Varietal Response of Spring Barley to Applied Nitrogen

Olga S. Walsh¹, Jared A. Spackman², Albert T. Adjesiwo³, Ritika Lamichhane¹, Emmanuella Owusu Ansah¹, and Jordan R. McClintick-Chess¹

University of Idaho, ¹Parma R&E Center, ²Aberdeen R&E Center, ³Kimberly R&E Center

JUSTIFICATION OBJECTIVE

The University of Idaho researchers have been awarded a USDA NIFA AFRI Sustainable Agricultural Systems grant (2021-2025) to support the adoption of technologies that transform nutrients in dairy manure into commercial fertilizers and manure-based bioproducts. Updating fertilizer guidelines for Idaho crops (including barley) and evaluating the long-term effects of nitrogen fertilizers and new manure-based bioproducts on soil carbon, nitrogen, and phosphorus levels plus soil health (e.g., microbial biomass, organic matter content, and soil carbon content) are among the top priorities of this project.

Fertilizer management guidelines for Idaho cereal crops need to be updated to better address modern cultivars with varied genetics and greater yield potential, changes in production practices, and to improve nutrient use efficiency. Idaho barley production consists of approximately 75% malt, 22% - feed, and 3% - food barley. Irrespective of the class, grain must meet specific end-use quality parameters that are strongly affected by growing conditions such as water and nutrient availability. The task of updating the fertilizer guidelines has begun with nitrogen response trials. Once optimal nitrogen rates are determined for Southern Idaho, research can continue to focus on other nutrients and aspects of cereal crop production. Field experiments were initiated in spring 2021 by planting spring barley (malt, feed, and food).

OBJECTIVE

OBJECTIVE (2021-2023): To analyze the effects of N fertilizer rates on spring barley yield and quality, and soil health parameters.

MATERIALS and METHODS

Location: University of Idaho, Parma, Aberdeen, and Kimberly R&E Centers R&E Centers

Varieties: ABI Voyager (malt), Altorado (feed), Goldenhart (food)

TREATMENT set-up: Randomized Complete Block design with 4 replications

NITROGEN: applied at planting as urea (46-0-0) at five rates: 0, 45, 90, 135, and 180 lb N/ac (malt and feed barley), and 0, 30, 60, and 120 lb N/ac (food barley). The rates were based on the preplant soil test results, and current University of Idaho recommendations for yield goals typically achieved in Southern Idaho for evaluated varieties.

Data collection (Fig 6): Plants at Feekes 5 (tillering), and Feekes 10.5 (flowering): 1) Plant height - 10 plants per plot; 2) Chlorophyll estimate (MC-100, Apogee Instruments, Inc., Logan UT; and SPAD 502 Plus Chlorophyll Meter, Spectrum Technologies, Aurora, IL) – 10 plants per plot; 3) Normalized Difference Vegetative Index (Greenseeker, Trimble Agriculture Division, Westminster, CO); and 4) barley above-ground biomass nitrogen content – 10 plants per plot (Brooksire Laboratories, Inc., New Bremen, OH, utilizing the 7Elementar EL Combustion analyzer, Elementar Americas, Inc., Ronkonkoma, NY). Soil: analysis by Brookside Laboratories, Inc. (New Bremen, OH). Preplant (field-scale composite) and postharvest (by-plot) soil samples will be analyzed for 20 soil health parameters. In addition to preplant comprehensive soil test, in-season soil samples will be analyzed for total available nitrogen content at Feekes 5 (tillering), and Feekes 10.5 (flowering) growth stages.

Harvest: In the Fall, barley plots will be harvested with the Wintersteiger Classic (Wintersteiger, Inc., Salt Lake City, UT) small plot combine. The grain will be analyzed for moisture, test weight, and total nitrogen content utilizing InfraCat 9500 NIR Grain Analyzer (PerkinElmer, Waltham, MA).

Data analysis: The response of spring barley yield and quality, and soil health parameters to applied nitrogen treatments will be assessed.

PRELIMINARY RESULTS

The results reported here are from Parma, 2021, Aberdeen, and Kimberly data still being collected. Plant samples are being currently analyzed for nitrogen content.

Biomass weight ranged from 30.6 to 40.4 g. Biomass weight was positively linearly correlated with chlorophyll content (Fig 1), and plant height (Fig 2).

NDVI ranged from 0.65 to 0.83. NDVI was positively linearly correlated with chlorophyll content (Fig 3), and biomass weight (Fig 4).

Biomass index (product of chlorophyll content x plant height x biomass weight) ranged from 100 to 462. Variation in NDVI explained 77% variation in biomass index (Fig 5).

