

## Winter Wheat Response to Nitrogen and Sulfur Fertilization

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### Introduction

In response to producer questions concerning use of sulfur (S) and nitrogen (N) fertilizers, a series of experiments were initiated to evaluate the response of small grains to S and N fertilization. This paper summarizes winter wheat responses to both S and N.

### Methods

Experiments were conducted in the Knees area of the Golden Triangle about 25 miles east of Brady, Montana. The soil series of the experimental area is a Scobey clay loam. Nitrogen fertilizer treatments (0, 30, 60, and 90 lb N/ac) were applied in combination with S fertilizer (0, 10, 20, and 30 lb S/ac). All fertilizer materials were applied while planting, and all plots received P and KCl fertilizers. Nitrogen as urea (46-0-0) and potash (30 lb KCl/ac as 0-0-60) fertilizers were broadcast, P (60 lb/ac of monoammonium phosphate, 11-52-0) was placed with the seed, and S as ATS (ammonium thiosulfate, 12-0-0-26) was dribbled on the soil surface two inches away from the seed row.

Plots were planted into chemical fallow using a six-row, double disk plot drill with 12 inch row spacing. Rampart was seeded in 2002 and 2003 and Genou in 2004 and 2005 (20 seeds/ft<sup>2</sup>). Plot size was 6 by 25 feet with four replicates. Nitrate N (extracted by KCl) and sulfate S (extracted by ammonium acetate) soil tests were performed (data not shown). Sulfate soil tests were considered very high. Nitrogen and S content of the grain was determined by combustion using the Leco method.

### Results

Grain yield and protein content data from the four years are shown in Table 1, while test weight and grain S content data are indicated in Table 2. In 2002, this site did not have a yield response to N or S fertilization likely due to drought conditions; average yield was 34 bu/ac.

However, both protein and test weight were significantly affected by N and S. Nitrogen and S increased both grain protein content and the S content of the grain, but, as expected, depressed test weights. Grain protein levels were high for winter wheat ranging from 13.6 to 17.7%; the highest level was achieved with the highest N and S fertilizer rates.

In 2003, the first documented winter wheat yield response to S in the Western Triangle area was measured. The N and S grain yield and protein responses were very dramatic and were classic examples of responses to two added nutrients. The S response was likely due to the previous year's dry conditions and the subsequent lack of sulfate release from gypsum, which is common in Western Triangle soils, and reduced mineralization of soil organic matter. Yields averaged 48 bu/ac and protein content averaged 14.8%.

In 2004 and 2005, grain yields averaged 57 and 71 bu/ac, respectively, while protein content averaged 11.7 and 16.3%. Grain yield, test weight, protein content, and grain S content responded to N, but the only S response was a test weight decrease in 2005.

In summary, winter wheat generally responded to N as expected: increased yield and protein content and depressed test weight with increasing N levels. Growers should still plan on applying about 2.5 lb of N (soil test nitrate N plus fertilizer N) per one bushel yield increase depending on protein requirements. Winter wheat had the following responses to S fertilization: a protein and S grain content increase and a test weight decrease in 2002; a yield, protein, and S grain content increase and a test weight decrease in 2003; no response in 2004, and test weight decrease in 2005. These responses were unpredictable since S soil tests were all very high.

# Fertilizer

## F a c t s

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Table 1. Effect of N and S on winter wheat yield and protein content.

Nitrogen Summary								
Rate	2002		2003		2004		2005	
N (lb/ac)	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
	(bu/ac)	(%)	(bu/ac)	(%)	(bu/ac)	(%)	(bu/ac)	(%)
0	33.3	15.2	46.2	14.1	56.3	11.3	66.0	15.3
30	33.7	15.4	47.3	14.4	59.3	11.1	70.8	15.0
60	34.0	16.3	49.5	15.1	58.3	11.4	75.2	17.4
90	32.9	16.9	50.0	15.4	54.1	13.0	71.5	17.7
LSD (0.05)*	NS	0.6	2.1	0.5	4.5	1.3	5	1.8
S (lb/ac)	Sulfur Summary							
0	34.5	14.7	42.9	14.1	57.6	11.8	71.0	15.5
10	34.3	15.6	48.4	14.6	55.4	11.7	71.4	16.3
20	32.7	16.5	50.6	14.8	57.8	11.3	69.7	16.6
30	32.5	17.0	51.0	15.7	57.1	12.0	71.1	16.9
LSD (0.05)*	NS	0.6	2.1	0.5	NS	NS	NS	NS

LSD (0.05)\* Least Significant Difference with 95% confidence.

Table 2. Effect of N and S on winter wheat test weight and S grain content.

Nitrogen Summary								
Rate	2002		2003		2004		2005	
N (lb/ac)	Test wt.	S content	Test wt.	S content	Test wt.	S content	Test wt.	S content
	(lb/bu)	(%)	(lb/bu)	(%)	(lb/bu)	(%)	(lb/bu)	(%)
0	55.0	0.188	58.6	0.171	61.5	0.149	62.2	0.201
30	54.9	0.190	58.4	0.177	61.6	0.148	62.2	0.198
60	54.9	0.198	58.1	0.181	61.3	0.152	61.5	0.221
90	54.6	0.204	58.0	0.188	60.1	0.168	60.7	0.221
LSD (0.05)*	0.7	0.007	NS	0.009	0.8	0.013	0.7	NS
S (lb/ac)	Sulfur Summary							
0	55.4	0.179	58.1	0.173	61.1	0.156	62.1	0.199
10	54.9	0.191	58.6	0.174	61.0	0.154	61.9	0.213
20	54.7	0.203	58.5	0.179	61.3	0.149	61.3	0.212
30	54.3	0.208	58.0	0.193	61.0	0.158	61.4	0.215
LSD (0.05)*	0.7	0.007	0.5	0.009	NS	NS	0.7	NS

LSD (0.05)\* Least Significant Difference with 95% confidence.

### Fertilizer Facts:

- Winter wheat may respond to S fertilization during periods of drought when mineralization, gypsum weathering and decomposition of organic matter are reduced, producing less available sulfate S.
- Winter wheat can respond to S in a manner similar to N: increased yield (in 1 of 4 years) and grain protein content, and decreased test weight.
- When S responses were measured, optimum response was obtained at about 10 to 15 lb S/ac.
- Sulfur responses were unrelated to S soil tests.

*Edited by Clain Jones, Extension Soil Fertility Specialist, and Evette Allison, Research Associate*