OPTIMIZING NITROGEN USE AND EVALUATING ETHEPHON USE IN WAXY BARLEY

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Introduction

Treasure Valley Renewable Resources is in the process of putting a grain fractionation plant in Ontario, Oregon and one of their primary interests includes contracting barley that has fully waxy starch, and is high in beta-glucan fiber and protein. Very little research has been done on growing barley for high protein and response of barley varieties to nitrogen application. Previous work by Brad Brown, Cereal Specialist, University of Idaho at Parma, has shown that 'Merlin' and 'Salute', spring genotypes developed by WestBred (Bozeman, MT), are among the best waxy cultivars available. A fall barley genotype would work best in our rotational system due to higher yields. Unfortunately, there are currently no fall waxy barley cultivars available. Research needs to be done so producers know how to apply nitrogen for optimum yield and protein and yet prevent environmental contamination from excessive nitrate. The purpose of this trial was to determine winter survival of two fall-planted spring waxy barley varieties, and compare yield and quality under different dry urea nitrogen treatments applied late winter, dry urea and fluid urea at heading, and evaluate ethephon growth regulator use for reducing lodging while maintaining yield.

Methods

The experiment was planted on Owyhee silt loam at the Malheur Experiment Station on a field that grew potatoes the previous year. A second location of the experiment was planted by Brad Brown with the University of Idaho at Parma, Idaho but not reported here. Seedbed preparation included disking, cultivating and furrowing. Soil samples were collected prior to fall tillage and showed 41 lb/acre nitrogen (N) in the top 3 ft of soil, in the top foot of soil 21 ppm phosphorus (P) (Olson method), 387 ppm potassium (K), 20 ppm sulfate (SO_4), 2,378 ppm calcium (Ca), 373 ppm magnesium (Mg), 2 ppm zinc (Zn), 8 ppm iron (Fe), 8 ppm magnesium (Mn), 0.8 ppm copper (Cu), 0.8 ppm boron (B), and 1.25 percent organic matter. The field was planted on October 25, 2005 with a plot drill on 30-inch beds with 3 drill rows per bed.

The experimental design was a randomized complete block design with three replications. The treatment design was a split plot design with varieties as the whole plots being varieties, and the sub-plots were an incomplete factorial design of late winter applications of 0, 60, 120, or 180 lb N/acre combined with treatments of 0 or 40 lb N/acre dry urea, 40 lb N/acre fluid urea foliarly applied at the 50 percent heading stage, and Ethephon 2® (ethephon) (FarmSaver.com LLC) applied at boot stage at 1.5 pt/acre plus 40 lb N/acre fluid urea foliarly applied. The late winter application of 180 lb N/acre treatment applied to Merlin and Salute did not receive any other treatments. Late winter N applications were hand applied February 13. The ethephon application was sprayed at boot stage on May 10. Heading applications were made May 26. Heading was designated when 50 percent of the heads had emerged from the boot.

Visual plant stand estimations were taken on April 12. Thirty flag leaves were taken from each plot and combined into one sample on May 25 and sent to Brookside Laboratory, New Knoxville, Ohio, for analysis. Twenty of those flag leaves were measured with a SPAD meter for greenness. The field was sprayed for weeds with Bronate® herbicide at 1 qt/acre applied May 11, 2006. The trial was furrow irrigated for 24 hours on May 2, May 19, June 1, June 15, and June 29. Plant height was measured on June 23, 2006. Plots were cut to size and harvested with a Hege combine on July 21 and 24.

Response variables were compared using GLM ANOVA and least significant differences at the 5 percent probability, LSD (0.05). Differences between response variables should be equal to or greater than the corresponding LSD (0.05) value before means are considered different from others.

Results

Fall planting of these spring genotypes resulted in reduced plant stands. Coming out of the winter, Merlin had a 40 percent stand, which was better than Salute at 30 percent. Averaged over varieties, as N rate increased from 0 to 180 lbs N/acre the percent stand dropped from 43 to 32 percent, respectively. Covariate analysis using percent stand indicated that stand did not significantly influence yield. Salute yield was more than Merlin with no late winter N application; however Merlin and Salute did not differ in yield at the 120-lb N/acre rate (Fig. 1). Averaged over late winter N application rates and heading treatments, Salute produced fewer seeds per area, fewer seeds per pound (larger seeds), had lighter test weight, lower crude protein in the grain, higher beta glucan, was taller, lower in flag leaf N concentration, had lower SPAD meter readings (less green leaves), and lower seed moisture at harvest than Merlin (Table 1). Averaged over varieties and N applications at heading and ethephon treatment, increasing late winter N rate from 0 to 120 lb/acre resulted in a maximum increase in yield of 24.6 bu/acre. The yield increase came from increased seed numbers (33 percent) and increased seed weight (4 percent). Increasing N rate further from 120 to 180 lb N/acre actually decreased yield by 11.7 bu/acre, even though lodging did not occur.

