Changes to Barley Protein and Yield on Variable Terrain

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A study has been conducted at the CREC in 2016 and 2017 to investigate the application of precision agriculture concepts in barley. Specifically, the study was looking to utilize variable rate nitrogen and seeding strategies to optimize barley protein and yield across a hill with variable terrain to improve the number of acres in a field that qualify for malting grade. The goal was to start with traditional production parameters and determine performance in different zones along a hill. A combination of three seeding rates (0.8 m, 1.3 m and 1.8 m PLS) and three soil nitrogen levels (75, 100, and 125 lbs/ac) were used.

To set up this study, a hill was divided into six zones based on elevation. The hills represent an elevation change of only about 5 ft. However, the soil properties vary drastically over that distance. The organic matter varied from 0.8 to 3.7% and the pH changed from 5.7 (bottom) to 8.5 (top). Thus, we not only had an elevation gradient, but also a pH and organic matter gradient. These locations represent a typical eroded hill in North Dakota complete with a substantial lightening of soil color (nearly white) at the top. A UAV (unmanned aerial vehicle) and Greenseeker™ were used to capture in-season differences in plant health through NDVI (a vegetation index) with the hope that it would be a useful tool in predicting crop quality.

Previous research had indicated that increasing plant population is more likely to result in lower protein levels. We were expecting that increasing plant population on the hills would result in lower protein content due to more main stem heads and fewer tillers. This study showed that tiller number did not change much from the bottom to the top of the hill, regardless of plant population. The number of stems per acre did decrease toward the top of the hill, but treatments did not influence stem number. Results showed that protein decreased on the hill tops naturally, regardless of nitrogen treatment (Figure 1). Protein content ranged from 10-15.5% but protein levels typically did not change until near the top of the hill in zone 5 and 6. The best predictor of grain protein was soil pH. Elevation and organic matter had a correlation to protein content but not nearly as strong of a relationship as pH. The UAV was able to moderately predict crop quality, but soil pH was a better indicator.

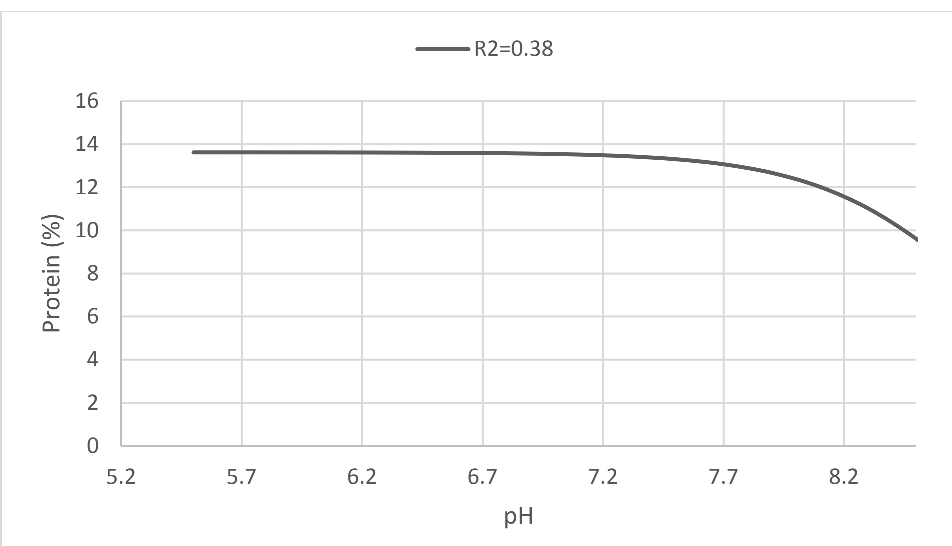

Figure 1. Barley protein content across a pH gradient. The pH increased going up the hill.

Crop yields were monitored in the same fashion as the protein. Not surprisingly there were drastic differences in crop yield. Crop yields ranged from 68-150 bu/ac in 2017 and 27-58 bu/ac in 2016. In this case, the above-soil characteristics did a poor job of predicting yield. Instead, remote sensing with the Greenseeker™ or UAV was the best tool for yield estimation when NDVI was captured 40 days after planting (Figure 2).

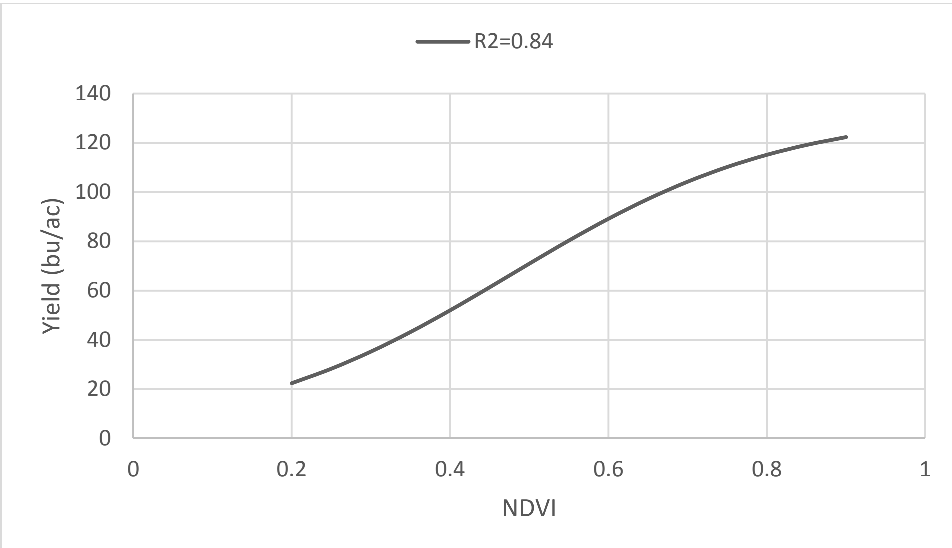

Figure 2. Barley yield changes with NDVI captured with an unmanned aerial vehicle in mid-season.

While this study will be ongoing through 2019, there are some meaningful outcomes thus far. The above data indicates that expected protein differences can be predicted through changes in soil pH on a hill, and yield potential can be captured with mid-season remote sensing. Combining the two methods could provide useful insight into production potential prior to harvest, which could lead to partitioning a field into areas that are most likely to make malting grade, particularly when it is believed that the protein levels may be high in a particular year.

As for precision agriculture applications, as of now, it does not appear that using variable rate seeding will affect crop quality. Variable rate nitrogen is still a possibility. Applying nitrogen to the top of our hills seemed unnecessary. At our locations, which weren't using variable N rates previously, the soil residual N content at the top of the hill typically far exceeded the residual N at the bottom of the hill. The hill tops had inherently higher N content but protein levels largely fell within desired values, plus they had lower yield potential; so reducing N application to hill tops seems like a sound strategy. 2016 and 2017 were years with high mineralization potential. Thus, the higher organic matter content in the lower elevations likely meant that nitrogen would not be a limiting factor at the bottom of the hills, which has led to no nitrogen response.

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