Establishing Criteria for Applying Additional N In-Season

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Research Questions

Grain protein content can dramatically impact the value of spring wheat at the elevator. Generally, in high yielding years, protein is low and protein premiums/discounts are high. Being able to predict the likelihood of a high yield early enough in the season to allow for additional N to be applied to increase grain protein could increase the profitability of growing wheat, particularly when the newer, higher yielding cultivars that inherently have relatively low protein are grown. Our research questions are: Using in-season NDVI, can we predict protein levels far enough prior to harvest so as to inform the decision as to whether additional N is needed and what kind of protein and yield response can be expected from N applications at various crop growth stages?

Results

We have not yet finalized the research that attempts to predict protein and yield with in-season sensors or crop growth modeling. We plan to focus on this during the coming months now that all of the data have been collected. The 2016 growing season was very favorable for yield and, we surmise, for mineralization of N in the soils, at least at the Red Lake Falls site where the unfertilized check yielded 62 bu/acre (see tables in annex). Adding 30 lbs/acre of nitrogen regardless of type or timing tended to increase yield, more so at Ada than at Red Lake Falls. Adding 60 lbs/acre of additional N, however, gave little or no response above that seen from the 30 lbs/acre rate. Protein increased with the addition of extra N, with the higher rate generally providing higher levels of protein regardless of fertilizer type and timing. Though locations varied somewhat, urea and UAN appeared to have roughly the same effect on protein when applied at similar growth stages. In Ada, the highest protein at 30 lbs/acre of N was with the foliar application of UAN, but this treatment was similar to other sources of extra N at the Red Lake Falls location. This response is contrary to what has been observed in previous research.

Application/Use

The data from this research demonstrates the value of applying extra nitrogen in-season in order to increase protein but less so for increasing yield. It also suggests that the type and timing of the N fertilization is less critical to the type of response obtained. These data need to be looked at in conjunction with the results from previous seasons in order to determine how the environment influences the outcome. This was an exceptional year for yield and N mineralization, so this year's data must be viewed in light of that.

Material and Methods

Field experiments were established in three locations to mimic field conditions with slightly less than optimal fertilization in order to verify the effect of various in-season N timings, rates, and sources on the yield and protein of spring wheat. In-season additions of N were applied at the 6-leaf, boot, and post-flowering stages. Yield and protein were measured for the various nitrogen additions relative to the untreated check. Using historical weather from NDAWN, yield will be predicted at various N application timings using the DSSAT Crop Growth model (those data were not reported here as this research is still in process). Also, with the aid of an N rich strip, data from sensors will be obtained at these same growth stages to see if a relationship between NDVI and yield and protein can be established and therefore used as a predictive tool for the need of an in-season nitrogen application.

Economic Benefit to a Typical 500 Acre Wheat Enterprise

If the market offers a $0.50 premium/discount per percent of protein, applying an additional 30 lbs of N in-season could return more than $17,000 in a 500-acre field. The actual net benefit would be impacted by the actual yield and the premium/discount in the market for the extra protein and minus any application costs.

Related Research

The nitrogen use efficiency research that we have been conducting is supportive of this research. Since NDVI data were also collected in these other trials, those data can be used to verify the results obtained from this research with regards to predicting protein. The on-farm research group also conducted some in-season nitrogen strip trials.

Recommended Future Research

We recommend an additional year of research with the incorporation of drones in fields with N rich strips as a way of monitoring in-season N needs.

Publications

Rellaford, M. and J. Ransom. 2016. Can in-season NDVI be used to predict grain protein in spring wheat? Abstract of presentation at the Nitrogen Use Efficiency Conference in Boise Idaho, August 2016.

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Appendix

Table 1. Yield of spring wheat at two locations, 70% base rate plus extra N at different timings.

Treatment	Ada	Red Lake Falls
70% rate urea at planting (77 lbs/acre)	60.3	69.7
70% rate urea at planting + 30 lbs N as urea extra at planting (107 lbs/acre)	69.7	74.7
70% rate urea at planting (77 lbs/acre) + 30 lbs N as urea 4 to 5 leaf stage	70.3	75.0
70% rate urea at planting (77 lbs/acre) + 60 lbs N as urea 4 to 5 leaf stage	73.9	75.2
70% rate urea at planting (77 lbs/acre) + 30 lbs N as urea at the boot stage	69.7	73.2
70% rate urea at planting (77 lbs/acre) + 60 lbs N as urea at the boot stage	69.9	75.1
70% rate urea at planting (77 lbs/acre) + 30 lbs N of UAN at flowering	70.6	72.5
70% rate urea at planting (77 lbs/acre) + 30 lbs N as UAN 4 to 5 leaf stage	72.2	73.1
70% rate urea at planting (77 lbs/acre) + 60 lbs N as UAN 4 to 5 leaf stage	74.1	73.1
70% rate urea at planting (77 lbs/acre) + 30 lbs N as UAN at the boot stage	71.9	74.4
70% rate urea at planting (77 lbs/acre) + 60 lbs N as UAN at the boot stage	70.9	75.4
200 lbs. urea at planting	67.0	74.5
Check	47.6	62.5

Table 2. Protein of spring wheat at two locations, 70% base rate plus extra N at different timings.

Treatment	Ada	Red Lake Falls
70% rate urea at planting (77 lbs/acre)	12.1	12.8
70% rate urea at planting + 30 lbs N as urea extra at planting (107 lbs/acre)	12.7	13.1
70% rate urea at planting (77 lbs/acre) + 30 lbs N as urea 4 to 5 leaf stage	12.9	13.4
70% rate urea at planting (77 lbs/acre) + 60 lbs N as urea 4 to 5 leaf stage	13.2	13.5
70% rate urea at planting (77 lbs/acre) + 30 lbs N as urea at the boot stage	13.2	13.5
70% rate urea at planting (77 lbs/acre) + 60 lbs N as urea at the boot stage	13.7	13.4
70% rate urea at planting (77 lbs/acre) + 30 lbs N of UAN at flowering	13.2	13.1
70% rate urea at planting (77 lbs/acre) + 30 lbs N as UAN 4 to 5 leaf stage	12.9	12.4
70% rate urea at planting (77 lbs/acre) + 60 lbs N as UAN 4 to 5 leaf stage	13.4	13.5
70% rate urea at planting (77 lbs/acre) + 30 lbs N as UAN at the boot stage	12.6	13.0
70% rate urea at planting (77 lbs/acre) + 60 lbs N as UAN at the boot stage	13.4	13.8
200 lbs. urea at planting	13.0	13.6
Check	11.4	11.0