Improving Wheat Performance with Manure on an Upland Field in Hurdsfield, ND

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Objectives

- To assess spring wheat yield response to nitrogen from manure.
- To assess the relative impact of sulfur, zinc, and phosphorus on wheat grain yield and protein.

Materials and Methods

The experiment was conducted on a producer's field (cooperator) where yields have generally been low on the eroded knoll with thin top soil and low fertility (N = 13.3, K = 422, S = 29.3, Zn = 0.7 lbs/ac, OM = 2.5%, and pH = 8.3). Manure and fertilizer treatments (Table 1) were applied to plots arranged in a randomized complete block design with three replicates. Composted cattle manure was applied and incorporated (one week later) in fall 2013, at N rates of 45, 90, and 135 lbs/ac, while the inorganic fertilizer N rates were 45, 90, and 135 lbs/ac with blanket S, P, and Zn applied at 9, 18, and 1 lb/ac, respectively (Table 1), and a check (0 lbs N) that received blanket S, P, and Zn. Three other treatments receiving blanket N (135 lbs) with and without S, P, or Zn were included but analyzed separately to assess the contribution of each nutrient on grain performance. Spring wheat (Glenn) was planted by the cooperator on May 30, at 7-inch row spacing on 25 by 40 foot plots one day after fertilizer application. Crops were harvested on September 9 and grain yields, test weight, kernel weight (KWT), and grain protein data were recorded.

Table 1. Influence of manure and urea fertilizer sources for spring wheat, Hurdsfield, ND.

N Source	Nitrogen (N) Rates	S	Zn	P	Yield	Protein	250 KWT	Test Weight
	-------------------- lb/ac			---------------------	bu/ac	%	gram	lb/bu
Check (F-check)	0	10	1	20	17.9c	10.87d	8.09b	63.5a
Manure	45	--	--	--	36.3abc	10.97d	8.33a	62.6a
	90	--	--	--	40.0ab	10.92d	8.23a	62.4a
	135	--	--	--	40.5a	11.79dc	7.27a	61.6a
Urea	45	10	1	20	19.5bc	13.12bc	7.06b	62.9ab
	90	10	1	20	24.4bc	14.56ab	6.78b	63.9b
	135	10	1	20	30.1bc	15.44a	6.75b	63.9b
	Tukey[1], α = 0.05				16.819	1.572	0.642	1.427
	P>F[2]				0.0029	<0.0001	<.0001	0.0003
	C.V.				16.68	4.39	3.00	0.79

[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.

Results and Conclusion

Response to fertilizer application was positive across fertilizer treatments. Significant differences ($P<0.05$) between grain yields were observed between manure and urea treatments, with manure treatment of 135 lbs N producing the highest mean yield of 41 bushels (Table 1). Significant differences in grain protein content were also observed, with the highest (15.44%) at 135 lbs N as urea. From figure 2, it can be seen the protein had a strong linear relationship with yield ($R^2 = 0.96$), while the relationship with manure treatment was weak ($R^2 = 0.40$). The lack of significant yield differences between 45 and 135 lbs N rates for manure suggest that optimum N rates would be 45 lbs since no significant additional benefits were recorded for protein either. Comparing between urea only treatments, application of 90 lbs urea might be considered optimal since the yields and protein at this level were comparable to yields at 135 lbs N. An economic analysis was performed considering fertilizer and application costs, manure transport costs (assuming 10 miles), application costs, and protein discounts at 14 percent standard rate. No operational costs were included in the analysis such as pesticide and herbicide application, harvest, etc. Urea applied at 135 lbs N produced the most economic return of $143.5/ac, followed by 90 ($98/ac), and 45 lbs N/ac (93$/ac). Manure at 45 lbs N gave a net profit of $96/ac, about $54 and $90 greater than manure N at 90 and 135 lbs N, respectively. Surprisingly, the net profit from the check plot was higher than manure applied at 90 and 135 lbs N. These results indicate that premiums and discounts for protein can significantly affect the overall profitability of manure use without supplemental N. In addition, manure applied without immediate incorporation may have led to significant N loss which affected the final grain yield and protein content. The linear relationships between yields and N rates suggest that 135 lbs added N was probably not enough to satisfy the protein and yield potential of the crop, especially if some of the N fertilizer was lost through leaching or surface losses following application. The yield advantages from manure may have come from improved soil condition and better availability of nutrients.

