Response of Durum and Spring Wheat to Applied Nitrogen and Sulfur

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Introduction

Durum is an increasingly important crop for Montana growers, with Montana second only to North Dakota in durum production since 1997 (USDA, 2002). Several pasta production plants are ready markets for Montana durum. Durum buyers look for certain quality traits, including test weight equal to or greater than 60 lb/bu and grain protein equal to or greater than 13.5%.

Studies in Montana of spring wheat showed that late season nitrogen (N) did not increase grain yields when preplant N amounts were adequate, but did increase grain protein by up to 2% (Westcott et al., 1997a,b). Mid-season N increased durum yields by 1-6 bu/a, with increases even at the highest rate of applied preplant N while mid-season N increased spring wheat yield by 3-6 bu/a only at the lowest rates of applied preplant N (Eckhoff, 2000). Grain protein has previously been shown to be increased with sulfur (S) fertilization, yet this has not been well documented in Montana.

The objective of this study was to determine durum response to applied N and S. This study was conducted from 2001-2002 at the Eastern Agricultural Research Center in Sidney.

Methods

Dryland. Soil on the dryland site was a Williams loam. Fertilizer N was applied in the spring, following a year of fallow, just prior to planting. Soil tests indicated that sufficient N was available for durum crop production. Preplant rates used were 0, 20 and 40 lb N/a. Mountrail durum, Avonlea durum, and McNeal spring wheat were planted at a rate of 1 million live seed/a. When plant stems were beginning to elongate and become erect (Feekes stage 4-5), ⅓ of each plot was top dressed with 20 lb N/a as granular 46-0-0 and ⅓ of each plot was top dressed with 20 lb N/a and 13 lb S/a as liquid 12-0-0-26S + 28-0-0.

Irrigated. Soil on the irrigated site was a Savage silty clay. Plots were irrigated using furrow flood with gated pipe in both years. Previous crop in both years was sugarbeet. Fertilizer N was applied in the spring, just prior to planting. Fertilizer N rates were based on the recommendation for spring wheat of 2.5 lb N/bu of expected yield, and were calculated using the amount of residual soil N to four feet from the previous fall, N expected to be released from organic matter (30 lb N/a for each percent OM), and N expected to be released from the sugar beet crop residue (70 lb N/a). Preplant rates included no applied N, a rate for an expected yield of 70 bu/a (175 lb available N/a) and a rate for an expected yield of 86 bu/a (215 lb available N/a). Seeds were planted at a rate of 1.5 million live seed/a. When plant stems were beginning to elongate and become erect (Feekes stage 4-5), ⅓ of each plot was top-dressed with 40 lb N/a as granular 46-0-0 and ⅓ was top dressed with 40 lb N/a and 26 lb S/a as liquid 12-0-0-26S + 28-0-0.

Results

Dryland. Yield of Avonlea durum increased significantly as preplant N increased from 0 to 40 lb N/a, and yield of McNeal spring wheat increased slightly as preplant N increased (Table 1). Mountrail durum did not respond to applied preplant N. Soil tests prior to planting indicated sufficient soil N for expected yields. Yields of all varieties responded negatively when N and S were applied foliarly during the growing season, with yield of Avonlea durum significantly reduced.

Test weights of all varieties were reduced somewhat with applied preplant N, with test weight of Mountrail reduced significantly at the highest rate of preplant N. Test weights of both durum varieties were reduced to below that of U.S. No. 1 grade. Grain protein of all varieties increased as the rate of preplant N increased. Grain protein of Mountrail was similar for both rates of preplant N, but grain protein of Avonlea and McNeal continued to increase as preplant N rate increased. Top dressed N increased protein of all varieties. Top dressed S with N did not affect grain protein. Flag leaf N at heading increased in all varieties as preplant N increased. Flag leaf N also increased with top dressed N and was greatest when N and S were applied foliarly. The higher leaf N was not due to residue from the foliar application because the flag leaves were not yet emerged when N was top dressed. Flag leaf N content predicted grain protein when preplant N rates varied, but did not predict grain protein when top dressed N varied. Green seed percentages were not significantly affected by N or S treatments (data not shown).