Averaged over late winter N treatments and varieties, applying 40 lb N/acre of fluid urea increased seed yield by 7.5 bu/acre. The increase caused by the heading application was larger when no late winter N was applied and smaller when late winter applications were made (Fig. 2). Grain protein was significantly increased by late winter fertilizer applications but not by heading applications (Table 2 and Fig. 3). Ethephon reduced plant height by almost 2 inches but it had no influence on lodging since there was no lodging in this experiment. Ethephon did not influence yield, but did significantly reduce seed weight and, more importantly, reduced beta glucan content by 0.6 percent compared to the control, the fluid urea treatment (Table 3). Averaged across varieties, increasing late winter N rate had a consistent influence on both leaf N percentage as well as the SPAD metering readings (Fig. 4). The ANOVA indicated that variety influenced SPAD meter results but did not influence the leaf N percentage as the late winter N application rate was increased.

Conclusion

Merlin was more winter hardy and maintained yield under high N conditions better than Salute. Stand reductions show that fall planting of either variety is risky. Salute yielded more with less N and with higher N prices that is important. Merlin, being hulless, had higher test weights, higher protein, and more seeds per pound. Salute was much taller and produced much more straw than Merlin. Salute has a more upright growth habit compared to Merlin, while Merlin has a more decumbent growth pattern. Salute has higher beta glucan and lower protein content than Merlin.

Applying the correct amount of late winter N is important to yield and quality. In this experiment late winter N application rate was more important than the heading N applications. Yield can still be increased with N applied as late as heading; however, maximum yield was attained by the late winter application. Ethephon can reduce plant height without decreasing yield, which could help reduce lodging; however, it also significantly reduced the beta glucan content, an important component of the seed.

Acknowledgement

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Table 1. Waxy barley yield and quality results of Merlin and Salute averaged over late winter nitrogen rate, heading nitrogen rate, and ethephon treatments. Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

Variety	Yield[a]	Seed # per area	Seed weight	Test weight	Crude protein	Beta glucan	Plant height	Flag leaf N	Spad meter	Harv. moist-ure	Stand
	bu/acre	seed # per ft^2	seed # per lb	lb/bu	%	%	inches	%		%	%
Salute	106.6	1,375	9,348	53.4	12.1	5.9	39	3.6	43.7	6.6	35
Merlin	103.6	1,433	10,015	61.8	13.2	5.4	26	3.8	50.1	8.7	45
LSD (0.05)	NS	70	121	0.2	0.5	0.4	0.8	0.1	1.1	0.3	4

[a]Yield and protein were corrected to a 12 percent moisture basis.

Table 2. Barley yield and quality results of harvest on July 20 as influenced by late fall nitrogen rate and averaged over varieties, heading nitrogen, and ethephon treatments at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

Late winter nitrogen rate	Yield[a]	Seed # per area	Seed weight	Test weight	Crude protein	Beta glucan	Plant height	Flag leaf N	Spad meter	Harv. moist-ure	Stand
lb/acre	bu/acre	seed # per ft^2	seed # per lb	lb/bu	%	%	inches	%		%	%
0	90.1	1,177	9,481	57.8	12.1	5.57	29.2	3.2	43.6	7.8	43.4
60	111.1	1,476	9,645	57.6	12.5	5.59	33.3	3.7	47.1	7.6	39.9
120	114.7	1,561	9,874	57.4	13.3	5.80	34.3	4.1	49.0	7.4	38.5
180	103.0	1,398	9,862	57.2	13.4	5.67	35.9	4.3	51.3	7.5	31.8
LSD (0.05)	6.9	100	175	NS	0.8	NS	1.1	0.2	1.5	NS	5.1

[a]Yield and protein were corrected to a 12 percent moisture basis, 48 lb = bushel.

