Manure as a Source of N for Wheat and the Effect of Supplemental N on 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. Consequently, nitrogen fertilization is one of the largest single expenses to grow HRSW. The N fertilizer cost is causing some producers to look for alternative and more affordable sources of N for wheat production. Manure is an alternative fertilizer which can supply all the required nutrients at recommended levels for HRSW production. However, research done in North Dakota has shown that spring-applied solid manure results in slow mineralization and consequently delayed N release, which can lead to lower yields and/or lower protein content in the kernel. Average data (2009-2015) from a long-term cropping system study at the Carrington Research Extension Center (CREC), showed that composted beef feedlot manure produced similar or higher yields than the commercial N fertilizer (urea), and higher net income ($58.13/ac) when compared to urea treatments ($41.75/ac for 100 lbs N/ac). The net income for the composted manure treatment could be even higher if it was not for the steep discounts ($0.08/bu per each 1/5% of protein below 14%) resulting from lower protein content. Those discounts were on average (2009-2015) $29.40/ac and reached up to $54.17/ac in 2013. Based on those results, we initiated a study in 2016 to determine the effect of supplemental N rates on wheat protein when fresh feedlot manure is used as a source of N for wheat.

Materials and Methods

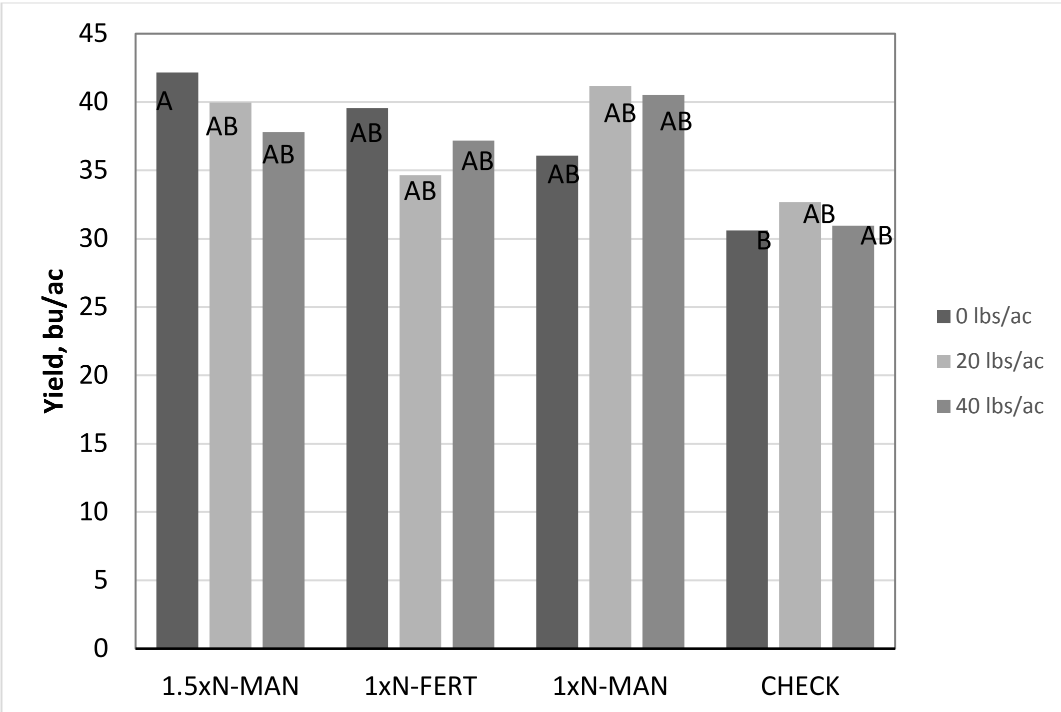
In the spring of 2016, we started a field trial to test the response of hard red spring wheat to fresh beef feedlot manure and commercial fertilizer. The following treatments were applied to the main plots (60 ft wide by 45 ft long): 1) 1.0 X N-recommendation as manure (1xN-MAN); 2) 1.5 X N-recommendation as manure (1.5xN-MAN); 3) 1.0 X N-recommendation as commercial fertilizer (1xN-FERT); and 4) CHECK. In addition to N, the fertilizer treatment received 25 lbs P_2O_5/ac (11-52-00). The main plots were then split into two subplots (30 ft wide by 45 ft long). One of the subplots received supplemental N at planting and the other one at boot stage. The subplots were then split into three sub-subplots (30 ft wide by 15 ft long), where we applied rates of N (0, 20, and 40 lbs/ac) at either planting or boot stage. The treatments were replicated four times.

The wheat (cultivar Faller) was planted on May 3, 2016, at the rate of 1.4 million PLS/ac. On the same day, supplemental N was applied. The remaining supplemental N was applied on June 23, 2016. The plots were harvested on August 17, 2016, using a plot size combine equipped with a scale system and sensors to measure test weight and moisture. A subsample was collected during harvest and sent to the lab to determine protein content.

Results and Conclusion

Results showed that yield was affected by fertility treatment (*P=0.04*) and by the interaction of fertility and N-rates (*P=0.04*). There was no significant yield difference among the fertility treatments (1.5xN-MAN = 40.0 bu/ac; 1xN-MAN = 39.2 bu/ac; and 1xN-FERT = 37.1 bu/ac), but all of them out yielded the CHECK (31.4 bu/ac). Looking at the different levels of N-rate within each main plot treatment, the treatment 1.5xN-MAN plus 0 lbs N/ac showed the highest yield (42.2 bu/ac), while the treatment CHECK plus 0 lbs N/ac showed the lowest yield (30.6 bu/ac; Figure 1). Those were the only two treatment combinations that showed significant differences, while the remaining did not differ from either the best or the worst treatment.

