Final #08-05

Final Report

Arizona Grain Research and Promotion Council

September, 2008

Can Preplant Fertilization of Small Grains be Eliminated?

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Summary

The results of this study support the practice of not applying nitrogen at planting time even if the soil N level is low. Highest yields were obtained if the nitrogen that would have been applied at planting time was applied at the 5-leaf stage in addition to the N that would normally be applied at this time. If the preplant N application is skipped, the crop nitrogen status must be monitored carefully and N fertilizer should be applied by the 5-leaf stage to avoid a yield reduction. If a large amount of N is applied at the 5-leaf stage, lodging may be encouraged.

Introduction

Nitrogen fertilizer costs have increased dramatically in the past few years. In small grain production, fertilizer represents a significant proportion of the cost of production. It may be possible to reduce fertilizer cost by skipping the preplant application. In some cases, the soil may contain enough nitrogen so that a preplant application is not necessary, which can be determined by a soil test. Even if a preplant soil test indicates that a preplant nitrogen application is warranted, we know from previous research that preplant nitrogen applications are not as efficient in getting into the plant as later applications. Preplant nitrogen applications are subject to more potential for loss due to leaching because the root system is not established, and can also be immobilized in the soil.

Procedure

A nitrogen study with durum was established on a sandy clay loam soil at the Maricopa Agricultural Center on Field 3, Border 89. The previous crop was sudangrass. At planting time, the soil contained 4.6 ppm NO_3-N and 12.3 ppm PO_4-P. This amount of soil nitrate is considered low and a response to preplant nitrogen fertilizer is considered likely. The preplant soil phosphate level was high, and therefore, no P fertilizer was applied. Kronos durum seed was planted on January 3, 2008 at a rate of about 160 lbs seed/acre and flood irrigated on January 4. The effect of preplant nitrogen on grain yield and protein was studied by varying the amount on nitrogen applied preplant and the proportion of fertilizer at each application (Table 1). Flood irrigations were applied on Jan 4, Feb 26, Mar 19, Apr 3, Apr 16, Apr 25, and May 5. The experimental design was a randomized complete block with 25 fertilizer treatments (control plus 8 N rates for each of 3 preplant N rates) and 4 replications. The plots were 10 ft x 20 ft.

Plants were sampled from a 18 inch x 14 inch (2 rows) area during the growing season on Feb 25 (5 leaf), Mar 18 (2 node), Apr 2 (boot-heading), Apr 15 (flowering), and May 13 (physiological maturity). The samples were dried in an oven at 150 F and then weighed to determine yield. Light interception was measured within an hour of solar noon using a Decagon Sunfleck Ceptometer on Feb 25 (5-leaf), Mar 18 (2 node), Apr 2 (boot-heading), and Apr 15 (flowering). Grain was harvested from the entire plots on June 13, but these results are not presented due to extensive bird damage. The samples taken on May 13 were used for grain yield since bird damage occurred after this date.

Results and Discussion

Light interception provides an indication of plant growth, and leaf area in particular. Greater light interception is correlated with greater leaf area. At the 5-leaf stage, light interception was not affected by nitrogen rate showing no response to preplant nitrogen fertilizer (Table 2). At the 2-node stage, light interception was less if N was 0 preplant and only 1x at 5-leaf. By the boot-heading stage, light interception was greatest where N application was 0 preplant and 2x at 5-leaf.

Preplant N affected plant growth during the season (Table 2). At the 2-node stage, greatest plant growth was measured where preplant N was applied. However, by the boot-heading stage, we were not able to measure differences in plant growth whether or not preplant N was applied.

At the end of the season, skipping the preplant N application resulted in reduced plant growth if N application at the 5 leaf stage was only 1x instead of 2x. However, grain yield was not affected by preplant N application, although grain yield was increased by the 2x N application at the 5-leaf stage (Table 3). Preplant N hastened the time to heading and flowering by about 1 day. N application at a 2x rate at the 5-leaf stage increased lodging. Preplant N had no affect on harvest index, test weight, HVAC, grain protein, or plant height.