Table 3. Barley yield and quality results of harvest on July 20 as influenced by late fall nitrogen rate and averaged over varieties and late fall nitrogen treatments, at the Malheur Experiment Station, Oregon State University, Ontario, Oregon, 2006.

Treatment	Yield[a]	Seed # per area	Seed weight	Test weight	Crude protein	Beta glucan	Plant height	Harvest moisture
	bu/acre	seed # per ft^2	seed # per lb	lb/bu	%	%	inch	%
No nitrogen	100.3	1,330	9,615	57.5	12.5	5.59	33.9	7.6
40 lb N/acre dry urea	106.1	1,399	9,568	57.8	12.6	6.06	32.6	7.6
40 lb N/acreliquid urea	107.8	1,434	9,644	57.7	12.9	5.79	32.5	7.4
40 lb N/acre liquid urea plus ethephon	107.8	1,478	9,921	57.5	12.6	5.19	30.6	7.8
LSD (0.05)	6.9	100.3	175	NS	NS	0.5	1.1	NS

[a]Yield and protein was corrected to a 12 percent moisture basis, 48 lb = bushel.

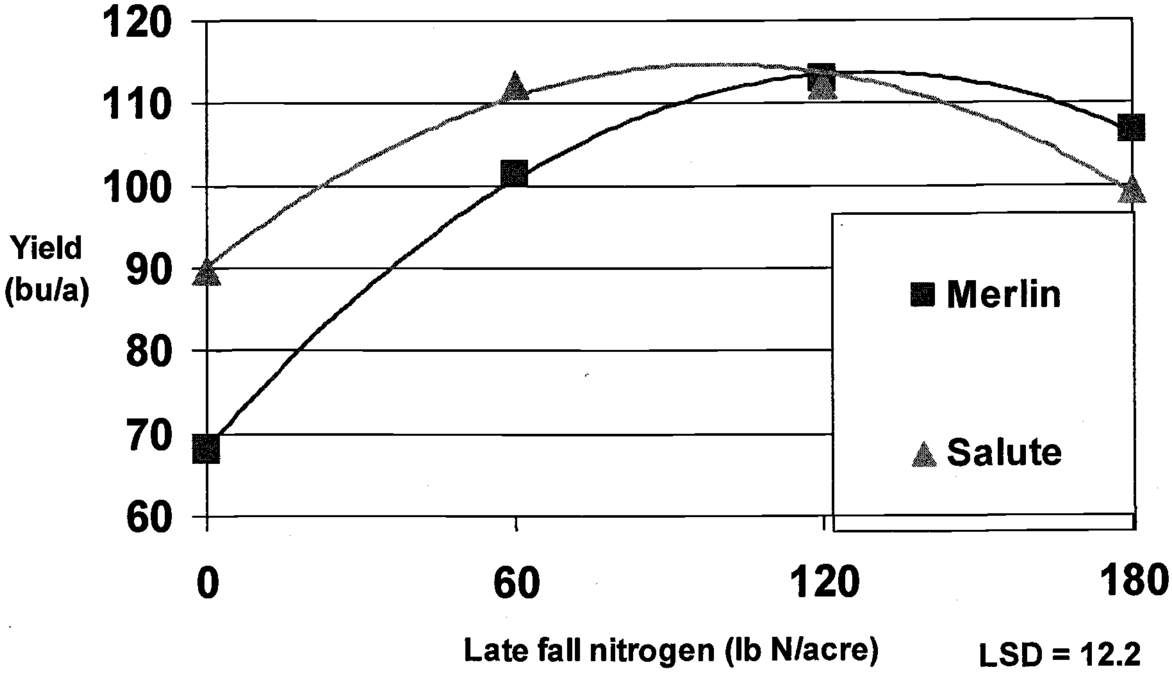

Figure 1. Yield of barley as influenced by late winter N application rate (lb N/acre urea) with no heading applications applied. Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

