

# Wheat and Barley Response to Nitrogen Fertilization at Safford Agricultural Center, 2000

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## Abstract

*Yields of both wheat and barley were increased with the addition of nitrogen and the largest gain was seen when it was applied at the initiation of growth or at boot stage. Effects of applied nitrogen were somewhat masked by the addition of nitrogen through the use of well water. Nitrogen level in the well water added 21 pounds of nitrogen per acre foot of irrigation, adding 48 pounds of nitrogen throughout the growing season. With the low value of grain and the given cost of nitrogen fertilizer, added nitrogen did not increase profitability for the producer.*

## Introduction

Nitrogen and water are the most influential factors affecting small grains being grown in the Safford valley. This study was designed to look at nitrogen applications at three key times during the growing season, namely; at planting, initiation of growth and boot stage. Varying amounts of nitrogen were applied in the form of Urea at the specified times and watered into the root zone. It was anticipated that nitrogen applied early would stimulate growth and that nitrogen applied at the boot stage would increase protein levels of the grain. The economics of nitrogen application were also evaluated.

## Materials and Methods

This nitrogen study on hard red wheat and barley was planted on the Safford Agricultural Center in December of 1999. Seed was planted with an International 12 foot grain drill with a fertilizer attachment over four 3-foot beds. Fertilizer was applied using an International 200 with hydraulically driven Gandy boxes delivering the determined amount of fertilizer into the furrows of the four rows being treated. The crop history follows:

### *Crop History:*

Elevation: 2954 feet above sea level

Soil type: Pima clay loam variant

Barley planting date: 20 December 1999

Seeding rate: 150 pounds per acre

Wheat planting date: 17 December 1999

Seeding rate: 180 pounds per acre

Herbicide: 2,4-D on 4-3-00 to control broad-leafed weeds

Fertilizer: 200 pounds per acre 16-20-0 at planting, nitrogen applied as specified by experimental plans

Insecticides: None

Irrigation: Furrow, watered up plus 9 irrigations for a total of ca. 35 acre inches ( 48 lbs/ac N in well water)

Rainfall during the growing season: 0.36 inches

Plot size: 12 feet by 45 feet

Replicates: Four

Harvest dates: Barley: 8 June, Wheat: 15 June. Heat units (40 to 81 °F) from planting to maturity (6-6) = 3260

Plots were harvested with a Gleaner Combine with a 13 foot header. Individual plots were weighed using

electronic weigh scales and samples were taken to determine moisture, bushel weight and percent protein.

Soil samples were taken at planting time and submitted for chemical analysis. The results of the soil tests are found in Table 2.

Nitrogen treatments applied:

Trt #	Nitrogen application dates (lbs N per acre)				Cost of Nitrogen Fertilizer
	At planting	9 February 2000	30 March 2000	Total	
1	0	0	0	0	\$0.00/acre
2	46	0	0	46	\$12.30/acre
3	92	0	0	92	\$24.60/acre
4	0	92	92	184	\$49.20/acre
5	46	92	92	230	\$61.50/acre
6	92	92	92	276	\$73.80/acre
7	92	92	46	230	\$61.50/acre

Doerge, et.al. (1) indicate that 150 to 230 pounds of nitrogen are usually needed for optimal production. The range of nitrogen applied in this study was chosen to go from zero to amounts in excess of these values. Table one shows the amounts of nitrogen that should be added preplant at given N-soil test values. The nitrogen levels in the soil called for 0 to 50 pounds of N preplant, so values of 0, 46 and 92 were chosen for the study. Applications for onset of growth and at boot stage were chosen as multiples of 46. What was not foreseen when planning the study was drought conditions that necessitated the use of the well for 7 of the 9 irrigations during the growing season.

