ANNUAL REPORT

Grant Code: AP6349
Title: Active Canopy Sensors to Prescribe In-Season Supplemental Nitrogen for Barley
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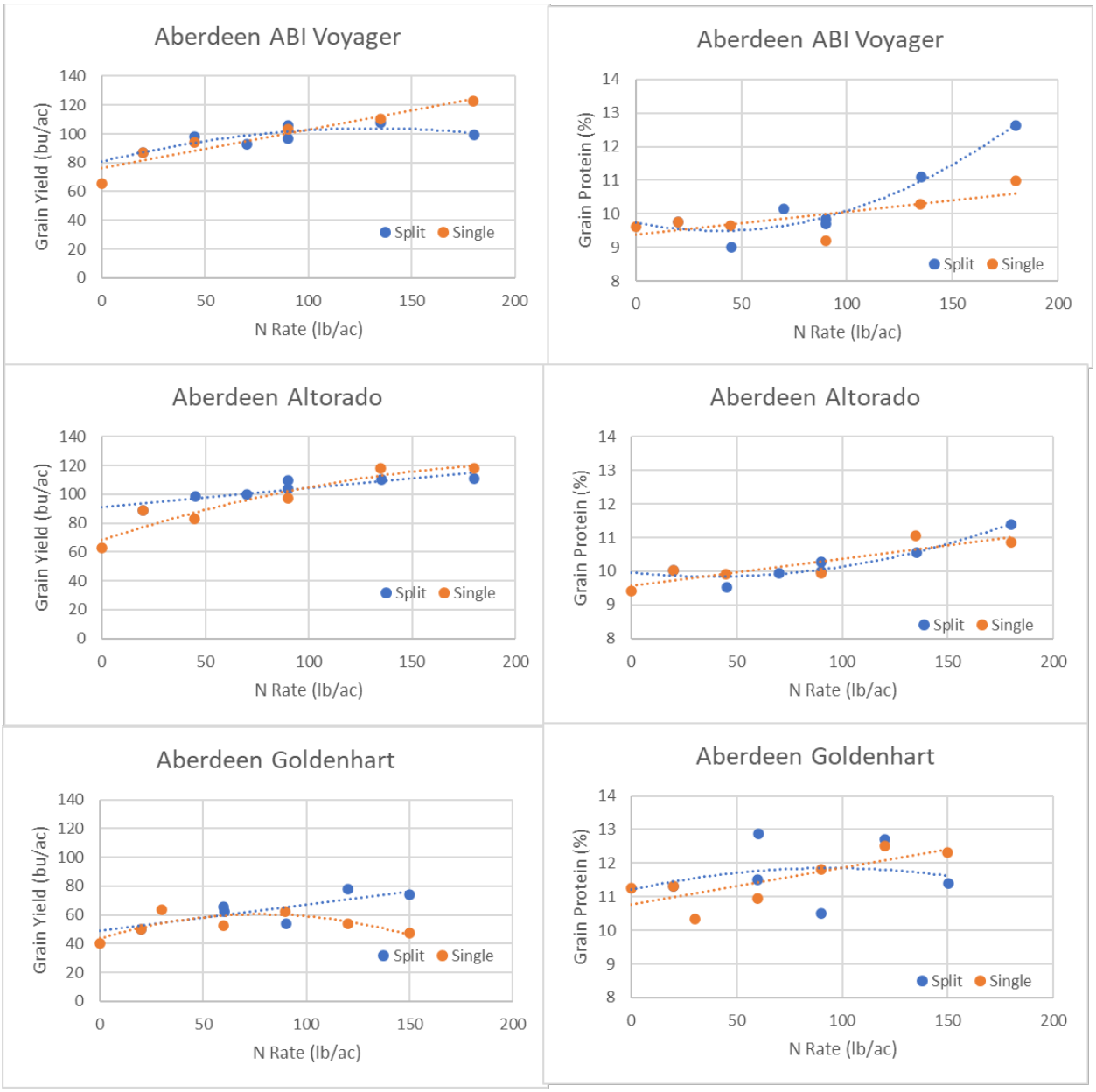
Accomplishments

The objectives of this study were:
Objective 1: Determine food, feed, and malt barley yield and grain protein response to in-season N application
Objective 2: Assess if split-applications can be done to achieve yield and protein goals for different barley classes
Objective 3: Develop crop sensor algorithms for Idaho conditions for different barley classes

We successfully established field plots at the Aberdeen Research and Extension Center in coordination with the USDA NIFA AFRI Sustainable Agriculture Systems grant (2021-2025). For the USDA NIFA grant, we banded urea at planting below and to the side of the seed row at 0, 45, 90, 135, and 180 lb N ac^{-1} for Altorado (feed) and ABI Voyager (malt) and 0, 30, 60, 90, 120 lb N ac^{-1} for Goldenhart (food). For the IBC grant, we applied 20 lb N as urea ac^{-1} at planting and 0, 25, 50, 70, 115, or 160 lb N ac^{-1} at tillering for Altorado and ABI Voyager. An additional treatment was applied as 20 lb N ac^{-1} at planting, 50 lb N ac^{-1} at tillering, and 20 lb N ac^{-1} at heading. For Goldenhart, we applied treatments of 150 lb N ac^{-1} at planting; 20 lb N at planting top-dressed with 0, 40, 70, 100, or 130 lb N ac^{-1}; and 20 lb N ac^{-1} at planting, 20 lb N ac^{-1} at tillering, and 20 lb N ac^{-1} at heading.

