Predicting In-Season Nitrogen Needs for Enhancing Protein Content of Hard Red Spring Wheat

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Introduction

- Farmers that do not meet the market standard of 14% grain protein content can receive heavy price discounts when marketing hard red spring wheat (HRSW) (*Triticum aestivum* L.). Producers can increase protein content by up to 1% with a post-anthesis foliar application of urea ammonium nitrate (UAN). Farmers could benefit from knowing if the protein content of their crop will be low prior to anthesis in order to know if an application of UAN will be profitable.

Objectives

- Determine if plant predictors can reliably assess the need for extra N late-season in order to meet protein market requirements.
- Determine if this methodology would be consistent across genotypes with different protein characteristics.

Materials and Methods

- Experiments were conducted at Crookston, MN, in 2011-2012.
- Field design was a RCBD with a split-plot restriction and four replicates.
- Main plot treatments were N rates (0, 68, 135, and 205 kg N ha^{-1}) and sub-plot treatments were cultivars of HRSW.
  - Two cultivars were higher yielding, lower protein (Faller & Samson)
  - Two cultivars were lower yielding, higher protein (Glenn & Vantage)
- Measurements used to predict protein content and when collected:
  - Greenseeker Model 505 handheld optical sensor Zadoks (GS 16 and 37)
  - CCM-200 chlorophyll meter (GS 16 and 37)
  - Leaf color chart (GS 16 and 37)
  - Leaf tissue sample (GS 16 and 37)
  - Stalk tissue sample (GS 37)
- A regression analysis was used to identify plant measurements that most effectively predicted grain protein content.

Figure 1: Diagnostic tools used for predicting protein content: a) Greenseeker Model 505; b) CCM-200 Chlorophyll meter. Measurements taken at the Zadoks GS 16.

Results

- Yield was similar in 2011 and 2012 across all cultivars with an average value of ~ 4,000 kg ha^{-1}.
- Protein content was also similar in 2011 and 2012 across all cultivars with an average range of 12-15%.
- Differences among cultivars' responses to plant predictors and grain protein content were observed in both 2011 and 2012 (Table 1 & 2).
- Across years and cultivars tissue samples of the flag leaf and stalk collected at the GS 37 provided the best prediction of grain protein (Table 1 & 2).
- Different growing environment seemed to have diverse effects on predicating grain protein content in both higher and lower protein cultivars (Figure 2).
- The recommended % N content in stalk samples for predicting protein content at 14% in higher protein cultivars may be 0.5-1.0% while in lower protein cultivars it may be 1.5-2.0% (Figure 3).

Table 1: Correlation coefficient between traits measured and protein content at harvest in 2011 at Crookston, MN.

	Cultivar				
	Faller	Glenn	Samson	Vantage	Combined†
Variable	--------------------------------R Value-------------------------------				
Greenseeker GS 16	0.63	0.82	0.71	0.94*	0.21*
Greenseeker GS 37	0.82	0.88	0.85	0.97**	0.46***
Chlorophyll content at GS 37	0.78	0.80	0.87	0.87	0.19
N content of 6th leaf tissue sample at GS 16	0.87	0.88	0.85	0.95**	0.59***
N content of flag leaf tissue sample at GS 37	0.92*	0.85	0.75	0.93*	0.58***
N content of stalk tissue sample at GS 37	0.91*	0.82	0.72	0.90*	0.55***

†Correlation coefficients across all four cultivars
* Significant at the 0.10 probability level.
** Significant at the 0.05 probability level.
*** Significant at the 0.01 probability level.

Table 2: Correlation coefficient between traits measured and protein content at harvest in 2012 at Crookston, MN.

