Nitrogen Fertilization of Dryland Malt Barley for Yield and Quality

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Nitrogen (N) is the main component of fertilizer programs necessary for production of high quality malt barley. Quality, or the ability of the commodity to meet the needs of the grain processor, has long been a component of N fertilizer management schemes for malt barley. Generally, kernel plumpness (plump) and protein content are the dominant quality factors associated with malt barley production. With the recent disease problems in malt barley in the upper Midwest, more western two-row barley is being purchased by the malt industry. Usually, only irrigated barley has been contracted for malting purposes. The increased demand for 2-row barley has created an increased number of dryland barley contract opportunities from major malt barley buyers, even though dryland barley has always been purchased for malting purposes if it met the protein and plump specifications. Barley that qualifies for malting is usually worth at least twice as much as feed barley. Therefore, dryland barley growers are looking for N fertilizer response information that addresses grain quality factors as well as yield.

Fourteen experiments from Central, North central, and the Western Triangle areas of Montana were selected for regression analysis. Selection criteria included a variation in N fertilizer rates (usually 0-120 lbs N/a), adequate P (usually 30 lbs P_2O_5/a) and K (usually 30 lbs K_2O/a), and two-row, malt barley cultivars with similar yield potential (Harrington and Clark). Nitrogen and K fertilizers were broadcast while planting, and P fertilizer was applied with the seed. Fertilizer materials were urea, monoammonium phosphate, and KCl. Soils were sampled just prior to planting. Regression equations were developed using initial nitrate-N in three feet of soil plus fertilizer N as the independent variable versus the following dependent variables: grain yield, grain protein content, and kernel plumpness. A maximum location yield of 70 bu/a was used as the criterion to equally split the data into two databases with seven locations each. The less than 70 bu/a database included two fallow, three no-till recrop, and two conventionally tilled recrop locations. The database had initial soil nitrate-N levels ranging from 16 to 123 lbs N/a with an average of 44 lbs N/a. The greater than 70 bu/a database consisted of four fallow and three no-till recrop locations and had initial soil nitrate-N levels ranging from 18 to 55 lbs N/a with an average of 36 lbs N/a. The previous crop for all the recrop locations was small grains, usually barley.

The regression equations showing the relationship of N on grain yield, protein content, and plump are plotted in Figures 1, 2, and 3, respectively. As indicated in Figure 1, the two databases have distinctly different grain yield versus N response curves. However, optimal yields occur near 140 lbs N/a for both yield response curves. These yield response curves mean very little to malt barley production until the effects of N on grain protein and plump are considered. As expected, both databases showed a positive relationship between grain protein and available N, with nearly identical slopes (Figure 2). The regressions indicate that barley with a potential yield less than 70 bu/a (Equation 3) contains about 1.2% more protein for each N level than barley with a potential yield greater than 70 bu/a (Equation 4). For example, at the 140 lb/a N level, Equation 3 predicts 12.7% protein while Equation 4 predicts 11.5% protein. Both protein levels should be within standard malt barley specifications, which require that protein be less than 13.5%.

Kernel plumpness, however, is a different story. Kernel plumpness requirements by malt barley buyers vary from year to year depending upon the quantity and quality of barley production available for malting. Sometimes malt barley can be upgraded by removing thin kernels. In 1999, dryland barley was purchased for malting if it contained 70% or more plump kernels; however, current dryland contracts specify a minimum of 75% plump. The relationship of N management and kernel plumpness is readily apparent and demonstrates its role in producing dryland malt barley. Growers with yield potential of 70 bu/a or less must watch their N very closely because Equation 5 predicts 75%

plump at 55 lbs N/a, and most fallow fields would not need fertilizer N to produce malt barley. Using Equation 1, 55 lbs N/a would produce 38 bu/a (1.4 lbs N/bu). Producers with the higher yield potential can use equation 6 to estimate kernel plump, and in this case, 75% plump occurs at about 115 lbs N/a which according to Equation 2 would produce about 80 bu/a (1.4 lbs N/bu). Table 1 summarizes the effects of N on yield, protein, and plump, and demonstrates that plump, not protein, is the characteristic that likely limits N fertilizer application rates for the locations tested.

For dryland malt barley growers, producing quality malt barley is often a matter of luck and art because N fertility must be matched with growing season water in order to produce a crop with acceptable kernel plumpness. Management techniques that emphasize large kernels rather than more kernels should be practiced. Soil testing to measure the initial soil nitrate N is a must. If soil nitrate N levels exceed 50 lbs N/a in three feet of soil when the potential yield exceeds 70 bu/a, then producers should plan to topdress more N at or after tillering, if needed, when yield potential can be more accurately estimated. Then, N fertilizer can be used to adjust the total N fertility (includes soil nitrate N in three feet of soil) to the anticipated yield at the rate of 1.2 to 1.4 lbs N/bu to maximize yield while meeting plump specifications.

