Wheat and Barley Response to Nitrogen Fertilization at Safford Agricultural Center, 2001-02

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Abstract

This study is a follow-up on a study initiated three years ago with an emphasis on the timing of application of nitrogen (N) fertilizer. The times targeted in this study were: at planting, at initiation of growth and at boot stage. A nitrogen starter fertilizer at planting increased yields over 100 pounds of grain per acre for both wheat and barley compared with plots which did not receive the added nitrogen at planting. No difference was seen between applying 46 or 92 pounds of N per acre as a starter fertilizer. Amount of N added at boot stage seemed to increase barley yields slightly but had no effect on wheat yield nor protein content. An economic analysis is included to show the profitability of nitrogen applications.

Introduction

Nitrogen and water are the most influential factors affecting small grains being grown in the Safford valley. This study was designed as a followup to our study done in the 1999-2000 grain season. 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 two-year nitrogen study on hard red wheat and barley was planted on the Safford Agricultural Center in December of 2000 and again in 2001. 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 histories are as follows:

Crop History (2001):

Elevation: 2954 feet above sea level
Soil type: Pima clay loam variant
Planting date: 20 December 2000 Seeding rate: 150 pounds per acre
Herbicide: None
Fertilizer: 200 pounds per acre 16-20-0 at planting, nitrogen applied as specified by experimental plans
Insecticides: None
Irrigation: Furrow, watered up plus 7 irrigations for a total of ca. 35 acre inches (ca. 48 lbs/ac N in well water)
Rainfall during the growing season: 2.99 inches
Plot size: 12 feet by 45 feet
Replicates: Four
Harvest dates: Barley: 20 June, Wheat: 21 June. Heat units (40 to 81EF) from planting to maturity (6-6) = 3276

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Crop History (2002):

Elevation: 2954 feet above sea level
Soil type: Pima clay loam variant
Planting date: 18 December 2001 Seeding rate: 150 pounds per acre
Herbicide: 2,4-D applied on 8 April 2002 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. 40 acre inches (ca. 54 lbs/ac N in well water)
Rainfall during the growing season: 3.14 inches
Plot size: 12 feet by 45 feet
Replicates: Four
Harvest dates: Barley: 13 June, Wheat: 15 July. Heat units (40 to 81EF) from planting to maturity (6-6) = 3165

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.

Nitrogen treatments applied:

	Nitrogen application dates (lbs N per acre)				
Trt #	At planting	Early February (init. of growth)	Late March (boot stage)	Total	Cost of Nitrogen Fertilizer
1	0	92	92	184	$49.20/acre
2	46	92	92	230	$61.50/acre
3	92	92	92	276	$73.80/acre
4	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 in Arizona. Our experience, at this location, indicates that 200 pounds of nitrogen is needed to produce our best yields. The range of nitrogen applied in this study was chosen to go from 184 to 276 pounds of nitrogen per acre.

Results and Discussion

Table 1 provides yields and other agronomic variables measured on the wheat study in 2001. Because of space limitations the last treatment was not applied in this portion of the study. An increase in yield was seen with the first incremental addition of nitrogen as a starter fertilizer, even though the increase was not statistically significant. Adding more nitrogen at planting did not increase yields. Information from the study in 2002 are displayed in Table 2. Yields were lower than in the previous year along with bushel weights and plant heights. Yields were not significantly different but the same trend as the previous year was observed. The higher rate of nitrogen applied at boot stage did not increase yields nor protein content.

Table 3 gives a yield summary and economic analysis of the treatments. Grain values were estimated at 4 cents per pound and nitrogen cost at 26.7 cents per pound. Yields were averaged over the two years of the study and gross grain values are calculated before and after fertilizer costs were taken out. With the low value of grain, the greatest economic yield is produced by the treatment with the least fertilizer costs.

The barley data for 2001 and 2002 are found in Tables 4 and 5. The treatment effects are essentially the same as seen with the wheat. One difference is a trend for the higher rate of nitrogen applied at boot stage to produce a slightly higher grain yield. The economic summary shown in Table 6 shows the same trends as with the wheat. The low value of grain does not justify high nitrogen inputs.

The authors do not suggest that all small grain producers in this valley drastically reduce the amount of nitrogen fertilizer applied to their crops, because all soils may not have the residual nitrogen 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.

2. Clark, L.J. and E.W. Carpenter. 2000. Wheat and Barley Response to Nitrogen Fertilization at Safford Agricultural Center, 2000. Forage and Grain, A College of Agriculture and Life Sciences Report. The University of Arizona, Tucson, AZ. Series P-124, pp. 96-100.

