Use of Tissue Testing to Prevent Low Grain Protein Content in Durum, 2004

M. J. Ottman, S. H. Husman, and P. A. Clay

Summary

Low grain protein content in durum can be prevented by applying nitrogen fertilizer after heading. Tentative guidelines were established from previous research for nitrogen fertilizer applications after heading based on the lower stem nitrate content near heading. Ten commercial durum fields were selected for testing the use of these guidelines to ensure grain protein contents greater than 13%. The average protein content was 14.00%, the amount of nitrogen fertilizer actually applied by the growers after heading averaged 44.5 lbs N/acre, whereas the amount recommended by the tentative guidelines averaged 41.5 lbs N/acre. If the tentative guidelines had been followed, we estimate that the average grain protein content would have been about 13.92%, and two fields would have been slightly below 13% protein (about 12.8% protein). Our tentative nitrogen fertilizer recommendations based on stem samples near heading appear accurate.

Introduction

Low protein content in durum is caused primarily by nitrogen deficiency later in the season. We have conducted research on using various tissue tests at heading to predict the need for late season nitrogen application to increase grain protein (Riley et al., 1998; Riley et al., 1999). The most promising of these tests is the lower stem nitrate test. We have developed tentative guidelines for the use of this test, and propose to test the use of these tentative guidelines on commercial farms. The purpose of this investigation is to evaluate the tentative guidelines for the use of the lower stem nitrate test at heading to prevent low grain protein content in durum.

Procedures

Ten commercial fields were selected in Pinal, Maricopa, and Yuma Counties for evaluation of the use of the lower stem nitrate test at heading to prevent low grain protein content in durum. The lower portion of the stem was sampled at heading and nitrate content determined using a nitrate electrode. Nitrogen fertilizer was applied between flowering and milk based on the guidelines developed from the lower stem nitrate test (Table 1). Grain protein was supplied to the grower by the grain company. The target grain protein is 13%.

Results and Discussion

Grain protein for the various sites averaged 14.00% and no sites had grain protein content below 13% (Table 2). The amount of nitrogen fertilizer actually applied after the stem samples were taken averaged 44.5 lbs N/acre, and the amount recommended to be applied according to the tentative guidelines in Table 1 averaged 41.5 lbs N/acre. The difference in the recommended and actual amounts of nitrogen fertilizer to be applied after stem sampling is 3.0 lbs N/acre. If we assume that 37.5 lbs N/acre is required to increase grain protein content by 1 percentage point, then the average grain protein content would have been 13.92% instead of 14.00% if the recommended amount of N

had been applied on average. If we perform the same calculation for individual fields, the fields that would be below 13 protein would be Eloy (12.78% protein) and Paloma (12.81% protein).

The 2004 durum growing season was characterized by low grain yields and high protein contents well above 13%.

References

Doerge, T. A., R. L. Roth, and B. R. Gardner. 1991. Nitrogen fertilizer management in Arizona. Univ. Ariz. College Agric. Tucson.

Riley, E. A., T. L. Thompson, S. A. White, and M. J. Ottman. 1998. Late season tissue tests for critical grain protein content in Durum, Maricopa, 1998. p. 43-50. Forage and Grain. Univ. Ariz. College Agric. Report Series P-114. Tucson.

Riley, E. A., T. L. Thompson, S. A. White, and M. J. Ottman. 1999. Late season tissue tests for critical grain protein content in Durum, Maricopa, 1999. p. 76-83. Forage and Grain. Univ. Ariz. College Agric. Report Series P-118. Tucson.

Table 1. Recommended growth stages for lower stem tissue sampling and interpretation of lower stem nitrate-N levels for small grains in Arizona (Doerge et al., 1991). Proposed interpretation of lower stem nitrate-N levels at the heading stage is in bold.

Stage at Stem Sampling	Stem Nitrate-N Levels	Stage at N Fertilizer Application	Suggested N Fertilizer Rates
	ppm		lbs N/acre
3-4 leaf	>5000	3-4 leaf to Joint	0
	2000-5000		0 - 50
	<2000		50 - 100
Joint	>3000	Joint to Boot	0
	1000-3000		0 - 50
	1000		50 - 75
Boot	>3000	Boot to Heading	0
	1000-3000		0 – 30
	1000		30 - 60
Heading	**>3000**	**Heading to Milk**	**0 - 30**
	1000-3000		**30 - 60**
	1000		**60 - 90**

Table 2. Cultural practices and other pertinent information related to stem nitrate concentration near heading and grain protein for various sites.

