INFLUENCE OF NITROGEN FERTILIZER APPLIED AT FLOWERING ON DURUM WHEAT GRAIN YIELD AND QUALITY

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Abstract

Application of nitrogen (N) fertilizer in conjunction with the irrigation event occurring closest to the flowering stage is effective in reducing the incidence of yellowberry and boosting grain protein levels of durum wheat. However, N applications at this time normally do not increase grain yield, except perhaps on very sandy soils. A field experiment was conducted to determine the profitability of applying 35 pounds of N per acre at flowering to durum wheat to avoid dockage for poor grain quality. Two treatments consisted of a check plot with no N applied at flowering and UAN 32 water run at a rate of 35 lbs. N/acre to basin irrigated durum wheat grown on a loamy sand soil. Maximum durum wheat grain yield (6157 lbs./acre), protein concentration (13.7%), and corrected income per acre ($480.31) was obtained with the N fertilizer application. In fact, N fertilization at flowering on this sandy soil increased durum wheat grain yield by 255 lbs./acre compared to the unfertilized plot.

Introduction

Wheat grown in western Arizona normally requires nitrogen (N) fertilizer applications to attain acceptable grain yields and quality. Wheat plants take up a majority of their N prior to the booting growth stage. Nitrogen deficiencies during this vegetative period can result in stunted wheat plants with fewer tillers (and heads) per plant, and reduced grain yield. Nitrogen deficiencies later in the season during grain fill tend to result in smaller kernel size, reduced bushel weight, lower grain protein, and a higher incidence of yellowberry. Conversely, N excesses tend to result in lodged wheat plants and grain yield reduction due to excessive vegetative growth, plus the potential for environmental pollution due to leaching of unutilized fertilizer-N.

Depending on native soil-N levels, irrigation practices, yield potential, and other factors, split N fertilizer applications totaling from 150 to 300 pounds of actual N per acre are usually required for optimum durum wheat grain yield and protein level (Ottman and Doerge, 1994). They suggest the application of 25 to 50 pounds of N fertilizer with each post emergence irrigation until flowering. Guidelines suggested for a N fertilizer program are the following: 75 pounds N per acre preplant, 40 pounds at tillering, 40 pounds at early jointing, 40 pounds at boot, and

25 to 35 pounds near flowering. They caution that excess irrigation water applications during grain fill or extremely high grain yields can result in yellowberry and grain protein problems.

Previous research conducted by the University of Arizona has shown that 20 to 40 pounds of N per acre in conjunction with the irrigation event closest to flowering is effective in reducing yellowberry incidence and boosting grain protein levels (Ottman et al., 1995). However, N applications at this time normally will not increase grain yield, except perhaps on very sandy soils. Furthermore, assuming durum wheat grain is worth $160 per ton and N fertilization costs $0.35 per pound of N, an application of 35 pounds N per acre would require a grain yield increase of 153 pounds (0.077 tons) to recover the expense of this N fertilizer application.

Materials and Methods

A field experiment was conducted during 1996 in Vicksberg, AZ located in eastern La Paz County to determine the effect of late season nitrogen (N) fertilization on basin irrigated 'Durex' durum wheat grain yield and quality. The experiment was conducted on a soil with a loamy sand texture. Individual plots were one irrigation basin wide (80 feet) by 1250 feet long (2.3 acres). Two treatments consisted of: 1) a check plot receiving split applications totaling 195 lbs. N/acre prior to flowering, with no N applied at flowering; and 2) Split N applications totaling 195 lbs. N/acre, plus UAN 32 applied in the irrigation water at a rate of 35 lbs. N/acre at flowering on April 9. The two treatments were replicated four times in randomized complete blocks.

Wheat basal stem samples were collected from 30 plants within each plot at heading on April 4 (prior to N fertilization on April 9 at the irrigation event closest to flowering) for laboratory determinations of nitrate-N concentration. Additionally, flag leaf samples were taken from 30 wheat plants within each plot on April 4 prior to N application and again on April 26 at 17 days after N application for laboratory determinations of Kjeldahl-N concentration. Each plot was harvested with a commercial combine and loaded on trucks that were weighed on a certified scale to determine grain yield at 10% moisture on June 10. Degree of lodging was estimated visually at harvest. A subsample of grain from each plot was taken from the combine for determinations of yellowberry percentage, protein concentration, moisture, and bushel weight. Laboratory analyses were done by Stanworth Crop Consultants (Blythe, CA). Statistical analyses were performed on the data using ANOVA and the least significant difference (LSD) test at the 0.05 level of probability when appropriate.