The results of this study suggest that preplant N can be delayed until the 5-leaf stage without reducing yield even on a soil low in nitrate.

Acknowledgments

Financial support for this project was received from the Arizona Grain Research and Promotion Council. The technical assistance of Mary Comeau and Mike Sheedy is greatly appreciated.

Table 1. Nitrogen fertilizer treatments.

			N Rate (lbs N/A)				
Preplant	5-leaf	Total N rate	Preplant (Jan 4)	5-leaf (Feb 26)	2-node (Mar 19)	Boot-heading (Apr 3)	Flowering - watery kernel (Apr 16)
		lbs N/A					
N/A	N/A	0	0	0	0	0	0
1x	1x	50	10	10	10	10	10
		100	20	20	20	20	20
		150	30	30	30	30	30
		200	40	40	40	40	40
		250	50	50	50	50	50
		300	60	60	60	60	60
		350	70	70	70	70	70
		400	80	80	80	80	80
0	2x	50	0	20	10	10	10
		100	0	40	20	20	20
		150	0	60	30	30	30
		200	0	80	40	40	40
		250	0	100	50	50	50
		300	0	120	60	60	60
		350	0	140	70	70	70
		400	0	160	80	80	80
0	1x	40	0	10	10	10	10
		80	0	20	20	20	20
		120	0	30	30	30	30
		160	0	40	40	40	40
		200	0	50	50	50	50
		240	0	60	60	60	60
		280	0	70	70	70	70
		320	0	80	80	80	80

Table 2. Preplant and subsequent N application effect on light interception and total plant yield at various growth stages.

N application			Light Interception				Total Plant Yield				
Preplant	5-leaf	Total	5-leaf	2-node	Boot-heading	Flower-water	5-leaf	2-node	Boot-heading	Flower-water	Maturity
		lbs N/A	------------- % of incident -------------				------------------------ lbs/A ------------------------				
0	0	0	24	53	61	58	205	1,543	2,352	4,207	5,489
1x	1x	50	26	57	69	68	355	2,875	3,547	6,770	11,027
		100	34	73	80	80	429	2,340	3,696	7,542	8,276
		150	39	76	86	82	442	3,348	5,526	5,912	13,416
		200	38	78	84	83	274	1,904	6,671	5,501	13,304
		250	53	81	91	91	529	3,896	5,750	9,496	14,138
		300	39	79	90	88	492	4,393	6,148	8,924	13,292
		350	46	79	92	90	498	4,144	4,543	9,135	14,400
		400	29	76	91	88	274	2,751	4,070	7,816	6,808
0	2x	50	---	63	75	70	---	2,526	3,609	6,186	9,434
		100	---	69	84	79	---	2,390	4,368	6,845	14,089
		150	---	77	92	92	---	2,775	4,306	8,625	14,561
		200	---	72	88	86	---	2,551	4,294	8,650	8,787
		250	---	75	91	90	---	2,713	4,418	8,102	14,213
		300	---	76	92	93	---	1,357	5,762	7,604	14,051
		350	---	86	97	94	---	2,402	4,543	11,089	11,998
		400	---	81	94	94	---	3,037	5,215	9,471	15,072
0	1x	40	---	58	71	66	---	2,340	3,647	8,712	9,322
		80	---	62	74	72	---	2,278	5,538	6,111	10,056
		120	---	68	81	81	---	1,892	4,082	8,575	9,869
		160	---	64	82	83	---	2,178	4,891	8,027	9,036
		200	---	73	89	90	---	2,340	5,028	8,575	13,143
		240	---	66	86	85	---	1,991	4,256	7,393	9,496
		280	---	75	93	90	---	2,539	5,339	8,301	12,010
		320	---	76	91	89	---	1,543	5,028	6,982	12,608
$LSD_{.10}$		All N	NS	9	6	5	NS	1101	1673	2736	3533
Preplant N * Total N rate			---	NS	NS	NS	---	+	NS	NS	*
1x	1x	Avg.	38	75	85	84	416	3,206	4,994	7,637	11,833
0	2x	Avg.	---	75	89	87	---	2,469	4,564	8,322	12,776
0	1x	Avg.	---	68	84	82	---	2,138	4,726	7,835	10,692
$LSD_{.10}$		Avg. N	---	3	2	2	---	395	NS	NS	1267
CV(%)			47	10	5	5	50	25	21	20	18