Location	Casa Grande	Casa Grande	Coolidge
Variety	Kronos	Kronos	Ocotillo
Planting date	1/5/04	1/5/04	12/18/03
Irrigations + fertilization	1/5 + 75 lbs N/a	1/5 + 75 lbs N/a	12/18 + 84 lbs N/a
	2/3 + 50 lbs N/a	2/3 + 50 lbs N/a	2/7 + 53 lbs N/a
	3/17 + 60 lbs N/a	3/17 + 60 lbs N/a	3/13 + 71 lbs N/a
	4/1 + 53 lbs N/a	4/1 + 53 lbs N/a	4/1 + 53 lbs N/a
	4/16 + 60 lbs N/a	4/16 + 60 lbs N/a	4/21 + 53 lbs N/a
	4/24	4/24	5/4
	5/5	5/5	
N rate (lbs N/a)	298	298	314
Yield (lbs/a)	6400	6400	4800
Grain protein (%)	15.11	14.40	14.86
HVAC (%)			
Stem sample date	4/8	4/8	4/19
Stem nitrate (ppm)	4155	4155	1545
N applied after stem sample (lbs N/a)	60	0	53
N recommended after stem sample (lbs N/a) according to Table 1	0 - 30	0 - 30	52

Location	Eloy	Paloma
Variety	Mohawk	Alamo
Planting date	12/19/03	12/20/03
Irrigations + fertilization	12/19 + 20 lbs N/a	12/20 + 20 t/a sludge
	1/22 + 81 lbs N/a	53 lbs N/a
	2/9	53 lbs N/a
	3/12 + 45 lbs N/a	
	3/29 + 53 lbs N/a	
	4/12 +89 lbs N/a	
	4/28	
	5/11	
N rate (lbs N/a)	288	106 + 20 t/a sludge
Yield (lbs/a)	6680	
Grain protein (%)	13.29	13.7
HVAC (%)		99
Stem sample date	4/8	
Stem nitrate (ppm)	650	5475
N applied after stem sample (lbs N/a)	89	0
N recommended after stem sample (lbs N/a) according to Table 1	70	0 - 30

Table 2. (con'd) Cultural practices and other pertinent information related to stem nitrate concentration near heading and grain protein for various sites.

Location	Paloma	Yuma	Yuma
Field		4 (S1-3)	86 (C1-4)
Variety	Alamo	Kronos	Kronos
Planting date	12/20/03	1/8/04	1/17/04
Irrigations + fertilization	12/20 + 48 lbs N/a	1/8 + 106 lbs N/a	1/17 + 53 lbs N/a
	53 lbs N/a	2/18 + 53 lbs N/a	2/24 + 71 lbs N/a
	53 lbs N/a	3/15 + 25 lbs N/a	3/18 + 25 lbs N/a
	53 lbs N/a	3/29 + 53 lbs N/a	3/30 + 42 lbs N/a
	53 lbs N/a	4/12 + 42 lbs N/a	4/12 + 42 lbs N/a
N rate (lbs N/a)	260	279	233
Yield (lbs/a)		6840	6380
Grain protein (%)	13.0	14.0	14.5
HVAC (%)	98		
Stem sample date		4/7	4/8
Stem nitrate (ppm)	2100	2300	5000
N applied after stem sample (lbs N/a)	53	53	42
N recommended after stem sample (lbs N/a) according to Table 1	46	48	0 - 30

Location	Yuma	Yuma
Field	1 (N-4)	8
Variety	Duraking	Duraking
Planting date	2/13/04	3/11/04
Irrigations + fertilization	2/13 + 115 lbs N/a	3/11 + 53 lbs N/a
	3/15 + 42 lbs N/a	4/4 + 53 lbs N/a
	3/29 + 53 lbs N/a	4/19 + 53 lbs N/a
	4/12 + 53 lbs N/a	4/30 + 71 lbs N/a
	4/26 + 53 lbs N/a	5/15 + 42 lbs N/a
N rate (lbs N/a)	316	272
Yield (lbs/a)	4100	4580
Grain protein (%)	13.3	13.8
HVAC (%)		
Stem sample date	4/22	5/10
Stem nitrate (ppm)	1800	2500
N applied after stem sample (lbs N/a)	53	42
N recommended after stem sample (lbs N/a) according to Table 1	48	38