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NITROGEN MANAGEMENT FOR WINTER MALTING BARLEY

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Abstract

Winter malting barley is a potential alternative crop for dryland producers in eastern Oregon. Excessively high or low grain protein levels will result in unacceptable malt quality. The objective of this research was to evaluate the effects of different nitrogen (N) management schemes on grain yield and protein and various malting quality characteristics. We seeded three winter barley varieties and six winter barley lines in mid-October. Pre-plant fall N was applied at 0, 50, 100, or 150 lbs per acre and spring N was applied at either 0 or 50 lbs per acre when the barley was in the four-leaf stage of development. Increasing fall N application rates increased grain yield and protein. Applying 50 lbs of N in the spring further increased grain protein but had little effect on grain yield. Spring N application had mixed effects on malting quality.

Key Words
Malting barley, nitrogen management, barley yield, malting barley quality

Introduction

The development of a superior quality, well-adapted winter malting variety will offer growers in eastern Oregon a potential alternative crop. Winter malting barley lines suitable for production in eastern Oregon are being developed at Oregon State University (OSU); the most promising of these lines are currently undergoing evaluation for malting and brewing quality. We are evaluating the response of these lines to various agronomic variables in this research program. This report will discuss only the nitrogen (N) management component of the program.

Grain protein is a key “gateway” characteristic for malting quality. Excessively high or low protein levels result in unacceptable malt quality. Six-row malting barley should have from 11.5 to 13.5% protein. In many other production areas, the major grain quality issue is excessively *high* protein levels and growers are challenged to produce grain with protein levels less than 13.5%. This presents real difficulties since there are only limited crop management options to minimize grain protein under these conditions. Fortunately, we in the dryland Pacific Northwest (PNW) are in the enviable position of having to manage our barley crops to increase the grain protein levels. There are more management options available to growers to raise protein levels.

New barley varieties are being developed and their yield and grain protein response to N fertilizer has not been evaluated. Determining the effect of N management on grain protein levels in advanced barley lines will permit us to make informed decisions about these lines prior to public release.

There are questions regarding the optimum N fertilization practices that are needed to consistently produce malting barley with acceptable protein levels. There has been only limited research on N management for malting barley in the PNW so we must turn to N management research on wheat for some general guidelines. Preplant N applications to hard red winter wheat tend to increase grain protein only after the yield potential is achieved. Further increasing the N application rate beyond that needed for maximum yield will then lead to increased grain protein. High rates of preplant N fertilization can be used to increase grain yield and protein but there are significant disadvantages to this practice. This practice increases the potential for N losses and the higher N rates used increase grower cost and often lead to lodging that can reduce yield and greatly increase harvest difficulty.

The objectives of this research were to evaluate the effects of increasing N application rates and split N applications on the plant height, grain yield, grain protein, and plumpness of three winter barley varieties and six winter barley lines. In this article we will report on the first year of the study.

Materials and Methods

Three winter barley feed varieties and six winter malting barley lines were seeded on October 16, 2000 using a nine-row Hege cone seeder with disk openers on 6-in row spacing. Soil samples collected prior to seeding were analyzed and the results are shown in Table 1.

Table 1. Soil test results.

Sample depth	NO_3-N	NH_4-N	P	SO_4-S
--- ft ---	----------------------------------	ppm	----------------------------------	
0 – 1	8.3	4.0	21	7
1 – 2	6.5			8
2 – 3	7.3			
3 – 4	4.5			
4 – 5	5.3			
Total	31.9	4.0		

Preplant nitrogen was applied at 0, 50, 100, or 150 lbs of N/acre as anhydrous ammonia. The entire trial area received 100 lbs K_2SO_4/acre to supply K and S and 80 lbs of P_2O_5/acre as triple superphosphate (0-45-0). Individual treatments received an additional 50 lbs of N as urea broadcast applied on March 5, 2001 when the plants were in the four-leaf stage of development. The trial was arranged as a split-split plot design with preplant fall N rates as main plots, spring N rates as sub-plots and malting barley lines as sub-sub-plots. Plant height was measured and the plots were harvested using a Hege plot combine. The grain from the plots was weighed and subsamples collected for determination of test weight, grain protein, and plumpness.

Results and Discussion

Averaged across all N rates, the plant height of the three varieties and six lines in this study varied from 35.8 in for Stab 113 to 39.2 in for 88Ab536 and Stab 47 (Table 2). It is important to note, however, that none of the varieties or lines lodged, even at the highest N rates.

There were significant differences in the yield potential of the three varieties and six lines averaged across all N rates (Table 2); Strider had the greatest grain yield with 5735 lbs/acre while Kold produced the least grain with only 4840 lbs/acre.

Table 2. Plant height, yield, and protein for three winter barley varieties and six winter barley lines averaged across all N rates.

