Predicting Crude Protein in Silage Corn using Sensor Technology

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Abstract

Laboratory procedures are traditionally applied to determine various quality parameters of corn silage. Even though effective in determining forage quality, this analysis is conducted post-harvest and does not allow for management adjustments in the standing crop when quality standards are not met. Predicting quality factors mid-season would help producers to make management adjustments in the growing crop. The objectives of this study were 1) to evaluate the response of crude protein and biomass in silage corn to added nitrogen (N) fertilizer; 2) to investigate if mid-season ground sensor measurements could be used to predict crude protein and biomass in silage corn.

Introduction

Various researchers have used remote sensing to evaluate crop quality parameters, biomass, and the N status of plants (Zhao et al., 2004). In-season crop sensor measurements have been shown to reliably predict yield in winter wheat (Raun et al., 2005). Other studies have also delivered encouraging results for using remote sensing to predict grain protein in winter wheat (Zhao et al., 2004). However, there is little evidence in literature about 1) the use of ground based sensors to predict quality parameters and 2) the use of vegetation indices to predict crude protein in silage corn. In this study in-season normalized difference vegetation index (NDVI) readings, collected with the GreenSeeker™, were evaluated in their ability to predict crude protein and biomass in standing silage corn.

Materials and Methods

Two corn hybrids, 4099SS/RIB; 3699VT3P/RIB[RR2] were evaluated in a field experiment at the Mann Valley Lab Farm in River Falls, WI. Pre-plant N was applied at 134 kilogram per hectare while, selected treatments received additional N at 22 , 45, and 67 kilograms per hectare at V6 growth stage. The N source used was urea.

The GreenSeeker™ was used to collect normalized difference vegetation index (NDVI) readings at V5, V6, V8, and V10 growth stages. Plants from each plot were harvested at an average moisture content of 70%. SAS software was used to perform statistical analysis of the collected data. Correlation and regression were used to evaluate the relationship between NDVI, biomass, and crude protein.

Figure 1. Maintaining research plot

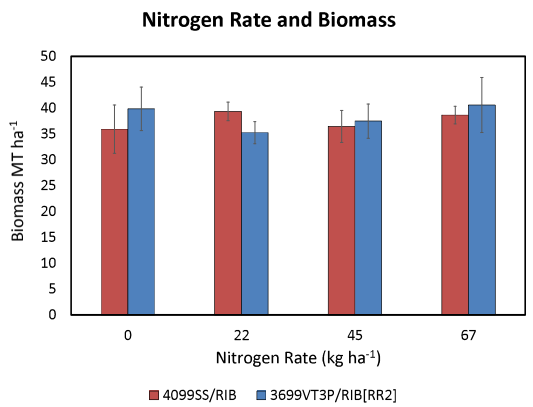

Figure 2. Bar graph comparing the two varieties of corn planted and the effect nitrogen rate had on biomass (MT ha-1)

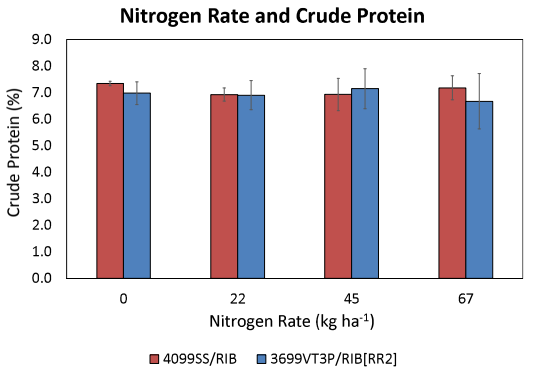

Figure 3. Bar graph comparing the two varieties of corn planted and the relationship nitrogen rate had on crude protein content (%).

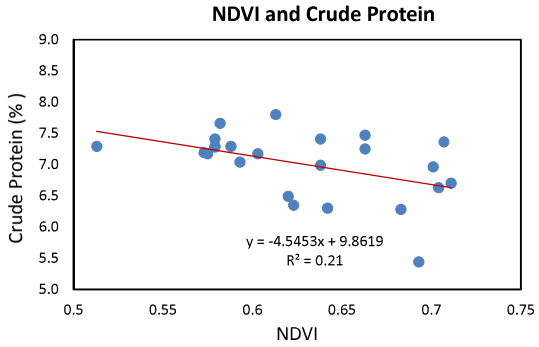

Figure 4. Graph showing a negative relationship between NDVI and Crude Protein at growing stage V6 .

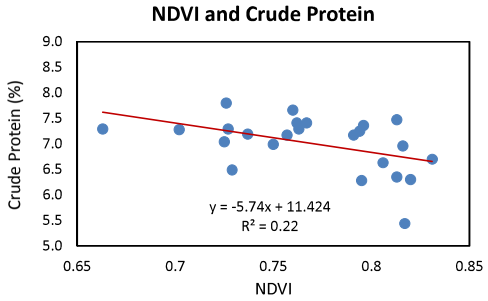

Figure 5. Graph showing a negative relationship between NDVI and Crude Protein at growing stage V8 .

Results & Discussion

There was no statistical difference (α=0.05) in biomass and crude protein as a function of fertilizer rate, The lack of a response to additional N (side dress application) could have been a result of the already high N rates pre-plant applied. There was also no difference in biomass and grain protein between the two hybrids of corn (Fig.2,3). There was a slight negative relationship between NDVI at V6 and V8 and crude protein (Fig. 4,5). However, there was no relationship between NDVI at any other growth stage and crude protein. Contrary to what was expected and previous research no relationship was found between NDVI and biomass. One issue with the NDVI as a vegetation index is that it saturates at high biomass.

Conclusions

There was no significant relationship between NDVI and crude protein. Continued research at multiple sites and the addition of other sensors or vegetation indices is recommended to investigate the potential for prediction of crude protein and other quality parameters in silage corn.

References

- Raun, W.R, et al. 2005. Optical sensor based algorithn for crop nitrogen fertilization. Comm. Soil Sci. Plant Analys. 36:2759-2781.
- Zhao, C. et al. 2005. Predicting grain protein content of winter wheat using remote sensing data based on nitrogen status and water stress. Int. J. Appl. Earth Obs. Geoinf. 7: 1-9.

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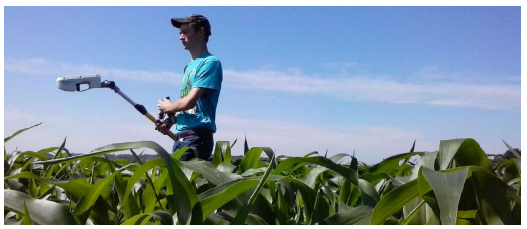

Figure 6. Collecting NDVI data at V8 with the GreenSeeker™.