Fertilizer Facts

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Irrigated. Lodging was severe in 2001, and was increased in all varieties by preplant N (data not shown). Top dressed N also increased lodging of Plaza. Yields of all varieties were below average because of the lodging problem. Preplant N did not affect yield of Mountrail or McNeal, but the medium rate of preplant N significantly increased yield of Plaza. Top dressed N increased yield of all varieties, but when N and S were top dressed in liquid form, yield did not change, or decreased slightly. The lower yields from liquid applications were likely due to leaf burn based on visual observations.

Test weight of McNeal was not affected by preplant N. Top dressed N and S had little effect on test weight of durum and spring wheat varieties. Grain proteins were high in 2001 and low in 2002. Preplant N increased grain protein slightly in 2001, but not in 2002. This protein increase paralleled the increase in lodging and subsequent decrease in yield. Top dressed N improved protein content of all varieties, yet S had no effect. Sulfur content in irrigation water was measured during the growing season in 2002 and ranged from 20 to 120 ppm; a likely reason why S did not increase yield or protein under irrigated conditions**.**

Flag leaf N increased slightly with preplant N and increased significantly with top dressed N. In contrast to the dryland test, flag leaf N content did not predict grain protein when preplant N rates varied, but did a better job of predicting grain protein when top dressed N varied. As in the dryland tests, Mountrail had a higher percentage of green seed than Plaza and McNeal. Top dressed N increased green seed percentage of Mountrail slightly. Preplant N slightly increased green seed percentage in McNeal.

Fertilizer Facts:

- Too much preplant N reduced test weights to levels not acceptable for U.S. No. 1 durum.
- Granular N applied during the growing season increased grain protein of durum and spring wheat.
- Foliar-applied N+S did not benefit quality of irrigated and dryland spring wheat or durum when compared to granular topdressed N, and generally decreased yield, apparently due to leaf burn.

Table 1. Response of durum and spring wheat to preplant N, top dressed granular N, and topdressed foliar N+ S under dryland and irrigated conditions over two years. Letters behind numbers in the same group indicate a significant difference ($P \leq 0.05$). Numbers without letters indicate no significant differences within the group.

Variety	PP N rate (lb/a)	TD N rate (lb/a)	Grain Protein (%)	Flag leaf N (%)	Test Wt (lb/bu)	Yield (bu/a)
Dryland						
Mountrail	0		13.6a	3.96a	60.0b	50.2
	20		14.2b	4.08b	59.7b	50.6
	40		14.5b	4.18c	59.2a	50.2
		0	13.8a	3.90a	59.8	50.6
		20	14.4b	4.08b	59.7	51.8
		20 + S	14.2b	4.24c	59.4	48.6
Avonlea	0		14.4a	4.11a	60.1	42.6a
	20		14.8ab	4.25ab	59.8	44.9ab
	40		15.2b	4.37b	59.6	46.7b
		0	14.4a	4.02a	60.0	45.0b
		20	15.0b	4.28b	59.8	46.3b
		20 + S	14.9b	4.43c	59.6	42.8a
McNeal	0		13.8a	4.03a	59.6b	48.1
	20		14.0ab	4.14b	58.9a	49.6
	40		14.3b	4.30c	58.7a	51.8
		0	13.6a	3.98a	59.2	50.0
		20	14.2b	4.19b	59.0	50.8
		20 + S	14.0b	4.28b	59.0	48.8
Irrigated						
Mountrail	0		12.6	3.83	60.8	56.2
	16		12.6	3.93	60.6	57.4
	56		12.8	3.90	60.4	56.9
		0	12.4a	3.57a	60.6	54.4a
		40	12.8b	4.05b	60.8	60.3b
		40 + S	12.8b	4.04b	60.4	55.6a
Plaza	0		12.4	3.61a	61.2	60.0a
	16		12.5	3.83b	61.2	63.0b
	56		12.5	3.80b	60.9	59.8a
		0	12.3	3.43a	61.1	59.0a
		40	12.6	3.92b	61.2	63.6b
		40 + S	12.6	3.89b	61.0	60.0a
McNeal	0		12.6	4.06a	59.8	59.8
	16		12.6	4.09a	60.0	61.0
	56		12.8	4.25b	59.8	60.4
		0	12.4a	3.80a	59.9	59.1
		40	12.8b	4.30b	60.0	62.6
		40 + S	12.8b	4.30b	59.8	59.4

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