Selection	Plant ht	Yield	Grain protein
	-- inches --	lbs/acre	-- % --
Strider	36.9	5735	10.7
Scio	35.6	5300	11.0
Kold	36.3	4840	11.3
88Ab536	39.2	5015	11.2
Stab 7	37.1	5075	11.2
Stab 47	39.2	5015	11.6
Stab 113	35.8	5035	10.8
Stab 171	38.1	5230	11.4
Kab 68	38.0	5320	10.7
$LSD_{0.05}$	0.81	245	0.24

The yields in this trial were substantially less than the yields in a separate variety trial seeded about 2 weeks earlier in the same field. For example, Strider produced about 7,500 lbs of grain/acre in the adjacent trial that was seeded on October 4, 2000. We speculate that the earlier seeding date increased the yield potential of this variety.

Grain protein also varied significantly among varieties and lines; Strider and Kab 68 had the lowest average protein at 10.7% while Stab 47 had 11% protein. The grain protein of the other varieties and lines was intermediate between Strider and Kab 68 and Stab 47. These data are the mean of all the N rates used in the study.

Nitrogen fertilizer applications markedly increased the plant height, grain yield, and grain protein (Fig. 1). The mean plant height was increased from 33 in with no N fertilizer to about 39 in when 100 lbs of N/acre or more was applied (Fig. 1A). Spring N increased the plant height when 0 or 50 lbs of N/acre was applied in the fall but did not increase plant height when 100 or 150 lbs of N was applied in the fall.

Application of N markedly increased the grain yield; mean grain yield was increased from 4200 to 5330 lbs/acre by the application of only 50 lbs of N/acre in the fall (Fig. 1B). Spring N applications increased the grain yield only when no N fertilizer was

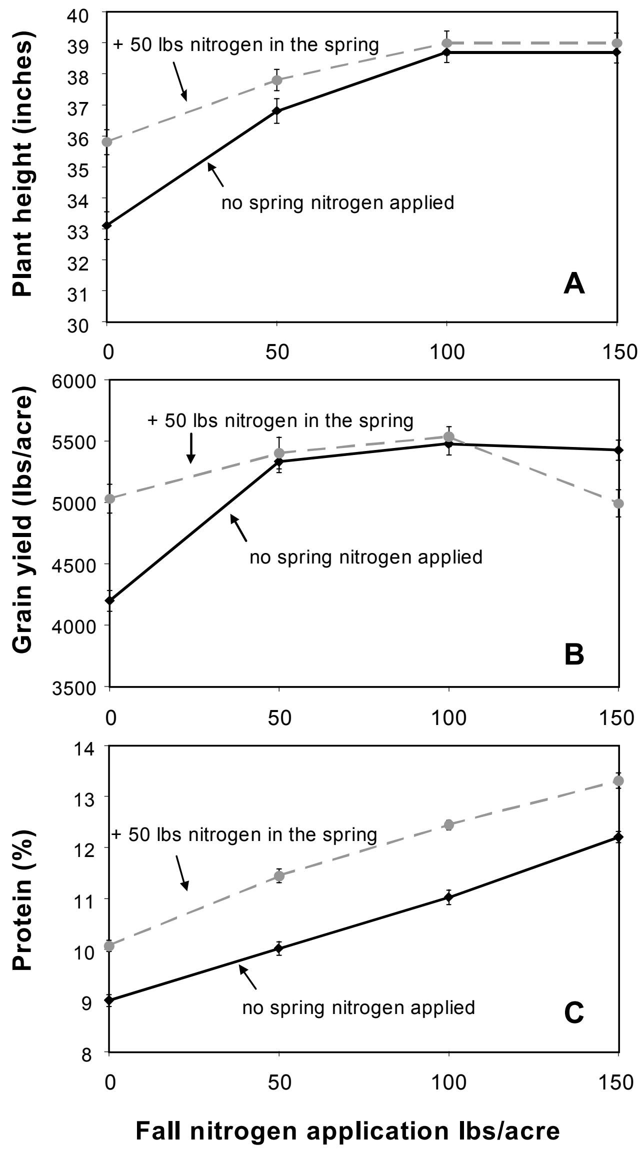

Figure 1. Average plant height (A), grain yield (B), and grain protein (C) of winter barley varieties and lines grown with different combinations of fall- and spring-applied N fertilizer. Error bars represent standard errors for each N treatment.

applied in the fall and actually decreased the yield when 150 lbs of N was applied in the fall. The possible reasons for this yield reduction are not clear; this yield reduction was not due to lodging as no lodging occurred in this trial.

Increasing the rate of fall N from 0 to 150 lbs of N/acre increased the mean grain protein from 9 to 12.2% (Fig. 1C). Applying 50 lbs of N in the spring resulted in about a 1% protein increase regardless of the fall N rate.

