Science Societies

Varietal response of wheat and barley to nitrogen

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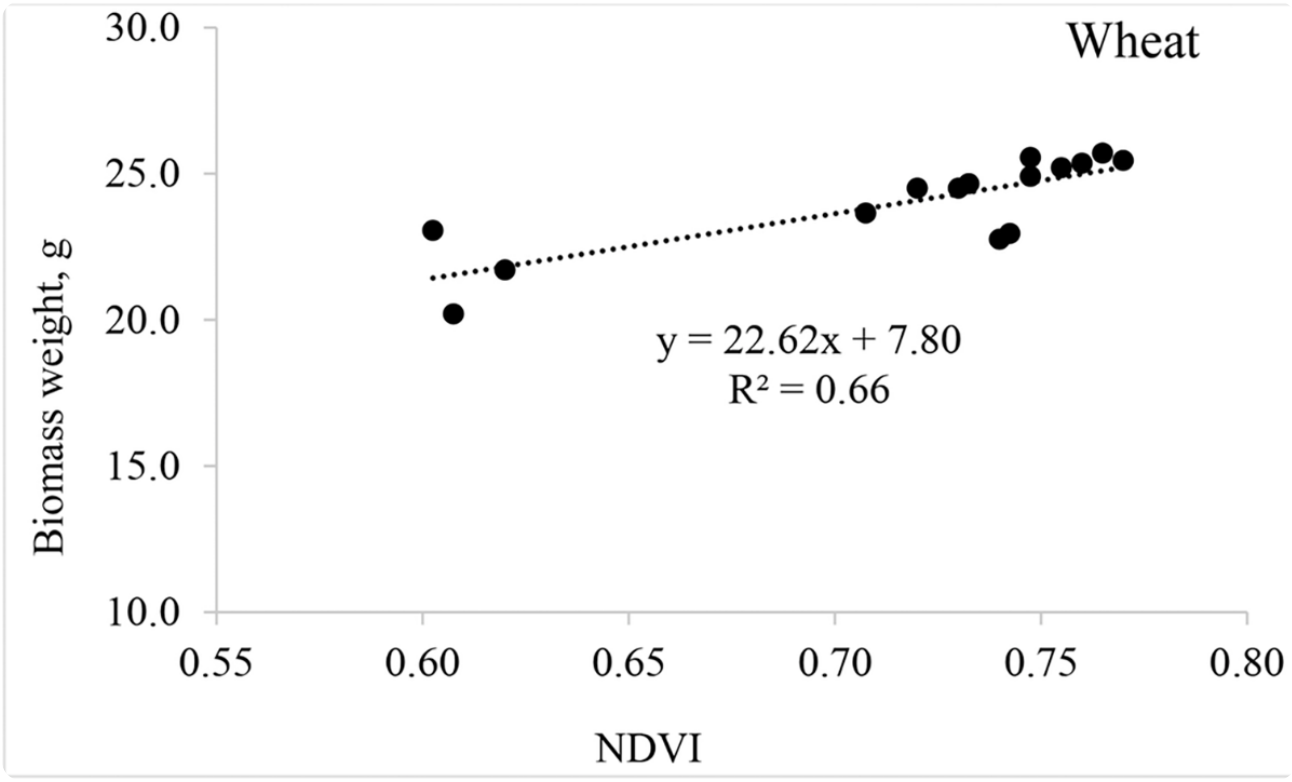

Figure 1, Relationship between GreenSeeker NDVI and wheat biomass weight, Feekes 5, Parma ID.

The University of Idaho researchers and extension specialists are collaborating on a state-wide project to support the development and adoption of technologies that transform nutrients in dairy manure into commercial fertilizers and manure-based bioproducts. Updating nutrient management recommendations for Idaho crops (including wheat and barley) and evaluating the long-term effects of nitrogen fertilizers and newly developed 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 key objectives.

Fertilizer guides for Idaho cereal crops must be updated to better address modern varieties with higher yield potential and nutrient use efficiencies as well as changes in grower practices. Regardless of the class, produced wheat and barley grain must meet specific end-use quality parameters. The grain quality is known to be strongly affected by growing conditions including water and nutrient availability. The team began updating the fertilizer guidelines with nitrogen response trials in southern Idaho. Once optimal nitrogen rates are established, research will continue to focus on other nutrients and aspects of cereal production.