Statistical analysis will be performed once the data from all three locations is available.

Preliminary data indicates that:

- vegetative parameters of malt, feed, and food barley might respond differently to applied nitrogen,
- higher nitrogen rates were not always associated with higher NDVI, chlorophyll content, plant height, and biomass weight,
- evaluating a combination of vegetative parameters and spectral indices may help us better understand the response of various barley classes to applied nitrogen and help to guide nitrogen fertilizer management for best yield and quality.

Table 1. NDVI, chlorophyll content, plant height, biomass weight, and biomass index (chlorophyll content x plant height x biomass weight) at Feekes 5, Parma, ID, 2021.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Notes</th>
<th>NDVI F5</th>
<th>CCI F5</th>
<th>HT F5</th>
<th>BIO WT F5</th>
<th>BIO index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 FEED SB, check</td>
<td>0.67</td>
<td>22.8</td>
<td>24.1</td>
<td>31.0</td>
<td>171</td>
<td></td>
</tr>
<tr>
<td>2 FEED SB @ low N</td>
<td>0.65</td>
<td>17.4</td>
<td>22.3</td>
<td>30.6</td>
<td>118</td>
<td></td>
</tr>
<tr>
<td>3 FEED SB @ moderate N</td>
<td>0.64</td>
<td>16.7</td>
<td>19.6</td>
<td>30.7</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>4 FEED SB @ high N</td>
<td>0.76</td>
<td>27.2</td>
<td>27.6</td>
<td>33.5</td>
<td>251</td>
<td></td>
</tr>
<tr>
<td>5 FEED SB @ very high N</td>
<td>0.76</td>
<td>25.7</td>
<td>31.0</td>
<td>34.7</td>
<td>277</td>
<td></td>
</tr>
<tr>
<td>6 MALT SB, check</td>
<td>0.73</td>
<td>24.9</td>
<td>19.9</td>
<td>33.6</td>
<td>166</td>
<td></td>
</tr>
<tr>
<td>7 MALT SB @ low N</td>
<td>0.83</td>
<td>29.7</td>
<td>33.7</td>
<td>39.8</td>
<td>398</td>
<td></td>
</tr>
<tr>
<td>8 MALT SB @ moderate N</td>
<td>0.75</td>
<td>31.2</td>
<td>33.3</td>
<td>38.0</td>
<td>394</td>
<td></td>
</tr>
<tr>
<td>9 MALT SB @ high N</td>
<td>0.73</td>
<td>21.2</td>
<td>22.8</td>
<td>35.8</td>
<td>173</td>
<td></td>
</tr>
<tr>
<td>10 MALT SB @ very high N</td>
<td>0.77</td>
<td>35.4</td>
<td>32.4</td>
<td>40.4</td>
<td>462</td>
<td></td>
</tr>
<tr>
<td>11 FOOD SB, check</td>
<td>0.82</td>
<td>33.7</td>
<td>31.5</td>
<td>38.1</td>
<td>404</td>
<td></td>
</tr>
<tr>
<td>12 FOOD SB @ low N</td>
<td>0.74</td>
<td>28.0</td>
<td>22.4</td>
<td>35.8</td>
<td>224</td>
<td></td>
</tr>
<tr>
<td>13 FOOD SB @ moderate N</td>
<td>0.79</td>
<td>30.0</td>
<td>29.6</td>
<td>36.2</td>
<td>321</td>
<td></td>
</tr>
<tr>
<td>14 FOOD SB @ high N</td>
<td>0.70</td>
<td>28.7</td>
<td>18.7</td>
<td>36.8</td>
<td>197</td>
<td></td>
</tr>
<tr>
<td>15 FOOD SB @ very high N</td>
<td>0.80</td>
<td>34.4</td>
<td>30.2</td>
<td>38.3</td>
<td>397</td>
<td></td>
</tr>
</tbody>
</table>

Fig 1 Chlorophyll vs biomass weight

y = 0.48x + 22.41
R² = 0.77

Fig 2 Plant height vs biomass weight

y = 0.51x + 31.42
R² = 0.55

Fig 3 NDVI vs chlorophyll

y = 81.67x - 33.47
R² = 0.69

Fig 4 NDVI vs biomass weight

y = 45.03x + 2.13
R² = 0.69

Fig 5 NDVI vs biomass index

y = 1733.80x - 1016.10
R² = 0.73

This project is funded by the USDA NIFA, and the Idaho Barley Commission. Contact Information: Olga Walsh, Cropping Systems Agronomist, University of Idaho, Parma R&E Center, owalsh@uidaho.edu; @IDCrops