

Nitrogen and phosphorus are the two primary nutrients required for profitable fertilizer management in dryland or irrigated winter wheat regardless of the rotation, moisture regime or prices. The probability of a yield increase from most other nutrients is low, although popular press articles might suggest the need for potassium (K), sulfur (S), zinc (Zn), or even chloride (Cl).

Soil testing is still the best method for determining the soil's fertility status and the need for additional fertilizer nutrients. Most current soil tests have been developed from hundreds of locations across Nebraska over many years and reflect the best "probabilities" for yield increases at different soil test levels. They are not perfect, however. Fertilizer management means managing four factors: fertilizer rate, method of placement, fertilizer source, and timing of application. Adequate soil fertility--not too high or too low--should be the goal of producers.

Nitrogen Management

Dryland Nitrogen Rates

Fertilizer N recommendations (NebGuide G02-1460) provides optimum N rates (lbs N/acre) for winter wheat (with a maximum rate of 100 lbs N/acre for dryland and 150 lbs N/acre for irrigated) calculated from the following equation:

$$((\text{N PRICE} / \text{WHEAT PRICE}) + 0.014558 * NO_3\text{-N} - 0.235) / -0.00138$$

Where,

- **N PRICE** is the price of nitrogen fertilizer in dollars per pound
- **WHEAT PRICE** is the price of wheat in dollars per bushel
- **NO_3-N** is the average ppm nitrate-N in the top three feet of soil.

An example is shown in Table 1 for two different N fertilizer costs and two different wheat prices. Both wheat price and fertilizer prices are much higher than they have been the past several years and this provides an incentive to take a serious look at N management this spring. Fertilizer prices have

remained strong through the winter coming into spring due to higher expected demand for more corn acreage. Currently there are projections that N will cost from $0.42 to $0.45 per pound of N for ammonia to $0.57 to $0.60 per pound of N for urea and N solutions. Spring application usually means paying the higher N price for liquid or dry.

Table 1. N fertilizer recommendations for winter wheat at current wheat and fertilizer prices.

Residual Nitrate	Wheat price per bushel			
Average ppm nitrate-N in a 3 foot depth	-----$7.00-----		-----$8.00-----	
	Nitrogen price per pound			
	$0.45	$0.60	$0.45	$0.60
	Nitrogen Rate - lbs per acre			
2	100	90	110	95
4	80	65	90	75
6	60	45	65	55
8	40	25	45	30
10	20	0	25	10

The above recommendations are assumed adequate for yields of 70 bu/a or less. UNL soil fertility staff are developing a web-based Excel calculator for N recommendations. A test version is at http://soilfertility.unl.edu. The NebGuide can also be used to calculate N recommendations.

Irrigated Wheat

For irrigated wheat, current guidelines suggest adding an additional 20 pounds of N to the recommendations above. A better approximation may be to add 1.5 pounds of N per bushel above the 70 bu/a yield level if you have consistently produced over 85 bu/a. Remember, simply adding more N will not 'enhance' yield potential. Many other production factors (seeding rate, variety, planting date, row spacing, irrigation timing, weed, disease and insect management) are controlling factors for consistently high yields.

What's the best way to manage the higher N applications required for irrigated wheat? Are split N applications preferable to applying all of the N preplant? A current research project in western NE (panhandle and southwest NE funded by the Nebraska Wheat Board) is looking at N rate and timing on irrigated white wheat. We expect similar N responses on irrigated hard red winter wheat. State average yields of irrigated wheat during the last decade have ranged between 55 to 70 bu/acre, however, yields of 90 to 110+ bu/acre are possible in the high plains under irrigation (NE irrigated wheat trials 2005-07 http://varietytest.unl.edu/winterwheat.html).

There is limited information about N management for irrigated wheat in Nebraska (red or white). To enhance yields and manage protein, more detailed information on N rates and timing was required for irrigated wheat and thanks to the Wheat Board that research is being done.

The objectives of the project are: (1) to 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 and (2) to determine N rate and timing effects on selected crop parameters (test weight, harvest index, moisture, baking quality).

The N rates are 0, 60, 100 and 140 lbs of N per acre. The 3 timing regimes are: (1) all preplant; (2) ¼ preplant, ½ at jointing, then ¼ at boot; and (3) ⅓ preplant and ⅔ at jointing. The 2006 plots were at the High Plains Ag Lab at Sidney, at Scottsbluff (PHREC) and near Alliance. The Scottsbluff site included 3 irrigation levels (low (4"), limited (8") and full (12"). Soil test information is shown in Table 2. Antelope white winter wheat was planted at all 2006 locations except Alliance where Lakin was included. Planting dates were September 23, 2005 for Alliance and Sidney and September 26, 2005 at Scottsbluff. All these dates are about 7 to 10 days 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: WCREC at North Platte and two sites between Imperial and Brandon, NE. Planting dates were October 3, 2006 for Alliance, September 27, 2007 for Sidney and September 14, 2006 at Scottsbluff with variety Antelope. For West Central, North Platte was planted October 16, 2006, Hajek site September 29, 2006 and Krajewski on October 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 in western NE.

Table 2. Soil test information for 2006 and 2007 sites.

Location	pH	OM	Olsen P	ppm NO_3-N			# NO_3-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

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

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.

The 2006 data showed a slight N response at Alliance and Scottsbluff 12 inch irrigation level (Table 3). Yield levels were very good at Alliance and Scottsbluff but were lower than expected at Sidney, due to the site, later planting date, poor emergence and stand.

Table 3. 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	¼p-½j-¼b	--	--	83	--	--	--
60	¼ p-½j-¼b	82	93	85	94	99	66
100	¼ p-½j-¼b	82	89	85	83	100	67
140	¼ p-½j-¼b	78	90	--	77	98	65
30	⅓p-⅔b	--	--	84	--	--	--
60	⅓p-⅔b	81	92	85	90	99	68
100	⅓p-⅔b	83	80	87	90	96	66
140	⅓p-⅔b	69	85	--	95	95	67

*Preplant = all N applied broadcast preplant; ¼p-½j-¼b = N application with one-fourth preplant, one half at jointing and the remaining one-fourth at boot stage; ⅓p - ⅔b = one-third preplant and two-thirds at jointing.

The 2007 data showed a slight N response at Alliance and Scottsbluff 12 inch irrigation level (Table 4). 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.

The significant information from two year's of research is the importance of measuring residual N. Yield levels were high at some locations, but usually a total of fertilizer N plus residual soil nitrate-N in 4 feet of 200 pounds N maximized yields. Further data analysis will be done but was not completed in time for the proceedings.

Too much N can cause problems in wheat. Note that when all the N was applied preplant, yields tended to be reduced at the higher N rates. As N rates increased, regardless of application method, yields often decreased. This again supports the idea that testing for residual nitrate is as important in irrigated wheat production as dryland. This work is continuing as five locations are planted for 2008 (4 in the panhandle and 1 in west central).

Table 4. 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
¼P-½J-¼B	30	54	----	----	----	63
	60	62	82	93	106	64
	100	59	78	99	113	63
	140	----	71	99	115	
⅓P-⅔J	30	57	----	----	----	----
	60	59	79	96	109	62
	100	53	77	98	109	62
	140	----	77	96	150	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
¼P-½J-¼B	40	55	74	75
	100	54	87	79
	160	51	89	71
⅓P-⅔J	40	52	78	71
	100	80	87	73
	160	47	92	75

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

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