	Cultivar				
	Faller	Glenn	Samson	Vantage	Combined†
Variable	-----------------------R Value------------------------				
Greenseeker GS 16	0.30	0.18	0.31	0.66	0.00
Greenseeker GS 37	0.67	0.92*	0.76	0.88	0.30**
Chlorophyll content at GS 16	0.82	0.80	0.74	0.24	0.17
Chlorophyll content at GS 37	0.87	0.76	0.92*	0.95**	0.35***
Leaf Color Chart at GS 16	0.75	-0.46	0.76	0.75	0.10
Leaf Color Chart at GS 37	0.35	0.78	0.97**	0.90*	0.05
N content of 6th leaf tissue sample at GS 16	0.93*	0.59	0.88	0.73	0.37***
N content of flag leaf tissue sample at GS 37	0.85	0.75	0.87	1.00***	0.41***
N content of stalk tissue sample at GS 37	0.98**	0.98**	0.94*	0.98**	0.75***

† Correlation coefficients across all four cultivars
* Significant at the 0.10 probability level.
** Significant at the 0.05 probability level.
*** Significant at the 0.01 probability level.

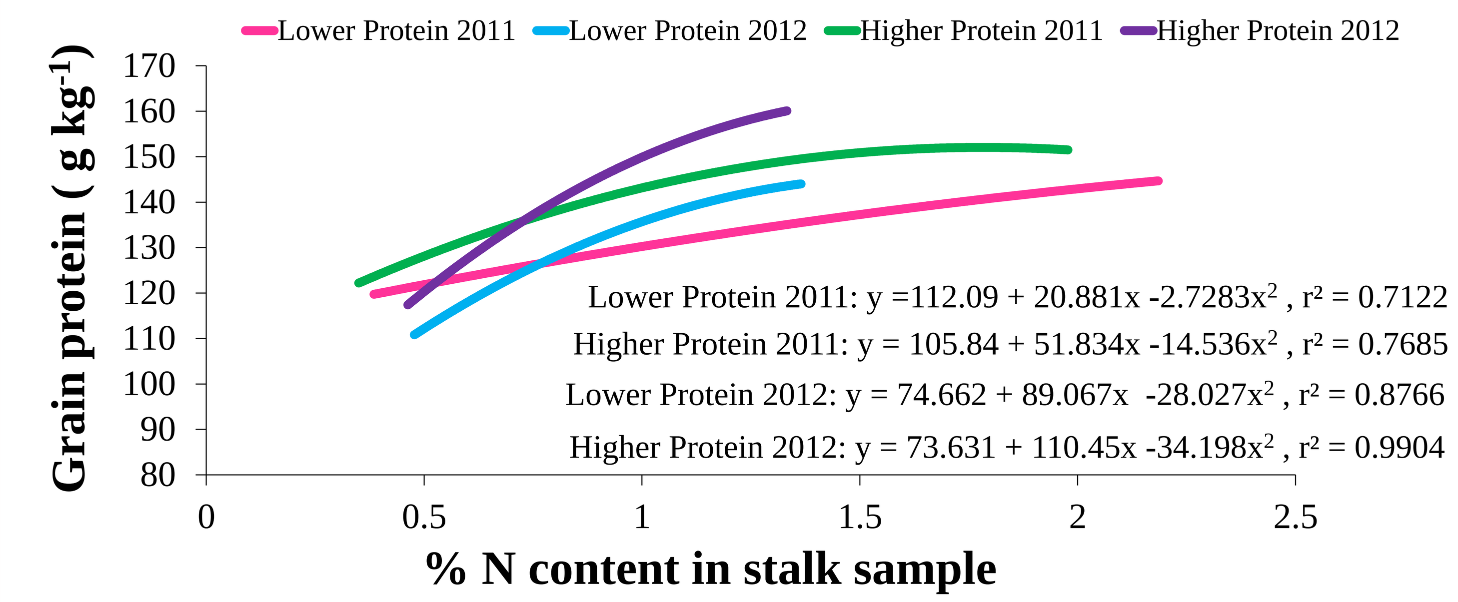

Figure 2: Polynomial regression of grain protein content and % N content in stalk samples collected at GS 37 for a higher (Vantage, Glenn) and a lower (Samson, Faller) protein content HRSW cultivars for two different environments (2011 & 2012) at Crookston, MN.

