Droughts in the western United States have led to an increased and pressing need to consider how to manage crops with less water for the future sustainability of production in the region. Fertilizer nitrogen (N) recommendations in the western United States have often been determined where irrigation was a non-limiting factor. However, when irrigation is a limiting factor, it is critical to consider the interrelationship with irrigation amounts and N applications rates as crop yield and quality can be heavily influenced in both positive and negative ways. An irrigation termination and N fertilizer rate study was conducted to investigate malt barley yield and quality response in Kimberly, ID. Earn 0.5 CEUs in Soil & Water Management by reading the article and taking the quiz at https://web.sciencesocieties.org/Learning-Center/Courses.
Yield Response

Irrigations were terminated at Feekes 10.0 (late boot), Feekes 11.2 (soft dough), and seven days (one irrigation) after Feekes 11.2 (+7F11.2). Termination of irrigation at Feekes 10.0 is considered water stressed, and termination of irrigation at F11.2 and +7F11.2 is considered well watered. Water-stressed conditions in the F10.0 treatment resulted in a more than 30% reduction in grain yields, and N fertilizer provided little benefit to a net negative effect under water-stressed conditions (Figure 1; Rogers et al., 2022). Maximum yield in the study occurred well below the maximum rates of fertilizer N applications for both F11.2 and +7F11.2, which did not differ.

Quality Reponse

Malt barley is a unique crop as it has specific acceptable varieties with very strict grain quality parameters that determine whether it will be accepted for higher-value malt barley or if it will be reduced to lower-value feed grain. The American Malting Barley Association publishes targets for acceptable ranges for both barley grain and malt quality that provide valuable general levels across the industry (AMBA, 2020). Key barley grain and malt quality parameters were above optimal levels from the early irrigation termination treatment. Grain protein above target levels of 13% has negative impacts during the malting process. This target protein level was exceeded when fertilizer was applied at any rate under water-stressed conditions. Well-watered fields maintained their protein levels below the 13% target regardless of N application rate. Nitrogen generally has a net negative effect on plump kernels even under well-watered conditions. Despite plumps being greatly under targets at all N levels for water-stressed conditions, the magnitude of reduction is increased as indicated by the more rapid decline in the slope for water-stressed barley.

Beta (β)-glucans are soluble fiber compounds that are used as a quality indicator for malted barley. This was the only measured quality factor where the well-watered F11.2 treatment behaved similar to the water-stressed F10.0 termination across N rates. Malted barley grain β-glucan targets should be below the threshold of 100 ppm. Increased N application at the highest rates applied in the research study resulted in elevation of β-glucan above the published target rate for both the F10.0 and the F11.2 irrigation terminations. Additional irrigation from the +7F11.2 treatment resulted in decreased β-glucans at all N rates compared with the other termination times.

Fertilizer nitrogen (N) recommendations in the western United States have often been determined where irrigation was a non-limiting factor. However, when irrigation is a limiting factor, it is critical to consider the interrelationship with irrigation amounts and N applications rates as crop yield and quality can be heavily influenced in both positive and negative ways.

An irrigation termination and N fertilizer rate study was conducted to investigate malt barley yield and quality response in Kimberly, ID located within the Snake River Plain. Irrigations were managed to match calculated evapotranspiration rates until irrigation termination timing using the Penman–Monteith equation obtained from the United States Bureau of Reclamation Agrimet Cooperative Agriculture Weather Network (Allen & Wright 2002; Allen et al., 1998; USBR, 2016). 

Small-plot barley irrigation research rate trial at the USDA-ARS Northwest Irrigation and Soil Research Laboratory Kimberly, ID. Photo by Dr. Christopher W. Rogers.
Conclusions

Western U.S. droughts have and will likely continue to have major negative impacts on crop production; therefore, it is important that we continue looking for ways to improve the management of our most critical production resources with a goal of meeting or exceeding production goals with less. Our study defined concerns of excess N, particularly under water-stressed conditions, that can result in elevation of grain protein, reduction in plump kernels, and elevation of malted grain β-glucans. Also, it was determined that irrigation past F11.2 did not generally improve production, while at the same time, it negatively increased water use and the potential for N loss from the system. Future research defining threshold levels of water stress and N fertilizer rates that can meet quality as well as yield goals are needed to achieve high agronomic yields, optimize quality, maintain sustainability, and ensure environmental stewardship through proper understanding of genetics × environment factors of production.

References


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1. Nitrogen applications generally result in a reduction in what malt barley grain quality measurement?
   a. Test weight.
   b. Plumps.
   c. Yield.
   d. Protein.

2. ________ is the quality factor that increases due to nitrogen application and must be considered as high levels are not acceptable for malting.
   a. Test weight
   b. Plumps
   c. Yield
   d. Protein

3. The western United States has historically high levels of precipitation that are having negative effects on crop production.
   a. True.
   b. False.

4. Target grain protein for malt barley should not exceed
   a. 14%.
   b. 13%.
   c. 10%.
   d. 18%.

5. Under ________ conditions in the study (see Figure 1), proteins rapidly exceeded the 13% target.
   a. all fertilized conditions
   b. all unfertilized conditions
   c. well-watered fertilized conditions
   d. water-stressed fertilized conditions