Results and Discussion

Table 1 shows basal stem nitrate-N concentrations prior to the application on N fertilizer at flowering. Stem nitrate levels measured in this study had fallen well below the critical level of 1000 ppm suggested by the University of Arizona for durum wheat at heading. Since nitrate-N levels were barely detectable in basal stem tissue sampled at heading, flag leaf samples were also taken and analyzed for total (Kjeldahl) N concentration prior to and following N fertilization (Table 1). Prior to N application, flag leaf total N levels were slightly above the critical level of 3.5% suggested at heading by researchers working in the Midwestern U.S. Flag leaf total N concentrations in unfertilized plots dropped from 3.8% observed at heading to 2.8% at the milky ripe growth stage. Flag leaf total N concentrations within fertilized plots averaged 3.1% at the milky ripe growth stage (17 days after fertigation), however this difference was not significant at the 0.05 level.

Furthermore, when flag leaf samples were taken at the milky ripe growth stage at 17 days after N fertilization, N deficiency symptoms were observed in wheat plants growing within the unfertilized check plots. Wheat plants that were fertilized at flowering were taller and darker green in color, compared to unfertilized wheat plants observed at 17 days after fertigation.

The application of N fertilizer at flowering produced maximum average durum wheat grain yield (6157 lbs./acre),

grain protein concentration (13.7%), and corrected net (minus the cost of late season N fertilizer) income ($480.31) on the loamy sand soil at this site (Table 2). No wheat plant lodging or grain yellowberry was observed. Nitrogen fertigation at flowering resulted in a statistically significant grain yield increase of 255 pounds per acre, compared to the unfertilized check plots. Grain protein concentration in unfertilized plots was below 13% which would result in a grain price discount of $20/ton. Late season N fertilization resulted in grain protein concentrations exceeding 13% which would add a $20/ton premium to the price of the grain. Thus, higher net income per acre due to late season N application resulted not only from the increased grain yield, but also from the higher price that would be paid for premium grain protein concentration. Consequently, late season N fertilization of durum wheat resulted in a $67.15/acre increase in income, compared to unfertilized plots.

References

Ottman, M.J., and T.A. Doerge. 1994. Durum quality is related to water and management. 1994 Forage and Grain Report. College of Agriculture Report, Series P-98. University of Arizona. Tucson, AZ. pp. 19-23.

Ottman, M. J., T.A. Doerge, and E.C. Martin. 1995. Late season water and nitrogen effects on durum quality, 1995 (Preliminary). 1995 Forage and Grain Report. College of Agriculture Report, Series P-102. University of Arizona. Tucson, AZ. pp. 37-42.

Table 1. Durum wheat basal stem plant tissue nitrate-N and flag leaf total N concentrations at heading (4 April) prior to N application at flowering and flag leaf total N concentrations at 17 days following N application (26 April).

N Rate	Pre-Application Basal Stem Nitrate-N	Pre-Application Flag Leaf Total N	Post-Application Flag Leaf Total N
lbs. N/acre	ppm	%	%
0	103 a	3.8 a	2.8 a
35	75 a	3.8 a	3.1 a
LSD (0.05)	N.S.	N.S.	N.S.
ANOVA-P Level	0.27	0.73	0.10
Suggested Critical Level	1000	3.5	3.5

Means within columns followed by the same letter are not significantly different at the 0.05 level of probability according to the LSD method.

Table 2. Response of durum wheat harvested June 10 to nitrogen (N) fertilizer water run as UAN 32 at a rate of 35 lbs. N/acre at flowering on April 9.

N Rate	Plant Lodging	Grain Yellowberry	Grain Protein	Grain Yield	Net Income
lbs. N/acre	%	%	%	lbs./acre	$/acre
0	0 a	0 a	11.8 b	5902 b	413.16 b
35	0 a	0 a	13.7 a	6157 a	480.31 a
LSD (0.05)	N.S.	N.S.	0.8	145	9.75

Means within columns followed by the same letter are not significantly different at the 0.05 level of probability according to the LSD method. Net income assumes N costs $0.35/lb., $160/ton is paid for durum wheat grain with protein levels exceeding 13% and $140/ton for grain with protein levels below 13%.