

# Use of Tissue Testing to Prevent Low Grain Protein Content in Durum, 2003

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%. Only one field had grain protein content less than 13% (12.83%), and this field had herbicide damage and had to be over-irrigated due to surface unevenness. The average protein content was 13.62% but the amount of nitrogen fertilizer actually applied by the growers after heading averaged 74.5 lbs N/acre, whereas the amount recommended by the tentative guidelines averaged 53.1 lbs N/acre. If the tentative guidelines had been followed, we estimate that the average grain protein content would have been about 13.04%. Our tentative nitrogen fertilizer recommendations based on stem samples near heading appear accurate, but another year of testing would add more certainty.*

## 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 Pima, Pinal, and Maricopa 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 and HVAC were supplied to the grower by the grain company. The target grain protein is 13% and the target HVAC is 90%.

## Results and Discussion

Grain protein for the various sites averaged 13.62% and only one site (Sacaton 1N) had a grain protein content below 13% (Table 2). This particular site had damage from Staple carryover and an uneven surface profile required over-irrigating. The amount of nitrogen fertilizer actually applied after the stem samples were taken averaged 74.5 lbs N/acre, and the amount recommended to be applied according to the tentative guidelines in Table 1 averaged

53.1 lbs N/acre. The difference in the recommended and actual amounts of nitrogen fertilizer to be applied after stem sampling is 21.4 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 13.04% instead of 13.62% if the recommended amount of N had been applied and only one field would have been less than 13% protein.

The 2003 durum growing season was characterized by high grain yields and protein contents generally above 13%. We hope to repeat this study next year to determine if our tentative nitrogen fertilizer guidelines after heading result in grain protein contents greater than 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 ppm	Stage at N Fertilizer Application	Suggested N Fertilizer Rates 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
<b>Heading</b>	<b>&gt;3000</b>	<b>Heading to Milk</b>	<b>0 - 30</b>
	<b>1000-3000</b>		<b>30 - 60</b>
	<b>1000</b>		<b>60 - 90</b>

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

Location	Red Rock	Casa Grande	Casa Grande
Field	33	---	7
Variety	WPB 881	Mohawk	Kronos
Planting date	1/12/03	1/15/03	1/08/03
Irrigations + fertilization	1/12 + 69 lbs N/a as 46-0-0	1/15 + 24 lbs N as 11-52-0 + 51 lbs N as 46-0-0 + 64 lbs N as 32-0-0	1/08 + 24 lbs N as 11-52-0 + 51 lbs N as 46-0-0 + 57 lbs N as 32-0-0
	2/10 + 92 lbs N/a as 46-0-0	2/21 + 53 lbs N/a as 32-0-0	2/19 + 42 lbs N/a as 32-0-0
	3/10 + 71 lbs N/a as 32-0-0	3/05 + 42 lbs N/a as 32-0-0	3/06 + 67 lbs N/a as 32-0-0
	4/08 + 71 lbs N/a as 32-0-0	3/20 + 42 lbs N/a as 32-0-0	3/23 + 58 lbs N/a as 32-0-0
	5/14 + 35 lbs N/a as 32-0-0	4/03	5/05
		4/14 + 50 lbs N/a as 32-0-0	5/14
		4/24	5/30
		5/09	
		5/19	
N rate (lbs N/a)	338	326	299
Yield (tons/a)	2.51	3.90	3.75
Grain protein (%)	13.6	14.0	13.5
HVAC (%)	---	98	98
Heading date	4/4?	3/25?	3/14
Flag leaf N (%)	5.06	3.77	3.62
Stem sample date	4/15	4/1	3/18
Stem nitrate (ppm)	3490	4050	2175
N applied after stem sample (lbs N/a)	35	50	58
N recommended after stem sample (lbs N/a) according to Table 1	30	30	42