Field experiments were initiated in spring 2021 by planting spring barley (malt, feed, and food) and spring wheat (hard white, soft white, and hard red) at three locations in southern Idaho. Five nitrogen rates were applied at planting based on the preplant soil test results and current University of Idaho recommendations for yield goals typically achieved in southern Idaho for assessed varieties. Added experiments will be established in fall 2021 for winter wheat and winter barley.

Intensive data collection will provide detailed information about wheat and barley growth, development, and grain yield and quality. In-season measurements of plant

height, plant chlorophyll content, and biomass production are accompanied by precision-sensing techniques, both ground based and aerial. On the ground, normalized vegetative difference index (NDVI) is measured with the hand-held GreenSeeker crop sensor as an accurate indicator of plant health, nitrogen uptake, and biomass production. The unmanned aerial system (UAS), a drone equipped with a multispectral camera, is used to acquire aerial imagery. Previous research conducted in 2015–2020 at the University of Idaho Parma Research and Extension Center has shown that in-season ground-based and UAS-based spectral indices can be effectively utilized to estimate crop yield and quality for crops like wheat and sugarbeets.

Crop Sensors Help Producers Make Informed Decisions

Preliminary analysis of 2021 data collected at Parma has shown that biomass production was closely related to the chlorophyll content for wheat and barley with strong relationships between the ground-based NDVI and leaf chlorophyll concentration and biomass production noted for both crops (Figures 1 and 2). This exemplifies that crop sensors perform well and can identify even very slight differences in plant health and vigor associated with nutrient application. In fact, crop sensors can help to accurately measure crop health condition and may even help to distinguish between various types of crop stress—drought, temperature, insect pests, disease pressure, and inadequate nutrition.

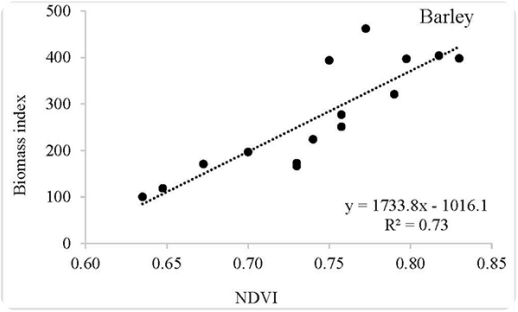

Figure 2, *Relationship between GreenSeeker NDVI and barley biomass index (product of plant height × biomass weight × leaf chlorophyll content), Feekes 5, Parma ID.*

One of the most promising applications for crop sensors is variable-rate nutrient management. Crop sensors allow for in-season real-time data collection and developing nutrient recommendations based on estimated yield potential and actual crop nutrient needs.

From an agronomic standpoint, this methodology improves input distribution to meet end-use grain quality goals. In many cases, following evaluation of crops with precision sensors, such as GreenSeeker, Crop Circle, and others, growers are benefiting by decreasing the amounts of applied fertilizers. The savings can be much more significant where fertilizer has traditionally been applied in excess of the crop's nutrient needs. Some growers may discover that nitrogen rates need to be increased to satisfy crop's nitrogen requirements to optimize the yield potential of high-yielding crops. The key take-home message is that using crop sensors enables growers to make an informed decision on the application of nitrogen and other inputs based on the crop's current health status and accurately estimated yield potential.

Many crop growers are stunned to learn that the efficiency of nitrogen fertilizer use (unit of grain/produce grown per unit of nitrogen fertilizer applied) is just 40–45% for most agricultural fields. This causes substantial economic losses to growers annually. Average savings in fertilizer expenses reported by growers using sensor-based technologies are about $20 per acre, depending on the crop and previous nutrient management. Adoption of crop-sensing technologies also offers significant environmental benefits since sensor-based fertilizer recommendations aim to supply just enough inputs to meet the crop's needs to reach its yield potential and optimize quality. This methodology helps to reduce nutrient losses due to volatilization, leaching, and runoff.

In addition, Dr. Jared Spackman is leading multiple studies in collaboration with Dr. Adjesiwor and Dr. Olga Walsh to (1) evaluate if split applications of nitrogen fertilizer would result in better barley and wheat grain yield and quality and (2) develop crop-specific sensor-based algorithms for barley and wheat grown in Idaho.

Acknowledgements

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