

Barley Production in Semiarid Regions— Making the Malting Grade

By Ross McKenzie and Grant Jackson

Field trial results indicate that malt barley yield was most influenced by seeding date and matching plant-available water with a crop nitrogen (N) requirement of 1.2 lb N/bu.

Malt barley production has moved west into semiarid regions of the northern Great Plains with the on-set of fusarium blight in the eastern regions. Weather conditions, mainly drought, are often unfavorable for malting barley quality in semiarid regions.

Well-fertilized barley fields subject to moisture stress will result in grain samples that are higher in protein (<12.5 to 13.0% accepted for malt) and have reduced kernel plumpness (>70 to 80% plump required for malt). Nitrogen fertilizer additions have been shown to increase barley yield and protein content, and to depress kernel plumpness. Increasing plant-available water increases yield and plumpness, while decreasing protein.

In dryland agriculture, finding the appropriate balance between nutrient supply and moisture is critical to successful production of high quality malt barley.

Research trials were conducted in northern Montana and southern Alberta to evaluate how fertilizer additions can influence the yield and quality of malt barley. Fourteen experiments from the Triangle region of north central Montana were considered, using N fertilizer rates of 0 to 120 lb N/A. Adequate phosphorus (P) and potassium (K) were added. The database was divided into two groups: seven trials with yields of <70 bu/A, and seven trials of >70 bu/A. A second database consisted of 15 experiments from Alberta's Brown, Dark Brown, Thin Black, Black,



Early seeding and appropriate N application rates related to moisture availability are keys for malt barley production in the northern Great Plains.

and Gray Wooded soil zones. All plot areas received an application of 27 lb P_2O_5/A and N treatments that varied between 0 and 140 lb N/A. The Alberta data were organized into two databases, seven locations with yields of <100 bu/A and eight locations with yields that were >100 bu/A. Regression equations were developed using initial nitrate (NO_3)-N in 3 ft. (Montana) or 2 ft. (Alberta) of soil plus fertilizer N as the independent variable vs. dependent variables of grain yield, grain protein content, and kernel plumpness. A second Alberta study on irrigated and dryland sites in the Brown, Dark Brown, and Black soil zones considered 14 sites using the treatments: 1) 0, 36, 72, 108, and 144 lb N/A, 2) 0, 13, 26, and 39 lb P_2O_5/A , 3) 0, 27, and 53 lb K_2O/A , 4) 0, 9, and 18 lb sulfur (S)/A, and 5) three seeding dates at 10-day intervals and seeding rates of 150, 200, 250, 300, and 350 viable seeds/m².

The results from the Montana and first

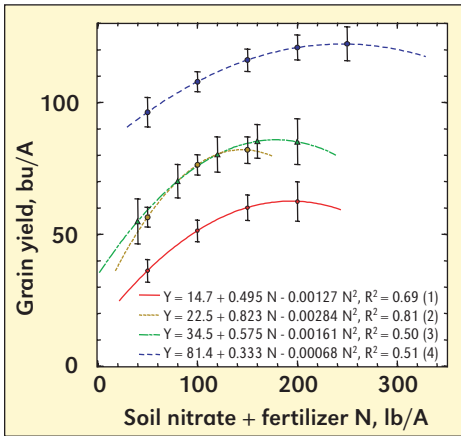


Figure 1. Effect of N on barley grain yield.

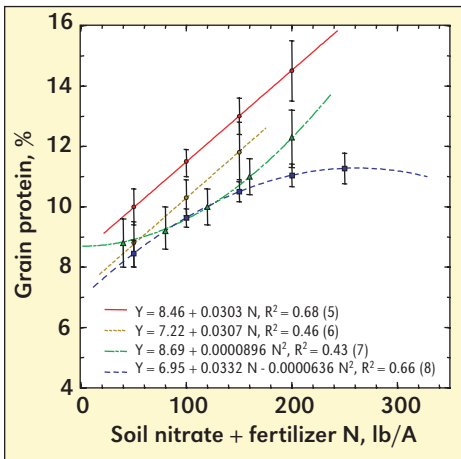


Figure 2. Effect of N on barley grain protein.

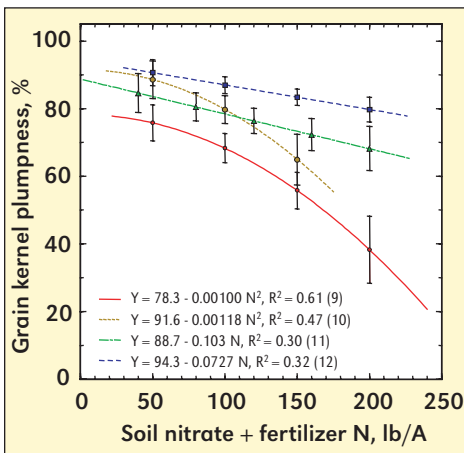


Figure 3. Effect of N on barley kernel plumpness.