Soil samples were collected by replication at 1 foot increments down to 2 feet at pre-plant and analyzed for complete nutrient analysis. Additional soil samples were collected from each plot at 1 foot increments down to 2 feet at jointing, flowering, and post-harvest for a total of 864 soil samples. These soil samples (and last year's samples) were shipped to Brookside Laboratories to be analyzed for soil nitrate and ammonium content. We also took bulk density samples from the 0-1' and 1-2' depths. Unless bulk density has been measured, a common rule of thumb is to multiply the measured concentration of nutrients by 3.6 (assuming a bulk density of ~1.3 g cm-3). We found that the soils' bulk density values were 1.45 and 1.52 g cm^{-3} at the 0-1' and 1-2' depths at Kimberly and 1.69 and 1.78 g cm^{-3} at Aberdeen. Our pre-plant soil sample indicated that we had 3 and 3 ppm nitrate-N at the 0-1' and 1-2' depth in Aberdeen. Using the multiplication factor of 3.6, the residual preplant nitrate-N is estimated at 22 lb nitrate-N ac^{-1}. However, using the real bulk density values, the residual preplant nitrate-N content was 28 lb nitrate-N ac^{-1}. At lower soil test values, the difference between the two values is small, but with higher residual soil N (such as when barley follows sugar beets) the difference increases. This implies that it is important that growers understand their soils' physical properties to correctly estimate soil nutrient availability for wheat production. This message was shared at the 2022 Southern Idaho Cereal School on February 2.

Crop canopy greenness was measured from each plot using the Apogee, SPAD, and Greenseeker sensors at jointing and flowering (864 measurements). Sensor measurements are currently being transcribed from paper to electronic format. Whole plant tissue samples were collected from each plot at jointing, flowering, and immediately before harvest by harvesting 1 meter of row. Samples collected before harvest were partitioned into heads and straw. The number of heads were counted and will be threshed to quantify the number of viable heads per meter of row and the average number of kernels per head. All plant tissue samples were dried and are currently being ground in preparation for total N analysis (720 samples). Additional measurements collected from each study were yield, plumps and thins, test weight, and grain protein content.



Our initial results indicated that all three barley varieties' yield responded positively to pre-plant and split nitrogen applications. For most sites and varieties, a single fertilizer application at planting performed similarly to a split application. However, split application may have

improved grain yield for Goldenhart by approximately 20 bu/ac at the highest N rates. At the highest two rates, split applications increased the grain protein content of ABI Voyager by 0.5 to 1.5%. It was only at the highest split N rate that grain protein content was outside malting specifications. Otherwise, there was no difference in grain protein content between a single or split fertilizer application for all varieties.

Projections: Dr. Spackman recently hired a postdoc to compile and analyze the data from this study. We will use data collected from FY22, FY23, and the next year of research to investigate the relationship of in-season soil and plant tissue nitrogen content to wheat yield and quality and nitrogen use efficiency. We will calculate the soil-crop nitrogen balance. We will also correlate our crop sensor readings to grain yield. We will create algorithms to estimate the in-season N rate required to achieve targeted yield and protein goals. We will also compare the apparent N use efficiency of the single vs split applications.

Publications:

Spackman, J.A. 2022. Nitrogen Management: Increasing Fertilizer Efficacy. Valley Ag Agronomists Meeting. Jackpot, NV. 18 Nov. 2022. (60 minutes)

Spackman, J.A., O.S. Walsh, A. Adjesiwor, J. Bevan, O. Adeyemi, J. Sagers, and R. Findlay. 2022. Nitrogen Fertilizer Rate and Timing Implication for Malt, Food, and Feed Barley Production in Southern Idaho. ASA-CSSA-SSSA Annual Meetings. Baltimore, MD. 6 – 9 Nov. 2022.

Walsh, O., **J.A. Spackman,** and A.T. Adjesiwor. Agronomy Reports. ISAID Annual Meeting 2022 and Regenerative Ag Workshop. Twin Falls, ID. 3 Oct. 2022.

Spackman, J.A. 2022. Nitrogen Management Research in Small Grains. University of Idaho - Limagrain Cereal Seeds Field Day. 19 July, 2022. (100 attendees, 20 minutes).

Spackman, J.A. and J. Bevan. 2022. Nitrogen Management for Cereal Production. Pesticide and Nutrient Management Field Day. Aberdeen, ID. 28 June, 2022. (55 attendees, 20 minutes)

Spackman, J.A. 2022. Nitrogen Management for Cereal Production. Snake River Weed Management and Tour Field Day. Kimberly, ID. 22 June, 2022. (55 attendees, 15 minutes).

Spackman, J.A. 2022. Nitrogen and Sulfur Fertility Research Updates for Barley and Wheat. Southern Idaho Cereal School. Aberdeen, ID. 2 Feb. 2022. (141 attendees, 30 minutes).