Table 1. Yield and other agronomic variables in nitrogen study on wheat at the Safford Agricultural Center, 2001.

Nitrogen Treatment	Yield per acre @10%M	Bushel Weight	% Moisture	Plant Height
0+92+92	4805.5 a[1]	63.0 a	6.8 a	24.6 a
46+92+92	4902.7 a	63.1 a	6.9 a	24.0 a
92+92+92	4901.7 a	63.0 a	6.9 a	24.8 a
92+92+46	--	--	--	–
Average	4870.0	63.0	6.86	24.5
LSD(05)	537.9	0.85	0.38	1.8
CV(%)	6.4	0.78	3.2	4.3

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 2. Yield and other agronomic variables in nitrogen study on wheat at the Safford Agricultural Center, 2002.

Nitrogen Treatment	Yield per acre @10%M	Bushel Weight	% Moisture	Plant Height	% Protein
0+92+92	2972.9 a[1]	60.25 a	10.02 a	21.12 a	16.39
46+92+92	3209.4 a	60.50 a	9.70 a	21.75 a	16.38
92+92+92	3115.6 a	60.50 a	10.25 a	21.00 a	16.37
92+92+46	3237.5 a	59.75 a	10.35 a	21.12 a	16.62
Average	3133.9	60.25	10.08	21.3	16.4
LSD(05)	772.8	1.07	0.72	1.31	--
CV(%)	11.9	1.11	4.50	3.84	--

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 3. Yield and economic summaries for nitrogen study on wheat at the Safford Agricultural Center, 2001/2002.

Nitrogen Treatment	2001 Yield per acre @10%M	2002 Yield per acre @10%M	Average Yield	Grain Value@ 4c/lb	Cost of Fertilizer per acre	Value less Fertilizer cost
0+92+92	4805.5	2972.9	3889.2	$155.57	$49.20	$106.37
46+92+92	4902.7	3209.4	4056.1	$162.24	$61.50	$100.74
92+92+92	4901.7	3115.6	4008.7	$160.35	$73.80	$86.55
92+92+46	--	3237.5	3237.5	$129.50	$61.50	$68.00

Table 4. Yield and other economic and agronomic variables in nitrogen study on barley at the Safford Agricultural Center, 2001

Nitrogen Treatment	Yield per acre @10%M	Bushel Weight	% Moisture	Plant Height
0+92+92	4489.5 a[1]	50.6 a	8.1 a	23.0 a
46+92+92	4580.0 a	51.0 a	7.9 a	22.1 a
92+92+92	4491.6 a	51.5 a	8.1 a	23.1 a
92+92+46	4472.1 a	51.4 a	8.0 a	21.9 a
Average	4508.3	51.1	8.0	22.5
LSD(05)	260.7	1.8	0.57	1.32
CV(%)	3.6	2.2	4.4	3.7

1. Values within columns followed by the same letter are not significantly different at the 95% level of confidence

Table 5. Yield and other economic and agronomic variables in nitrogen study on barley at the Safford Agricultural Center, 2002

Nitrogen Treatment	Yield per acre @10%M	Bushel Weight	% Moisture	Plant Height
0+92+92	3067.1 a[1]	48.00 ab	8.80 a	22.50 a
46+92+92	3149.7 a	46.75 b	8.25 a	21.62 ab
92+92+92	3186.8 a	49.25 a	9.28 a	21.12 b
92+92+46	3143.7 a	47.5 ab	9.25 a	21.38 ab
Average	3136.83	47.88	8.89	21.66
LSD(05)	272.47	2.21	1.18	1.22
CV(%)	5.43	2.89	8.33	3.53

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 6. Yield and economic summaries for nitrogen study on barley at the Safford Agricultural Center, 2001/2002.

Nitrogen Treatment	2001 Yield per acre @10%M	2002 Yield per acre @10%M	Average Yield	Grain Value@ 4c/lb	Cost of Fertilizer per acre	Value less Fertilizer cost
0+92+92	4489.5	3067.1	3778.3	$151.13	$49.20	$101.93
46+92+92	4580.0	3149.7	3864.9	$154.59	$61.50	$93.09
92+92+92	4491.6	3186.8	3839.2	$153.57	$73.80	$79.77
92+92+46	4472.1	3143.7	3807.9	$152.32	$61.50	$90.82