### Results and Discussion

Table 3a displays yields and the other variables measured on the wheat study. The first three treatments compare different rates applied at planting with no additional fertilizer being applied during the season. No increases were seen over the check plot which had no nitrogen fertilizer applied. The next three treatments are the same as the first three for preplant fertilizer applications, but have 92 pounds of N sidedressed at onset of growth and boot stages. The additional 184 pounds of N only increased yields by a couple of hundred pounds! The last treatment decreased the boot stage application from 92 to 46 pounds, the increase shown in yield is not statistically significant. The effects that were anticipated were not seen, probably because of the residual N in the soil and the nitrogen applied in the irrigation water. Looking closely at the N values shown in the chemical analyses reported in Table 2 - one sees between 7 and 8 ppm N in the soil as well as in the irrigation water from the well. This translates into 28 and 32 pounds of N available in the soil plus 21.2 pounds of N per acre foot of irrigation water. For this season, the combined soil reserve and water provided approximately 80 pounds of N for the crop. Doerge, et.al. indicated a harvest of 6700 pounds of durum wheat would take 230 pound of N from the soil. Our average yield was 5133 pounds, so on a proportional basis, we would have needed 176 pounds of N for our wheat crop. With 80 pounds of N being provided by the soil and water and 32 pounds being applied as starter fertilizer, only 64 pounds were needed to finish out the optimal crop's nitrogen needs. This explains why the anticipated effects were not seen, but doesn't completely explain why the check plot yields were as high as it were.

One can peruse the other data in Table 3a, but differences between values in the variables seem small and generally not significant.

Table 3b looks at the value of the crop by treatment compared with the cost of the fertilizer treatments. One can easily see that the most economical treatment had no fertilizer applied. With the low value of grain (around \$0.05 per pound), the increases in yield caused by the fertilizer applications were not sufficient to pay the cost of the

fertilizer.

Tables 4a and 4b contain data from the nitrogen study on barley. The information learned is basically the same as in the case of wheat. Yields were slightly increased by sidedressing nitrogen later in the season, but increases were not sufficient to pay for the fertilizer.

The authors do not suggest that all small grain producers in this valley cease the practice of applying fertilizer to their crops, because all soils may not have the residual found in the plots in this study and all wells may not contain the nitrogen content measured here. But, evidence is shown that with the low values of grain and with the cost of fertilizer increasing, traditional amounts of fertilization may not be economically justifiable. Grain producers are encouraged to check soil and well water samples for nitrogen content and put check strips in their fields to determine their maximum economic yields.

### References

1. Doerge, T.A., R.L. Roth and B.R. Gardner. 1991. Nitrogen fertilizer management in Arizona. College of Agriculture Report #191025, The University of Arizona, Tucson, AZ. May 1991.

**Table 1. Preplant nitrogen fertilizer recommendations for small grains grown in Arizona based on nitrate-N test values from the soil.**

Pre-plant NO <sub>3</sub> -N Soil test Value (ppm)	Recommended N rate (lbs/ac)
0 to 5	50 to 75 lbs/ac
5 to 10	0 to 50 lbs/ac
>10	0 lbs/ac

**Table 2. Soil analysis reports for samples submitted from test plots on the Safford Agricultural Center.**

Field/Date	pH	Calcium ppm	Magnesium ppm	Sodium ppm	Potassium ppm	Salinity EC*K ds/m	Nitrate-N ppm	Bicarb-sol Phos ppm	Exc.Na Percent	Free Lime
D1Wht 12-99	8.6	5700 VH	470 VH	1000 VH	580 VH	2.2 M	7.4 L	1.9 VL	11.4	H
D2Bar 12-99	8.5	5600 VH	450 VH	960 VH	590 VH	2.4 M	8.2 L	2.0 VL	11.1	H
Well 5/00	8.3	54.0	17.0	470.0	4.3	2.4	7.8	--	82.9	--