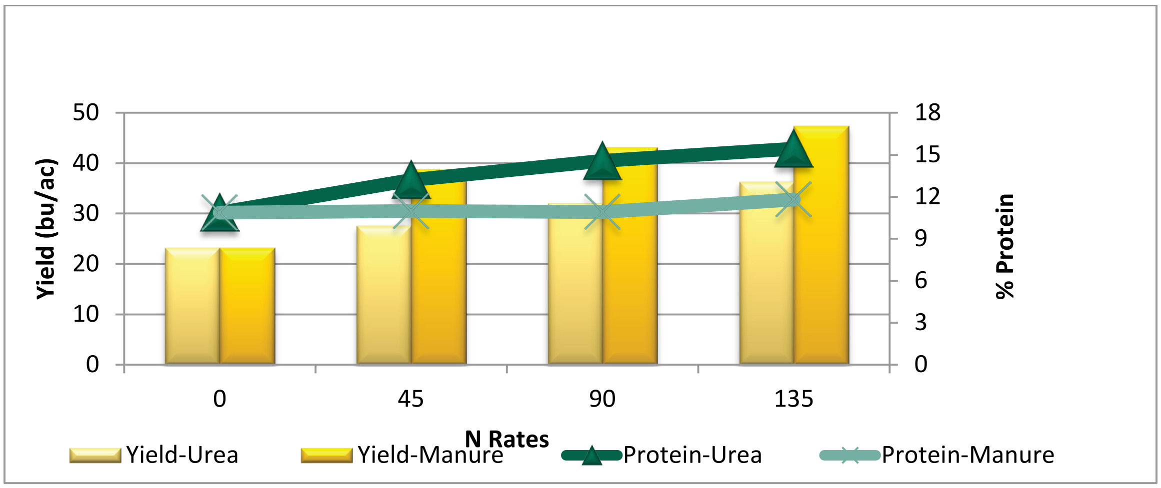

Figure 1. Wheat grain yield response to N from manure and urea, with and without added S, Zn, and P.

ANOVA F-test showed yield differences were not significant amongst treatments with 135 lbs N flat rate, where either S, Zn, and P was absent or where all were applied with urea. All urea treatments produced significantly higher protein than the manure treatments (*$P<0.05$*) from pairwise comparisons, while manure at 135 produced significantly higher test weight (TW) and kernel weight (KWT) than the urea treatments at the same N rate. Figure 2 shows protein and test weight have a strong inverse relationship, while kernel weight and test weight have a strong positive relationship. In conclusion, it may be necessary to compliment manure application with some synthetic N fertilizer in order to raise grain protein. The profitability of this practice would be highly dependent on what the protein premiums and discounts are when the grain is sold. Additional site years of data would be needed to draw any conclusion.

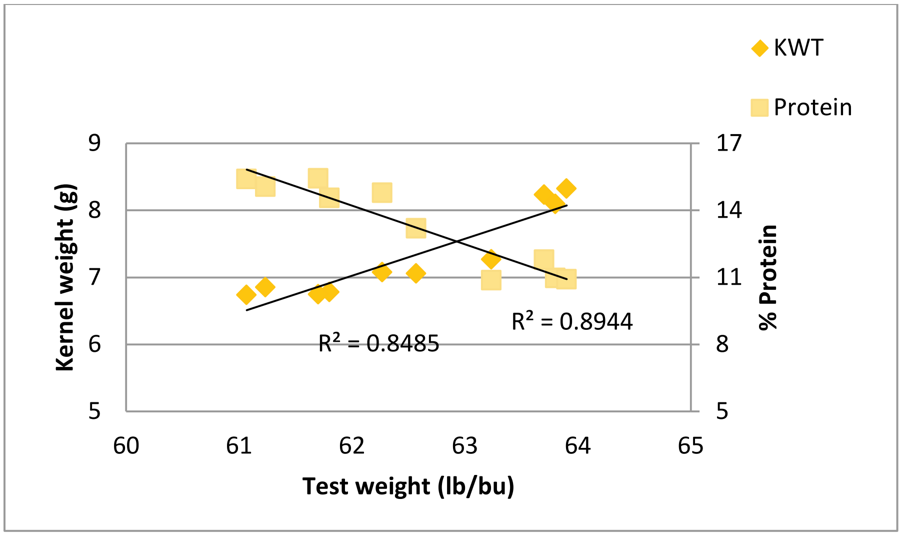

Figure 2. Relationship between protein and test weight and 250 kernel weight.