Sulfur Application Increased Wheat Grain Yield in a Fertilizer Rate Study at Carrington

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Objectives

- To assess spring wheat yield response to sulfur.
- To determine if yield response to S application translated to economic benefits.

Materials and Methods

Spring wheat variety Barlow was planted on May 9 with a 7-row Hege plot planter at 7-inch row spacing on 25 feet plots. A composite soil sample was taken in late fall 2013 and test results shown in Table 1. Plots were arranged in a randomized complete block design with four replicates. Sulfur treatments were applied at 0, 10, and 20 lbs S/ac as ammonium sulfate on June 11. Blanket urea was applied for a total soil available N of 150 lbs/ac. Following harvest on August 27, aboveground biomass (residue) was collected with a forage harvester; fresh weight was recorded before sub-sampling for subsequent dry matter determination and processing for S and N analysis. Grain yields, test weight, and kernel weight (KWT) were determined. Grain sub-samples were analyzed for protein content.

Table 1. Soil test analysis following Fall soil sampling of the dry land site at Carrington, ND.

NO_3-N	P-Olsen	K	S	Ca	Mg	Zn	CEC	OM	pH	EC
---------- lb/ac ----------				------ ppm -------			meq/100g	%		dS/M
32	50	216	80	2261	407	1.09	15.3	4	6.2	0.14

Results

Plants showed visual response to S application by producing darker green color of leaves. The F-statistic did not show significant yield response ($\alpha<0.1$, $p = 0.0531$). However, pairwise comparisons showed significant yield increases of 7 and 8 bushels at the 10 and 20 lb S rates, respectively, over the check. The 10 lb rate of S was adequate to support the plant growth requirement, yield and grain protein requirements (Table 2). Numerical increases in grain protein with S were not statistically different (Figure 1), meanwhile S significantly increased stubble (residue) S and N content as well as total residue S by weight. Failure to see significant differences of total N in residue was due to non-significant differences in the amount of residue produced, which is used to calculate total N accumulated in residue at harvest. Significant yield response to treatments was unexpected because the soil organic matter (SOM) content of 4 percent is generally expected to mineralize and supply the S needs of crops. Response was likely due to sulfur leaching during heavy snowmelt and slow S release from SOM during the cool spring and early summer season. An analysis to assess the net return to S treatments (Table 3), excluding other operational costs such as pesticide and herbicide application, harvest cost, wear and tear, etc. showed that S application at the 20 lb rate would have been more profitable with an increased return of $69 (difference between return from 20 lbs S and check), and $62 (difference between 10 lbs. S and check). The net benefits indicate the difference between applying and not applying S. These preliminary results showed that economic benefits of S application to wheat are possible even in soils with high SOM in North Dakota in growing seasons when nutrient leaching is high and mineralization from SOM is too slow to release S for plant uptake.

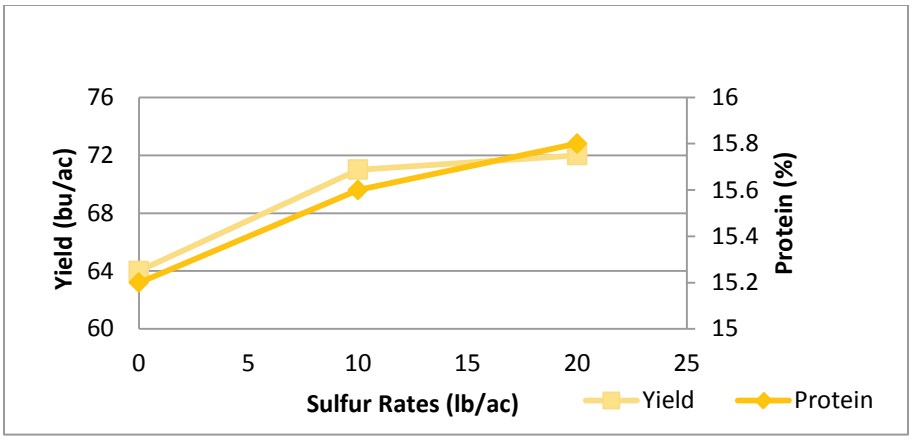

Figure 1. Wheat grain yield and protein response to sulfur.

Table 2. Wheat response to sulfur.

S Rate	Yield	Protein	TW	1000 KWT	Aboveground biomass	Flag Leaf Tissue S	Flag Leaf Tissue N	Tissue S	Tissue N	Total S in stubble (residue)	Total N in stubble (residue)
lb/ac	bu/ac	%	lb/bu	gram	ton/ac	---------- % ----------				----- lb/ac -----	
0	64b	15.17	61a	8.57	1.02	0.1925b	4.1975	0.063b	1.2b	2.15b	24
10	71a	15.62	60b	8.16	1.38	0.235a	4.4625	0.09a	1.22a	2.26a	34
20	72a	15.83	60b	8.17	1.31	0.245a	4.43	0.1a	1.19a	2.44a	31
Tukey[1], α = 0.1	6.65	0.86	0.83	0.57	0.53	0.0355	0.2774	3.72	3.98	3.72	12.81
P>F[2]	0.0531	0.2228	0.0525	0.1981	0.2797	0.0213	0.1012	0.0115	0.0182	0.0014	0.231
C.V.	5.41	3.11	0.77	3.85	24.6	8.89	3.57	11.71	3.34	8.36	24.28

[1] Probability of observing an F-statistic > observed; indicates significance of treatment differences at $P = 0.1$.

[2] Mean values followed by the same letter in each column are not significantly different from each other.

Table 3. Economic analysis of sulfur fertilization of spring wheat, 2014.

S rate	Cost of S	Cost of S+ application	Yield	Gross Income[1]	Protein	Protein Premium	Adjusted Gross Income	Change in Income due to S
	$/ac	$/ac	bu/ac	$/ac	%	$/bu	$/ac	$/ac
0	0	0	64.2	0.00	15.17	0.75	400.61	0.00
10	7	13.15	71.2	38.43	15.62	1.20	476.33	63.18
20	14	20.15	71.6	76.86	15.83	1.35	489.74	69.59

[1] Price per bushel at 14% protein set at $5.49.