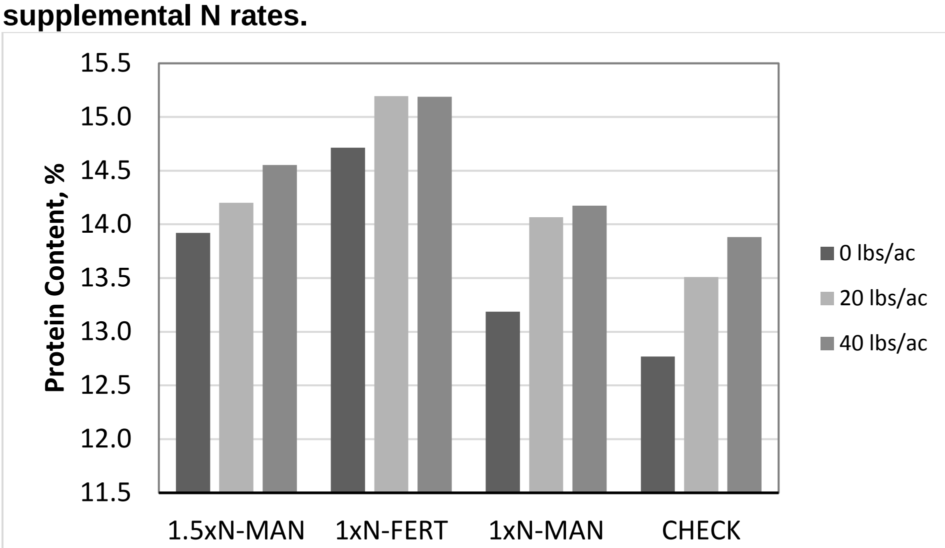
Figure 1. Wheat yield response to manure and urea used as sources of N plus supplemental N-rates.



Bars with the same letter are not significantly different (Tukey Test, α=0.05).

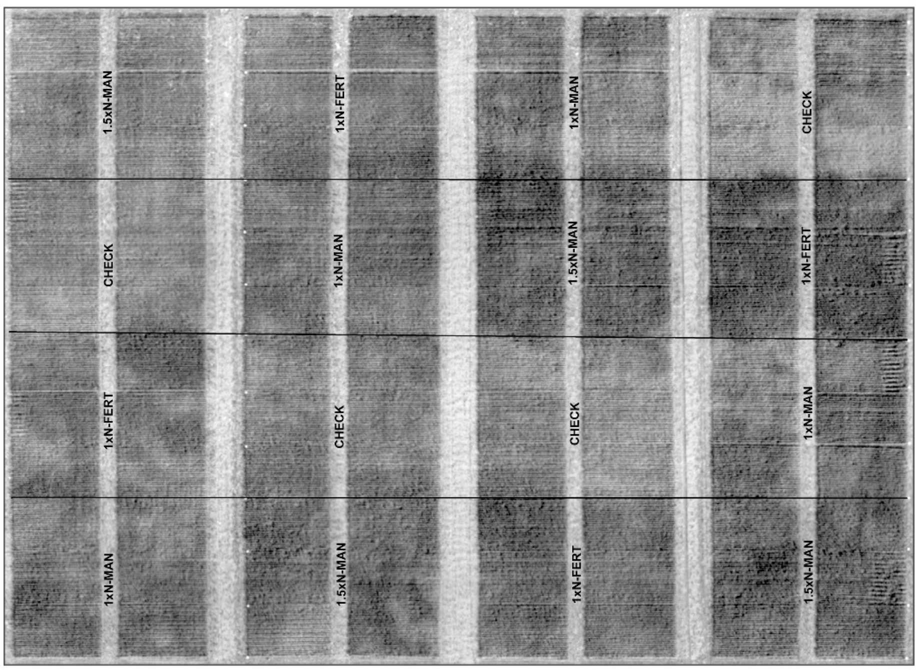
Fertility treatments (*P=0.0002*) and N-rate (*P=<0.0001*) were the only factors affecting wheat protein content, and there was no interaction between the two. The 1xN-FERT treatment showed the highest protein content (15.03%), while the CHECK showed the lowest (13.4%). The manure treatments were not significantly different from each other, but the protein content was lower when compared to the commercial fertilizer. Compared to the check treatment, the 1.5xN-MAN had higher protein content (14.2%), while the 1xN-MAN (13.8%) was not significantly different. The 40 lbs N/ac (14.4%) and 20 lbs N/ac (14.2%) were not significantly different from each other, but both showed higher protein than the 0 lbs N/ac rate (13.6%). Although there was no interaction between the fertility treatments and supplemental N-rates, results showed a positive trend of increasing protein content with the N rates within the fertility treatments (Figure 2).

Figure 2. Wheat protein content in response to manure and urea used as sources of N plus supplemental N rates.



In summary, wheat fertilized with fresh beef feedlot manure showed similar yields (2-3 bu/ac more) than wheat fertilized with urea. Although there was no interaction between the fertility treatments and supplemental N rates, the results suggest that when using manure as fertilizer a supplemental 20 lbs of N/ac would be enough to increase protein content above 14%, avoiding protein discounts. More years of data are necessary to verify the findings of this study.

Regarding recommendations about using either manure or commercial fertilizer for wheat production, we believe that many factors (fertilizer cost, manure application cost, manure nutrient value to subsequent crops, wheat price, protein discounts and premiums) play a role in that decision. Therefore, we suggest that such recommendations be done on a year by year basis, taking into consideration the most current information regarding the factors affecting the economics of wheat production at the time.



Aerial view from the trial, July 01, 2016, at 250 ft above ground level.