Alberta study clearly show how malt barley responds to fertilizer and soil N levels. Increasing N supply resulted in increasing grain yield (**Figure 1**) and grain protein (**Figure 2**) for all yield groups considered, and a decrease in kernel plumpness (**Figure 3**). Equations 1, 5, and 9 are for the <70 bu/A Montana data, equations 2, 6, and 10 are for the >70 bu/A Montana data, equations 3, 7, and 11 are for the Alberta <100 bu/A data, and equations 4, 8, and 12 are for the Alberta >100 bu/A data. With the low yielding, high water stress group from Montana, water stress conditions resulted in a modest yield response (**Figure 1**–Equation 1), while grain protein increased (**Figure 2**–Equation 5) and kernel plumpness declined (**Figure 3**–Equation 9) dramatically. Grain yield increase to N additions were large in the high yielding southern Alberta trials with minimal water stress (**Figure 1**–Equation 4), while modest increases were observed in grain protein (**Figure 2**–Equation 8), and minimal declines were noted in kernel plumpness (**Figure 3**–Equation 12).

While optimum grain yields were found to occur commonly in the 130 to 150 lb N/A range (**Figure 1**), this was not the case when the critical factor of malt barley quality, grain protein (**Figure 2**), and kernel plumpness (**Figure 3**), were considered. While most of the barley grain samples were less than the 13.0 to 13.5% level in this study, under dry conditions the addition of N resulted in a steep linear increase in grain protein (**Figure 2**–Equation 5), while only a modest curvilinear increase was noted under the low water stress conditions (**Figure 2**–Equation 8). Similarly, increasing N rate resulted in a decline in kernel plumpness of almost 50% with the high water stress trials (**Figure 3**–Equation 9), while the reduction was less than 10% for the low water stress, high yielding environment (**Figure 3**–Equation 12). These results indicate that the ability to grow a premium quality malt barley sample is severely limited under water stress conditions, a fact of life for semiarid dryland farmers.

The second Alberta study evaluated malt barley response to N using the available soil N supply as determined from the N uptake by the unfertilized check plot. This is significant in that the pre-plant soil test nitrate-N level was generally 18 to 36 lb N/A less than the unfertilized crop N uptake, with deviations of more than 45 lb N/A not uncommon. When the N uptake and fertilizer N additions were combined, they found that maximum malt barley grain yields were achieved at levels of approximately 1.2 lb N/bu (data not shown). This N level is very similar to application recommendations used in Montana, and considerably less than recommendations for hard red spring wheat (2.5-3.0 lb N/bu). Drier conditions in the second Alberta study meant that 43% of the trials had more than 13% grain protein when grain yield was optimized. They suggested that for this data set the optimum N rate for malt grain protein was more difficult to predict, and ranged from 0.7 to 1.2 lb N/bu, depending on environmental conditions.

The second Alberta study also focused on the impact of P, K, and S nutrition, as well as seeding rate and date for malt barley. Unfortunately, when all sites were combined the application of P, K, and S fertilizers did not affect malt barley grain yield or quality (data not shown). An economic analysis of grain yield response to P application showed a positive response at four of the 12 sites when the lowest P rate was used. Hot summer weather following a cool spring may explain the lack of a P response in most of this study. On an individual site basis, 3 locations showed a very modest, but significant grain yield response to K additions, ranging from 2.3 to 5.8%. Most of the soils in this second Alberta study had soil test K levels of greater than 100 parts per million (ppm), a level which has been shown to be sufficient for barley production in this region.

Seeding delays of approximately 20 days reduced barley grain yields by an average of 20% in the second Alberta study,



Nitrogen fertilizer response on stubble is dramatic in these barley plots in the Dark Brown soil zone near Carmangay, Alberta.

while it had little effect on grain protein or kernel plumpness (data not shown). With increasing drought stress on the barley crop, the yield loss with delayed seeding was even greater. Increasing seeding rates from 150 to 350 viable seeds/m² resulted in small yield gains and slight reductions in grain protein and kernel plumpness.

The most beneficial agronomic practices for malt barley production in the semiarid northern Great Plains were early seeding and application of N fertilizer at rates appropriate to the expected availability of moisture and soil N. Unfortunately, in the absence of an irrigation water supply this makes the selection of fertilizer N rates a major challenge for dryland farmers, and increases the risk of achieving a malting grade for barley grown. **BC**

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