Fertilizer Facts:

- With proper N management techniques, dryland malt barley can be grown and meet market specifications.
- Malt barley grain yield, grain protein, and kernel plumpness characteristics are strongly related to yield potential and available N.
- On average, available N (soil NO_3-N + fertilizer N) should be 1.2 - 1.4 lbs N/bu of yield potential.
- Environmental factors such as drought stress that occur late in the season can adversely affect grain yield, and, in particular, quality characteristics.

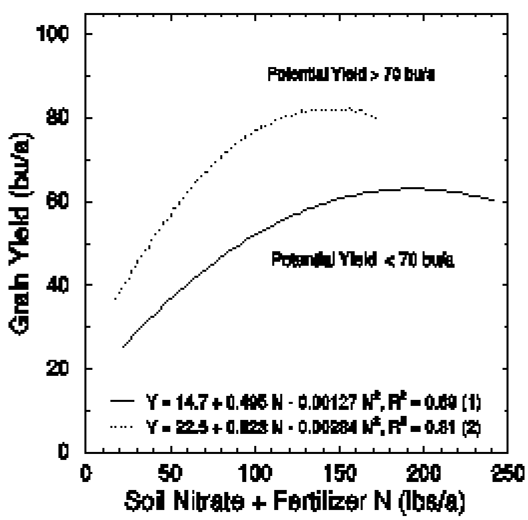

Figure 1. Effect of N on barley grain yield.

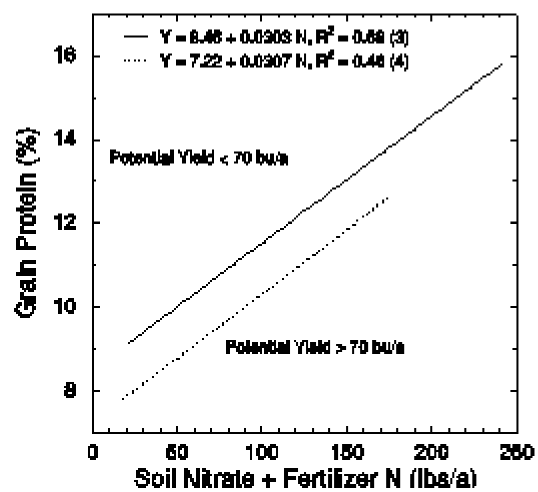

Figure 2. Effect of N on barley grain protein

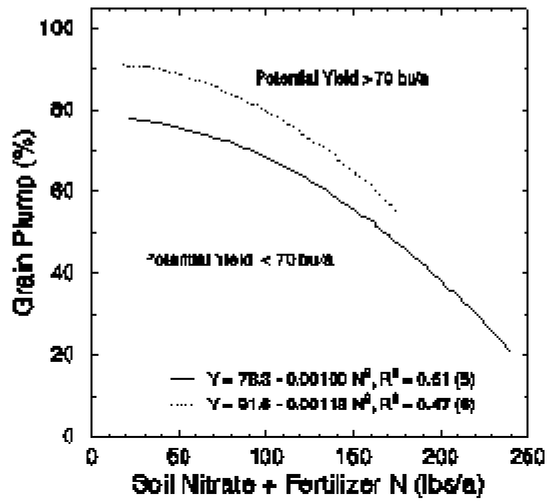

Figure 3. Effect of N on barley grain plumpness.

Table 1. Effect of N on barley yield, protein, and plump based on averages of seven locations for both potential yields.

Potential Yield <70 bu/a					Potential Yield <70 bu/a				
Soil $N0_3$+ Fert. N	**Yield**	**Protein**	**Plump**	**N/bu**	**Soil $N0_3$+ Fert. N**	**Yield**	**Protein**	**Plump**	**N/bu**
(lb/a)	*(bu/a)*	*(%)*	*(%)*	*(lb N/bu)*	*(lb/a)*	*(bu/a)*	*(%)*	*(%)*	*(lb N/bu)*
30	28.4	9.4	77.4	1.1	70	66.2	9.4	85.1	1.1
40	32.5	9.7	76.7	1.2	80	70.2	9.7	84.0	1.1
50	36.3	10.0	75.8	1.4	90	73.6	10.0	82.0	1.2
60	39.8	10.3	74.7	1.5	100	76.4	10.3	79.8	1.3
70	43.1	10.6	73.4	1.6	110	78.7	10.6	77.3	1.4
80	46.2	10.9	71.9	1.7	120	80.4	10.9	74.6	1.5
90	49.0	11.2	70.2	1.8	130	81.5	11.2	71.7	1.6

Edited by Jeff Jacobsen, Extension Soil Scientist