**Table 3a. Yield and other agronomic variables in nitrogen study on wheat at the Safford Agricultural Center, 2000.**

Nitrogen Treatment	Yield per acre @10%M	Bushel Weight	% Moisture	1000 Kernel Weight	Plant Height	% Protein	% Stand Count
0+0+0	4939.9 ab <sup>1</sup>	63.5 a	8.43 a	38	25.6 a	14.8	95.0 a
46+0+0	4394.4 b	61.8 d	7.95 a	41	25.8 a	14.5	96.3 a
92+0+0	4935.4 ab	63.1 ab	8.28 a	40	26.5 a	14.7	97.5 a
0+92+92	5169.7 ab	62.5 bcd	8.55 a	41	25.9 a	14.4	98.3 a
46+92+92	5484.3 ab	63.3 ab	8.28 a	42	26.1 a	14.5	98.3 a
92+92+92	5192.5 ab	62.8 abc	8.58 a	42	26.8 a	14.6	96.5 a
92+92+46	6012.6 a	62.3 cd	8.50 a	39	26.6 a	14.3	97.5 a
Average	5133	62.8	8.35	40.7	26.1	14.6	97.1
LSD(05)	1094.9	0.86	0.71	--	1.24	--	5.7
CV(%)	14.5	0.94	5.79	--	3.22	--	3.9

1. Values followed by the same letter, within columns, are not significantly different at the 95% level of confidence using Duncan's Multiple Range test.

**Table 3b. Yield and economic summaries for nitrogen study on wheat at the Safford Agricultural Center, 2000.**

Nitrogen Treatment	Yield per acre @10%M	Grain Value@ 5c/lb	Cost of Fertilizer per acre	Value less Fertilizer cost	Value less checks		
					0+0+0	46+0+0	92+0+0
0+0+0	4939.9	\$247.00	\$0.00	\$247.00	\$0.00	--	--
46+0+0	4394.4	\$219.72	\$12.30	\$207.42	(\$39.58)	--	--
92+0+0	4935.4	\$246.77	\$24.60	\$222.17	(\$24.83)	--	--
0+92+92	5169.7	\$258.49	\$49.20	\$209.29	(\$37.71)	--	--
46+92+92	5484.3	\$274.22	\$61.50	\$212.72	(\$34.28)	\$5.30	--
92+92+92	5192.5	\$259.63	\$73.80	\$185.83	(\$61.17)	--	(\$23.46)
92+92+46	6012.6	\$300.63	\$61.50	\$239.13	(\$7.87)	--	\$29.85

**Table 4a. Yield and other economic and agronomic variables in nitrogen study on barley at the Safford Agricultural Center, 2000**

Nitrogen Treatment	Yield per acre @ 10%M	Bushel Weight	% Moisture	1000 Kernel Weight	Plant Height
0+0+0	5790.2 ab <sup>1</sup>	51.3 a	10.6 ab	40	25.0 a
46+0+0	5981.0 ab	51.3 a	10.4 ab	28	24.8 a
92+0+0	5657.0 b	51.7 a	10.9 a	41	24.2 a
0+92+92	6052.4 ab	52.0 a	10.3 ab	37	24.6 a
46+92+92	6261.1 a	52.5 a	10.5 ab	39	23.5 a
92+92+92	6185.0 ab	51.8 a	10.0 b	38	23.5 a
92+92+46	5984.5 ab	51.8 a	10.5 ab	38	25.1 a
Average	5946	51.7	10.5	37.2	24.4
LSD(05)	654.6	1.70	0.83	--	2.36
CV(%)	7.48	2.2	5.42	--	6.59

1. Values within columns followed by the same letter are not significantly different at the 95% level of confidence using Duncan's Multiple Range Test.

**Table 4b. Yield and economic summaries for nitrogen study on barley at the Safford Agricultural Center, 2000.**

Nitrogen Treatment	Yield per acre @ 10%M	Grain Value@ 5c/lb	Cost of Fertilizer per acre	Value less Fertilizer cost	Value less checks		
					0+0+0	46+0+0	92+0+0
0+0+0	5790.2	\$299.05	\$0.00	\$299.05	\$0.00	--	--
46+0+0	5981.0	\$282.85	\$12.30	\$270.55	(\$28.50)	--	--
92+0+0	5657.0	\$282.85	\$24.60	\$258.25	(\$40.80)	--	--
0+92+92	6052.4	\$313.06	\$49.20	\$263.86	(\$35.20)	--	--
46+92+92	6261.1	\$299.23	\$61.50	\$237.73	(\$61.33)	(\$32.83)	--
92+92+92	6185.0	\$309.25	\$73.80	\$235.45	(\$63.60)	--	(\$42.57)
92+92+46	5984.5	\$299.23	\$61.50	\$237.73	(\$61.33)	--	(\$40.30)