Final Report

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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. However, the N that would have been applied at planting time should by applied by the 5-leaf stage in addition to N that would normally be applied at this time. The amount of N applied is not less under this system and it only involves a delay in N application. These results are preliminary.

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 4, Border 88. The previous crop was cotton. At planting time, the soil contained 6.0 ppm NO_3-N and 19.1 ppm P_2O_5. 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. Durum seed was planted on December 18, 2006 at a rate of about 160 lbs seed/acre and flood irrigated on December 20. 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 Dec 20, Feb 9, Mar 1, Mar 16, Apr 2, Apr 13, Apr 27, and May 11. The experimental design was a split plot with 13 fertilizer treatments as main plots, 2 varieties (Kronos and Westbred 881) as subplots, and 4 replications. The subplots containing the varieties were 5 ft x 20 ft, there were four subplots per main plot and two of the subplots were border plots and not harvested, and each main plot was 20 ft x 20 ft.

Plants were sampled from a 18 inch x 14 inch (2 rows) area during the growing season on Feb 9 (5 leaf), Mar 1(1 node), Mar 15 (boot), Mar 30 (flowering), and May 21 (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 9 (5 leaf), Mar 1(1 node), and Mar 30 (flowering). Grain was harvested from the entire plots on June 22, but these results are not presented due to extensive bird damage and apparent herbicide damage. The samples taken on May 21 for grain yield were from areas with minimal bird and herbicide damage.

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 increased with nitrogen rate showing a response to preplant nitrogen fertilizer (Table 2). At the 1 node stage, light interception was similar whether of not preplant N was applied if the N that would have been applied preplant was applied at the 5 leaf stage (0:40:20:20:20). By flowering, light interception was not affected by preplant N application, but less light was intercepted by the control that had no nitrogen fertilizer applied.

Preplant N and the proportion of fertilizer at each application affected plant growth during the season (Table 3). At the 1-node and boot stages, plant growth was less if preplant N was not applied. By flowering, plant growth was similar whether of not preplant N was applied if the N that would have been applied preplant was applied at the 5 leaf stage (0:40:20:20:20). If the N that would have been applied preplant was split among the next four applications (0:25:25:25:25), then plant growth was less without preplant N application.

At the end of the season, preplant N application had no detectable influence on plant growth or grain protein when averaged over N rates (Table 4). However, peak yields may be obtained at lower N rates if N is applied preplant or if the N that would have been applied preplant was applied at the 5 leaf stage (0:40:20:20:20). Likewise, with these fertilizer treatments, yield declined at a lower N rate partially because of declining harvest index. Grain protein was greatest at the highest fertilizer rate regardless of preplant N application.

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.

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Table 1. Nitrogen fertilizer treatments.

			N Rate (lbs N/A)				
Preplant N	Proportion of fertilizer at each application	Total N rate	Preplant (Dec 20)	5-leaf (Feb 9)	1-node (Mar 1)	Boot (Mar 16)	Flowering (April 2)
	% of total	lbs N/A					
N/A	0:0:0:0:0	0	0	0	0	0	0
Yes	20:20:20:20:20	100	20	20	20	20	20
		200	40	40	40	40	40
		300	60	60	60	60	60
		400	80	80	80	80	80
No	0:40:20:20:20	100	0	40	20	20	20
		200	0	80	40	40	40
		300	0	120	60	60	60
		400	0	160	80	80	80
No	0:25:25:25:25	100	0	25	25	25	25
		200	0	50	50	50	50
		300	0	75	75	75	75
		400	0	100	100	100	100

Table 2. Light interception within 1 hour of solar noon (as a percent of incoming light) at various dates and growth stages during the season as affected by seasonal N rate, whether or not preplant N was applied, and the proportion of fertilizer at each of the five applications during the season.

			Preplant N (Proportion of fertilizer at each application, %)		
Date	Stage	Seasonal N rate	Yes (20:20:20:20:20)	No (0:40:20:20:20)	No (0:25:25:25:25)
		lbs N/acre	Light Interception (%)		
Feb 9	5 leaf	0	20	--	--
		100	25	--	--
		200	28	--	--
		300	32	--	--
		400	31	--	--
		Average[1]	29	--	--
Mar 1	1 node	0	56	56	56
		100	67	72	64
		200	76	71	65
		300	76	75	67
		400	82	72	71
		Average (**)[2]	75	73	67
Mar 30	Flowering	0	62	62	62
		100	80	81	82
		200	88	88	87
		300	88	88	87
		400	88	86	89
		Average (NS)	86	86	86

[1] Average of N rates excluding the control, 0 lbs N/acre.

[2] Statistical significance of the preplant N fertilizer treatments (average of N rates), NS = not significant at P=0.10, ** = significant at P = 0.01.

Table 3. Total plant yield at various dates and growth stages during the season as affected by seasonal N rate, whether or not preplant N was applied, and the proportion of fertilizer at each of the five applications during the season.

			Preplant N (Proportion of fertilizer at each application, %)		
Date	Stage	Seasonal N rate	Yes (20:20:20:20:20)	No (0:40:20:20:20)	No (0:25:25:25:25)
		lbs N/acre	Total plant yield (lbs/acre)		
Feb 9	5 leaf	0	204	--	--
		100	219	--	--
		200	243	--	--
		300	253	--	--
		400	308	--	--
		Average[1]	256	--	--
Mar 1	1 node	0	1111	1111	1111
		100	1970	1485	1575
		200	2114	1679	1494
		300	2022	1750	1690
		400	2490	1769	1917
		Average (**)[2]	2149	1671	1669
Mar 15	Boot	0	2485	2485	2485
		100	2641	2659	3063
		200	3588	2804	2928
		300	3095	2829	2678
		400	3619	2310	2652
		Average (+)	3236	2651	2830
Mar 30	Flowering	0	4049	4049	4049
		100	5132	5880	4284
		200	5495	5034	4977
		300	5326	5611	4745
		400	5405	5259	4129
		Average (+)	5339	5446	4534

[1] Average of N rates excluding the control, 0 lbs N/acre.

[2] Statistical significance of the preplant N fertilizer treatments (average of N rates), NS = not significant at P=0.10, ** = significant at P = 0.01.

Table 4. Grain yield, total plant yield, harvest index (grain yield as a percentage of total plant yield), and grain protein at harvest as affected by seasonal N rate, whether or not preplant N was applied, and the proportion of fertilizer at each of the five applications during the season.

	Preplant N (Proportion of fertilizer at each application, %)		
Seasonal N rate	Yes (20:20:20:20:20)	No (0:40:20:20:20)	No (0:25:25:25:25)
lbs N/acre			
	Grain yield (lbs/acre)		
0	3976	3976	3976
100	6391	6229	5464
200	5607	4524	5619
300	4798	5184	5246
400	4263	3379	5918
Average[1] (NS)[2]	5265	4829	5562
	Total plant yield (lbs/acre)		
0	9565	9565	9565
100	15464	14848	12981
200	13989	12471	15084
300	12937	13255	14742
400	13697	9913	15333
Average (NS)	14022	12622	14535
	Harvest index (%)		
0	42	42	42
100	42	42	42
200	40	37	38
300	35	39	36
400	30	33	37
Average (NS)	37	38	38
	Grain protein (%)		
0	11.1	11.1	11.1
100	12.8	13.0	13.7
200	14.8	15.2	15.2
300	15.6	15.1	15.6
400	16.4	16.2	15.8
Average (NS)	14.9	14.9	15.1

[1] Average of N rates excluding the control, 0 lbs N/acre.

[2] Statistical significance of the preplant N fertilizer treatments (average of N rates), NS = not significant at P=0.10.