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

Location	Maricopa	Coolidge
Field	15	17
Variety	Alamo	Mohawk
Planting date	12/19/02	12/13/02
Irrigations + fertilization	12/19 + 15 lbs N/a as 10-34-0 + 61 lbs N/a as 32-0-0	12/13 + 68 lbs N/a as 27-0-0
	1/28 + 66 lbs N/a as 32-0-0	1/27 + 53 lbs N/a as 32-0-0
	2/11 (N only) 59 lbs N/a as 46-0-0	3/01 + 71 lbs N/a as 32-0-0
	3/07 + 72 lbs N/a as 32-0-0	3/15 + 64 lbs N/a as 32-0-0
	3/30 + 63 lbs N/a as 32-0-0	3/29 + 71 lbs N/a as 32-0-0
	4/14 + 35 lbs N/a as 32-0-0	4/12 + 35 lbs N/a as 32-0-0
	5/01	5/01
N rate (lbs N/a)	373	362
Yield (tons/a)	3.26	3.86
Grain protein (%)	14	13.87
HVAC (%)	98	98
Heading date	3/23	3/28?
Flag leaf N (%)	2.69	2.89
Stem sample date	3/31	4/8
Stem nitrate (ppm)	1060	925
N applied after stem sample (lbs N/a)	98	35
N recommended after stem sample (lbs N/a) according to Table 1	59	62

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

Location	Sacaton	Sacaton	Maricopa
Field	Sacaton 3S	Sacaton 1N	107E
Variety	Orita	Orita	Crown
Planting date	12/13/02	12/20/02	12/8/02
Irrigations + fertilization	12/13 + 92 lbs N/a as 46-0-0	12/20 + 92 lbs N/a as 46-0-0	12/8 + 16 lbs N/a as 11-52-0
	1/23	1/22	1/24 + 53 lbs N/a as 32-0-0
	3/01 (N only) + 69 lbs N/a as 46-0-0	3/01 (N only) + 69 lbs N/a as 46-0-0	2/12 + 53 lbs N/a as 32-0-0
	3/06	3/05	3/04 + 71 lbs N/a as 32-0-0
	3/27	3/27	3/21 + 42 lbs N/a as 32-0-0
	4/12 + 53 lbs N/a as 32-0-0	4/14 + 53 lbs N/a as 32-0-0	4/04 + 71 lbs N/a as 32-0-0
	4/29 + 35 lbs N/a as 32-0-0	5/02 + 28 lbs N/a as 32-0-0	4/18 + 21 lbs N/a as 32-0-0
N rate (lbs N/a)	249	242	327
Yield (tons/a)	3.66	3.43	3.42
Grain protein (%)	13.45	12.83	13.1
HVAC (%)	99	98	97
Heading date	4/1	4/3	3/24
Flag leaf N (%)	2.44	2.39	3.08
Stem sample date	4/8	4/8	3/31
Stem nitrate (ppm)	1940	1070	1115
N applied after stem sample (lbs N/a)	88	78	92
N recommended after stem sample (lbs N/a) according to Table 1	46	59	58

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

Location	Coolidge	Gillespie
Field	10	20
Variety	Crown	Duraking
Planting date	12/18/02	11/18/02
Irrigations + fertilization	12/18 + 53 lbs N/a as 32-0-0	11/18 + 11 tons sludge/a
	1/29 + 53 lbs N/a as 32-0-0	1/05
	2/14	2/27 (N only) + 46 lbs N/a as 46-0-0
	2/28	3/22 + 70 lbs N/a as 82-0-0
	3/11 + 53 lbs N/a as 32-0-0	
	4/01 + 35 lbs N/a as 32-0-0	
	4/15 + 53 lbs N/a as 32-0-0	
	4/29 + 53 lbs N/a as 32-0-0	
	5/06	
N rate (lbs N/a)	300	116 lbs N/a + 11 tons sludge/a
Yield (tons/a)	3.08	3.57
Grain protein (%)	13.4	14.4
HVAC (%)	95	97
Heading date	3/23	3/06
Flag leaf N (%)	2.37	---
Stem sample date	3/31	3/10
Stem nitrate (ppm)	70	1178
N applied after stem sample (lbs N/a)	141	70
N recommended after stem sample (lbs N/a) according to Table 1	88	57