Feedlot Beef Manure as a Source of Nitrogen for Wheat and Nitrogen Strategies to Increase Wheat Protein Content

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Low soil nitrogen (N) availability is the main limiting factor for yield and kernel quality in hard red spring wheat (HRSW) production, and consequently N fertilization is one of the largest single expenses to grow HRSW. The high price of commercial fertilizers is causing producers to look for alternative and more affordable sources of N for wheat production. Manure is an alternative complete fertilizer, which can supply all the required nutrients at recommended levels for HRSW production. Previous research at the Carrington REC has shown that plots fertilized with manure show similar yields to plots fertilized with commercial fertilizers, but the protein content is in general lower on the manure plots, which can result in large discounts at the elevator.

The study objective was to assess the effects of beef feedlot manure application in combination with strategic commercial fertilizer applications to improve wheat protein content.

Materials and Methods

The field trial took place at the Carrington REC in 2015, in a 150 ft x 240 ft parcel. The area was divide in four blocks (replicates), which had three main plots (45 ft x 60 ft, N source/rate). The treatments applied to the main plots were based on the N recommendation for wheat (103 lbs. N/ac) and consisted of 1.0 and 1.5 times N recommendations as manure (1.0XManure and 1.5XManure, respectively), and 1.0 time the N recommendation as urea (Fertilizer). One-half of the main plots (45 ft x 30 ft) received additional N (Urea) applications at boot stage and the other half at anthesis. The subplots were then split in three sub subplots (15 ft x 30 ft), which received three small N rates (0, 15, and 30 lbs./ac) at boot stage and at anthesis. Manure was applied on April 28-29 and it was incorporated the following day, by one disk pass, along with the other N treatments. The rates of manure applied were 21.3 and 29.9 ton/ac for the 1.0XManure and 1.5XManure treatments, respectively. Those were very close to the target rates (19.8 and 29.7 ton/ac), which were calculated based on the results of a manure sample collected a week earlier at the CREC. The manure before was applied before the manure analysis was available due to a favorable weather forecast for wheat planting. As it turned out, based on the analysis values, the N-manure applied was on average over double the N rate first intended (1.0XManure target 103 lbs. N/ac, applied 221 lbs. N/ac; 1.5XManure target 154.5 lbs. N/ac, applied 311 lbs. N/ac). HRSW, cultivar Glenn, was drilled into the soil on April 30 (1.5 million PLS/ac). The in-season N applications were made on June 19 (boot stage) and June 28 (anthesis). Plant population was assessed in May 22 (stand count), and the wheat was harvested on August 11. The combine was equipped with a scale system, and a grain subsample was taken for lab determinations of moisture, test weight and protein content.

Results and Conclusions

There was no interaction between the main plot treatments and N-urea applications during two growth stages of the growing season. The lack of interaction might be due to the excessive amount of N applied on the manure treatments. The excessive amounts of N applied can limit the significance of the results when comparing manure and commercial fertilizer treatments, since the total amount of N applied was much larger on the manure treatments. That said, the rates of manure applied to the 1.0XMANURE (21.3 ton/ac) and 1.5XMANURE (29.9 ton/ac) treatments are not too far off the rates commonly applied for crop production in North Dakota. The HRSW yields were at least 8 bu/ac higher for the manure treatments when compared to commercial fertilizer, and there were no significant differences between the manure treatments

(Table 1). Even with the amounts of N-manure applied in excess, protein content for the commercial fertilizer treatment was higher than the manure treatments (Table 1). As the average protein content for all treatments was above 14 percent, the manure treatments would not be penalized due to lower protein content, but manure did not increase protein much when compared to check plots (average protein content 14.1%; data not shown). No differences were found for either test weight or 1000 kernel weight (Table 1).

Table 1. Response of spring wheat to manure and commercial fertilizer applications in Carrington, ND.

Recommended N Rate/Source	Yield	Protein	Test Weight	KWt
	bu/ac	%	lb/bu	gram
1.0XMANURE	73.2a	14.2b	63.4	31.9
1.5XMANURE	75.9a	14.3b	63.9	32.0
1.0XFERTILIZER	65.0b	14.8a	63.5	31.8
LSD (0.05)	3.34	0.34	NS	NS
C.V. (%)	7.9	2.4	2.5	3.6

[a,b] Values followed by different letters are significantly different at $P < 0.05$.

Small N application rates during the spring wheat growing season affected both protein content and test weight, but no effects were seen on yield or 1000 kernel weight (Table 2). Despite the differences amongst N rates regarding protein content, the protein content for the no N treatment was above 14 percent, meaning it would be unlikely for a producer to have a positive economic return from applying 30 lbs./ac of N to increase protein.

Table 2. Response of spring wheat to additional in season N fertilization. Carrington, ND.

N Rate	Yield	Protein	Test Weight	KWt
lbs./ac	bu/ac	%	lb/bu	gram
0	72.9	14.3b	64.2a	31.9
15	70.7	14.4b	63.7ab	32.0
30	70.5	14.6a	62.9b	31.6
LSD (0.05)	NS	0.20	0.94	NS
C.V. (%)	7.9	2.4	2.5	3.6

[a,b] Values followed by different letters are significantly different at $P < 0.05$.

In conclusion, the spring wheat yield responded positively to manure applications when compared to 103 lbs./ac of N as commercial fertilizer and to check plots (50.7 bu/ac, data not shown), but even applying manure N in amounts over double the N recommendations, there was not a big increase on wheat kernel protein content when compared to check plots average (14.1%, data not shown). There is a need for more studies to better understand the dynamics regarding N-manure and wheat protein content. There was no interaction between small

nitrogen applications during the growing season and manure treatments regarding wheat protein content, which could be due to the excessive manure N applied on the manure treatments.