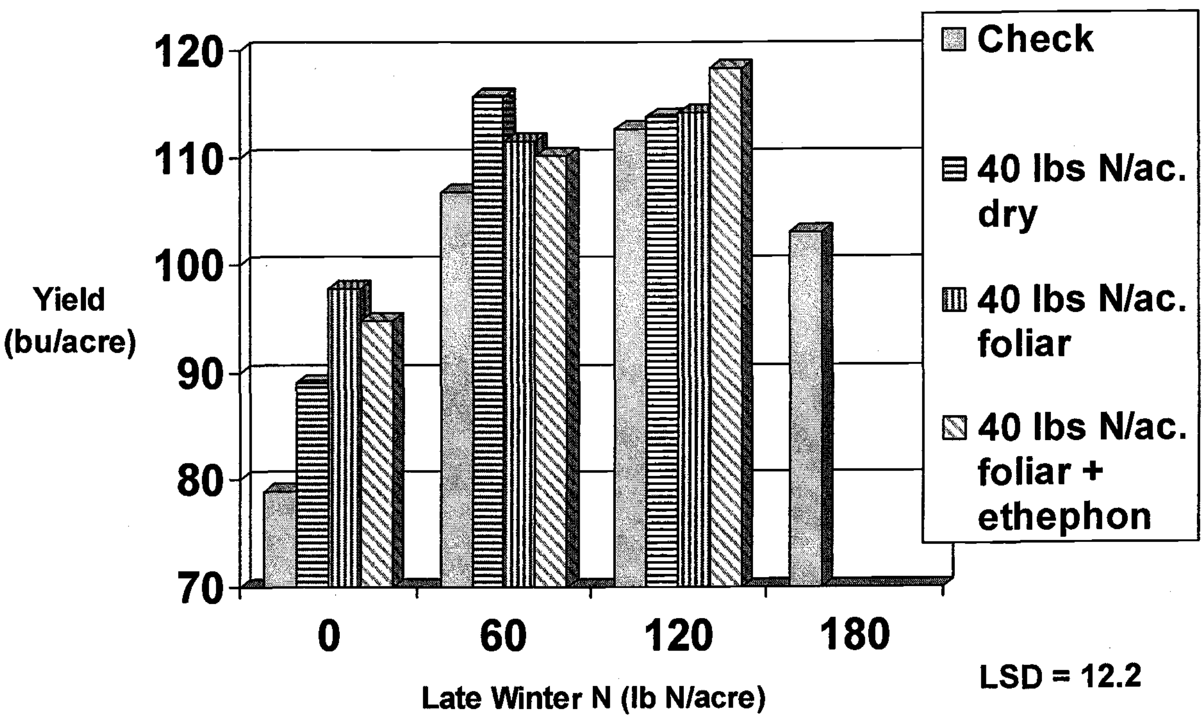

Figure 2. Averaged over varieties, barley yield as influenced by late winter N rate , heading nitrogen rates (dry and fluid urea), and ethephon at Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