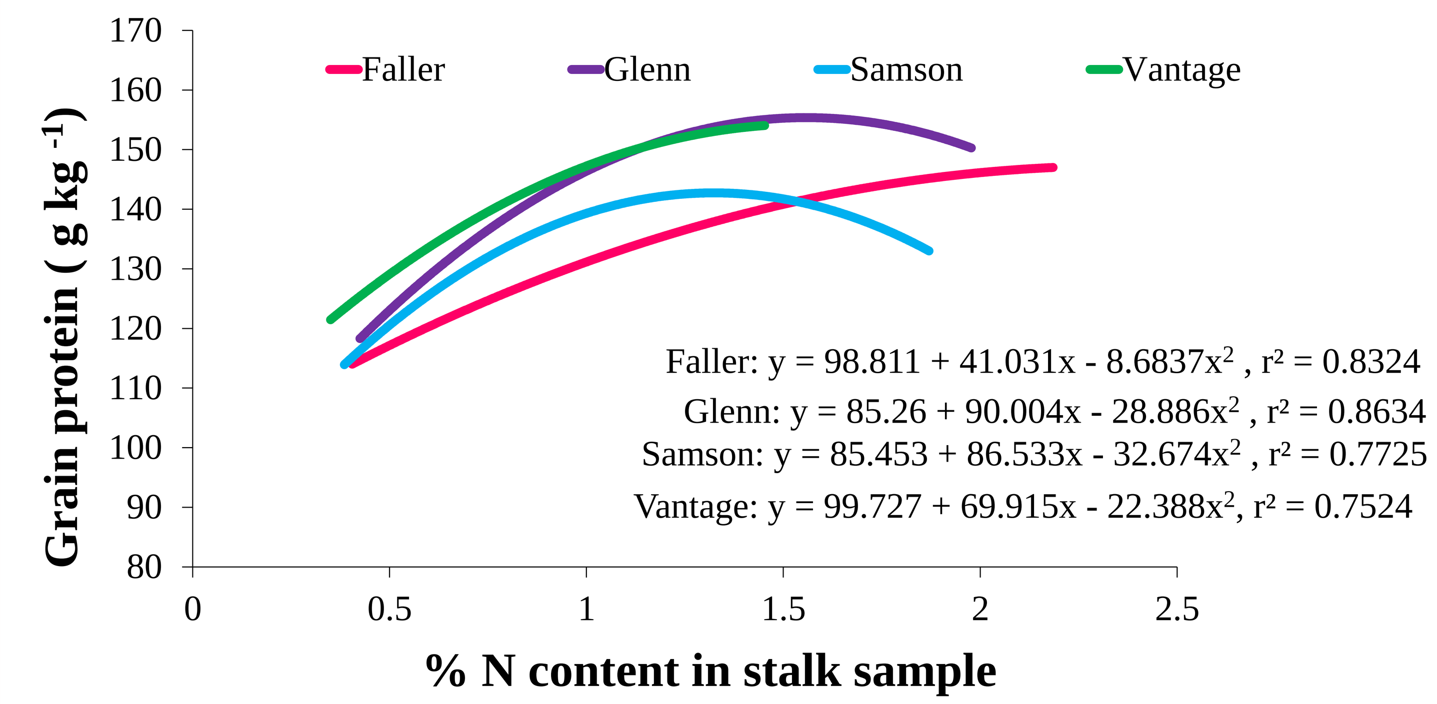

Figure 3*:* Polynomial regression of grain protein content and % N content in stalk samples collected at GS 37 for four cultivars of HRSW across two environments (2011 & 2012) at Crookston, MN.

Conclusions

- Using plant predictors may reliably assess the need for extra N late-season in order to meet protein market requirements.
- Nitrogen content in tissue samples of the flag leaf and stalk collected at the GS 37 provided the best indication in predicting grain protein levels for both 2011 and 2012.
- Environmental impacts can have diverse effects on protein content levels across cultivars, thus with additional research a response curve may be developed for individual cultivars.

Acknowledgement

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