Malting quality data was obtained for five lines from one replication. Results are therefore preliminary, and will need to be verified in future trials.

Averaged across all varieties and lines, grain plumpness decreased with additions of fall and spring N fertilizer (Fig. 2A). On the average, adding 50 lbs N/acre in the spring decreased plumpness from 59 to 49%. One likely explanation for these results is that tillering increased with increased N levels, resulting in higher yields, but smaller kernels per tiller.

Important malting barley quality parameters include malt extract percentage, alpha-amylase activity, diastatic power, and plumpness. Malt extract percentage decreased slightly with increasing levels of fall N (Fig. 2). Spring N application also caused a slight reduction in malt extract percentage. Despite these effects, increased N levels had a generally positive effect on alpha-amylase content and diastatic power. Fall fertilizer treatments had little effect on levels of alpha-amylase, but spring N applications increased alpha-amylase activity by 6.7 units (data not shown). Diastatic power increased in response to fall and spring N application (Fig. 2C). A maximum diastatic activity of 135 was obtained in plots that received 100 lbs N/acre in the fall and 50 lbs N/acre in the spring.

In general, ranks of genotypes for malting quality characteristics were fairly consistent across N levels, so only the averages across N levels are presented (Table 3). Stab 171 had the greatest plumpness, malt extract, and alpha-amylase content, and had

Table 3. Average malting quality of five winter barley lines across all nitrogen fertilizer treatments in Pendleton, Oregon, 2000-2001.

Lines	Plumpness (%)	Malt extract (%)	Alpha amylase (20ºDU)	Diastatic power %(DSB)
Stab 7	43.4	79.4	56.3	120
Stab 47	52.8	77.7	54.6	111
Stab 113	64.9	79.0	51.1	102
Stab 171	66.5	80.7	57.0	74
88Ab536	42.7	78.5	51.0	125
Mean	54.1	79.0	54.0	107

relatively low turbidity. Unfortunately, this genotype had low diastatic power, and will probably not have acceptable quality for malting and brewing. Among the new lines, Stab 7 had the highest level of diastatic power (120), which was comparable to that of the standard check variety, 88Ab536.

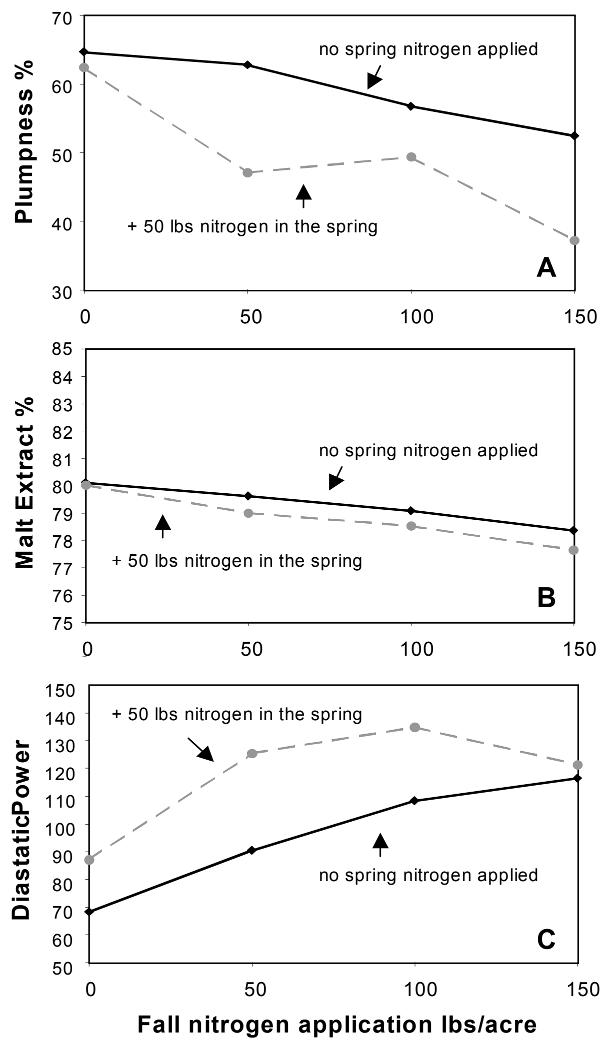

Figure 2. Average estimates of plumpness (A), malt extract (B), and diastatic power (C) of winter barley varieties and lines grown with different combinations of fall- and spring-applied N fertilizer. Data were obtained from a single replicate.

Summary

These three varieties and six lines of winter malting barley exhibited marked differences in plant height, grain yield, and grain protein and there were also significant differences in malting quality parameters between the malting lines. The application of N fertilizer increased the plant height, grain yield, and protein and had mixed effects on malting quality. These are preliminary results based on only 1 year of field trials but these results indicate that winter malting barley can be produced in the Pendleton area with acceptable yields and quality.

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