$LSD_{.10}$ = least significant difference at the 10% probability level.
NS, +, * = not significant at the 10% probability level, significant at the 10% probability level, and significant at the 5% probability level, respectively.
CV = coefficient of variation.

Table 3. Preplant and subsequent N application effect on grain yield and various grain and plant characteristics.

N application											
Preplant	5-leaf	Total	Grain yield	Harvest Index	Test weight	HVAC	Grain protein	Head-ing	Flower-ing	Plant Height	Lodging
		lbs N/A	lbs/A	%	lbs/bu	%	%			inches	%
0	0	0	2,775	51	61	57	10.7	3/29	4/01	25	0
1x	1x	50	5,314	48	62	83	11.2	3/30	4/02	27	0
		100	3,983	48	62	92	12.6	3/30	4/01	27	8
		150	6,484	48	61	98	13.3	3/29	4/01	26	20
		200	6,410	48	61	99	14.5	3/30	4/02	26	18
		250	6,397	45	61	99	14.1	3/28	4/01	27	45
		300	5,439	41	61	100	14.7	3/30	4/03	27	33
		350	5,974	41	60	99	14.8	3/30	4/03	28	38
		400	2,166	30	60	98	14.8	4/01	4/03	26	15
0	2x	50	4,493	48	62	82	11.4	3/30	4/02	27	0
		100	6,721	48	61	93	12.5	3/31	4/04	27	8
		150	7,107	49	61	99	14.0	3/30	4/02	27	53
		200	4,568	52	61	99	15.0	3/31	4/02	26	63
		250	6,534	46	61	98	14.6	3/31	4/04	26	45
		300	6,584	47	60	100	15.1	4/01	4/04	26	60
		350	5,078	42	60	98	14.7	3/30	4/03	27	68
		400	6,036	40	61	99	14.5	4/01	4/04	27	60
0	1x	40	4,916	53	62	82	11.4	3/29	4/02	27	0
		80	5,240	52	62	94	12.6	3/29	4/01	26	3
		120	4,929	50	61	96	13.2	3/30	4/02	27	15
		160	4,406	47	61	96	14.3	3/30	4/03	26	43
		200	5,551	42	61	100	14.7	3/31	4/03	27	33
		240	3,933	42	60	99	15.2	3/31	4/03	26	33
		280	5,115	42	60	99	15.1	4/01	4/04	27	38
		320	5,277	42	60	100	15.1	4/01	4/04	26	78
$LSD_{.10}$		All N	1786	NS	1	6	0.7	2	2	NS	26
Preplant N * Total N rate			*	NS	NS	NS	NS	NS	NS	NS	+
1x	1x	Avg.	5,271	44	61	96	13.7	3/30	4/02	27	22
0	2x	Avg.	5,890	47	61	96	14.0	3/31	4/03	27	44
0	1x	Avg.	4,921	46	61	96	14.0	3/30	4/03	26	30
$LSD_{.10}$		Avg. N	642	NS	NS	NS	NS	1	1	NS	9
CV(%)			20	13	1	5	4	0	0	6	70

$LSD_{.10}$ = least significant difference at the 10% probability level.
NS, +, * = not significant at the 10% probability level, significant at the 10% probability level, and significant at the 5% probability level, respectively.
CV = coefficient of variation.