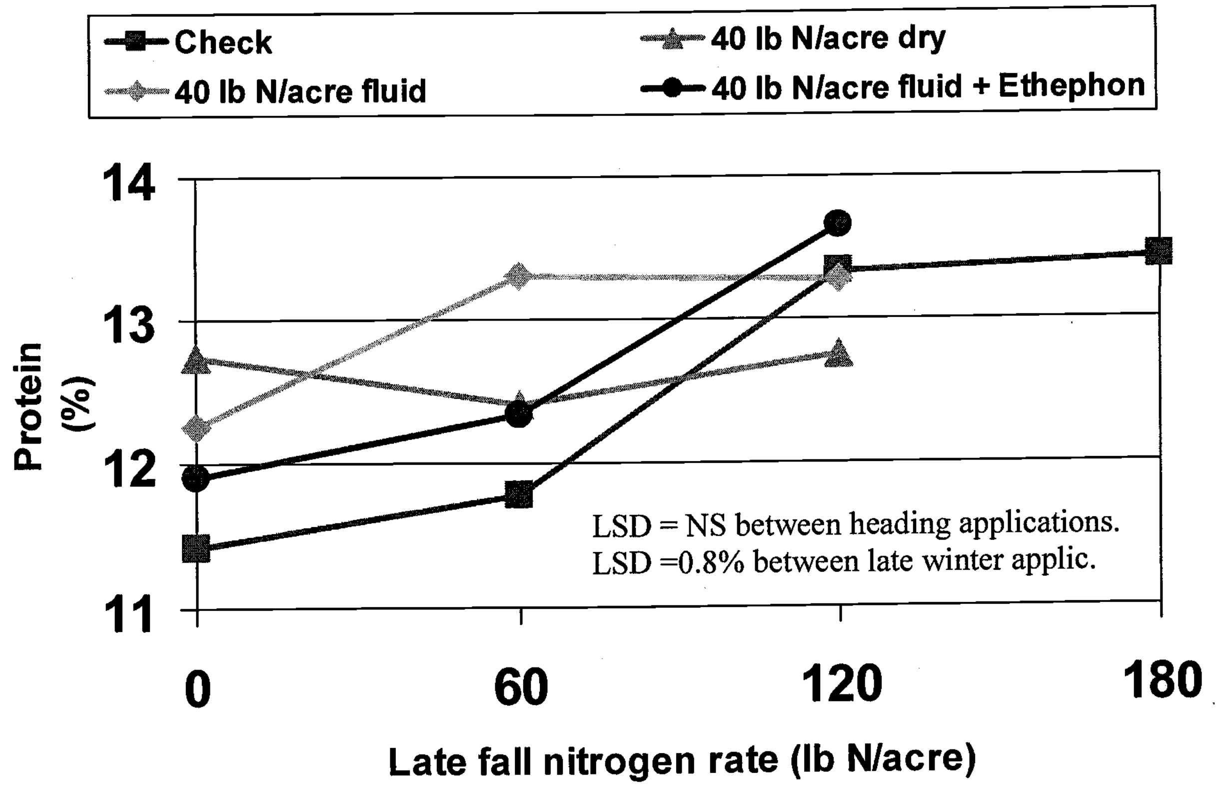

Figure 3. Grain protein averaged over varieties as influenced by late winter nitrogen rate, heading nitrogen (dry and fluid urea), and ethephon at Malheur Experiment Station, Ontario, OR, 2006.

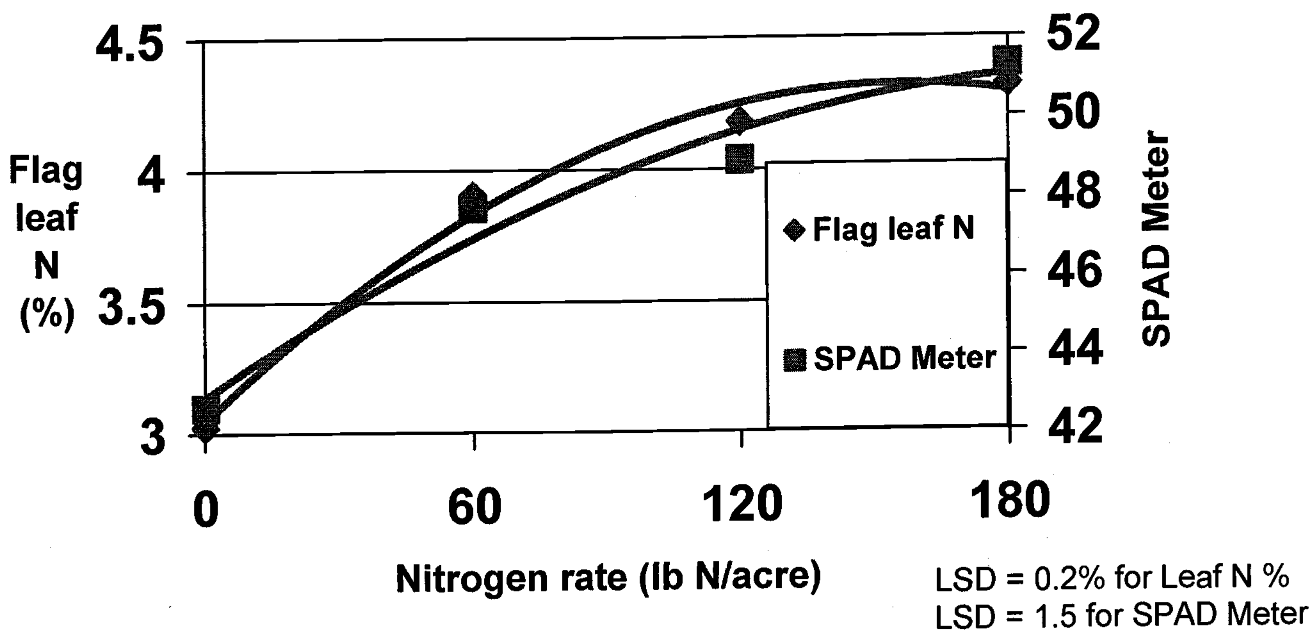

Figure 4. Flag leaf nitrogen and SPAD meter readings as influenced by late winter nitrogen application rate averaged over varieties Malheur Experiment Station, Ontario, OR, 2006.