FALL APPLIED CONTROLLED-RELEASE NITROGEN AS A NITROGEN SOURCE FOR SOFT RED WINTER WHEAT

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Soil conditions are often not conducive for timely spring N applications on wheat. Fall applications may save labor and be more economical when blended with other nutrients such as phosphorus. However, many N sources may be susceptible to loss before uptake by the wheat plant. This study evaluated fall applied controlled-release N as a N source for wheat.

Material and Methods

A nitrogen fertilizer study for soft red winter wheat was established in 1999 on a Hoytville silty clay loam at the Vegetable Crops Branch of the Ohio Agricultural Research and Development Center (Fremont, OH). Variety 'Hopewell' was planted at 120 lb per acre. Previous crop was soybeans.

Experimental design was a completely randomized block consisting of seven N treatments replicated four times (Table 1). All treatments received a total of 90 lb N per acre. Nitrogen source and time of application differentiated treatments. Nitrogen sources were ammonium sulfate, diammonium phosphate (DAP), POLYON AG® polymer-coated urea (PCU), and urea.

Fertilizer was applied with a Gandy 1010 drop spreader. Fall applications were applied and incorporated prior to planting. Green-up applications were applied as a topdress in March as soon as soil conditions allowed equipment traffic. Treatments receiving urea at Feekes growth stage 6 were applied as topdress.

Head counts were determined by sampling a three-foot row in three random areas of each plot. A chlorophyll meter was used to estimate plant N at early stem elongation (Feekes growth stage 6) and at anthesis.

Plots consisted of thirteen 75-foot long rows. Rows were 7 inches apart. Center nine rows were harvested for yield and grain moisture. Yields were adjusted to 14% moisture. Statistical analysis was ANOVA.

Results and Discussion

Conditions were unseasonably dry during planting. However, a warmer November and December with timely rains allowed adequate growth for good fall stands. Winter was mild -- with temperatures usually above normal and especially during February and March. Conditions were cooler during April but unseasonably warm during the first part of May. Moderate conditions returned for the end of May followed by a slightly warmer June. Rainfall was below normal most of the season except during April, May and June. Exceptionally high rainfall the end of June delayed harvest into July. Even though humid conditions prevailed during grain fill, moderate temperatures kept disease pressure low.

Differences were detected between treatments for yield (Table 2). Treatments that did not receive urea at greenup had yields 6-8% lower than other treatments. Fertilizer blends that contained 40-80 lb PCU-N per acre had similar yields except for Treatment 5, which yielded 6% more. Treatment 5 had received 30 lb urea-N per acre at greenup. Treatment 7 also received 30 lb urea-N per acre in the spring, but applied at Feekes growth stage 6. It yielded 6% less than treatment 5. Treatments that received urea at greenup had similar yields regardless of fall fertilizer blend or amount of urea applied in the spring. This would be expected since the N curve showed that yields did not respond to N rates above 60 lb per acre (Table 3). However, Treatment 5 shows evidence that the PCU material released some N since it only received 30 lb urea-N per acre at greenup and had similar yields to treatments receiving 50-90 lb urea-N per acre (Table 2).

Chlorophyll meter values taken at Feekes growth stage 6 and anthesis (Table 4) suggest that the fall applied PCU material may not have released N soon enough for maximum yields without additional N at greenup. Treatments that received more than 50 lb urea-N per acre had leaf N ratios 3-14% and 4-12% higher than other treatments at Feekes growth stage 6 and anthesis, respectively. Treatments without spring N had the lowest leaf N ratios, evidence that the N release rate was too slow from the PCU material. Compared to the N curve, these treatments had leaf N ratios similar to the 20 and 40 lb per acre rate for Feekes growth stage 6 and anthesis, respectively (Table 3). Treatment 5 and 7 had similar leaf N ratios at Feekes growth stage 6 suggesting that enough mineralized N was available to mask differences between treatments receiving less than 50 lb N per acre at greenup. Above normal temperatures for November through March may have allowed mineralization from the soil organic pool. The lack of yield reduction in Treatment 1, which received no fall N, and a 63.8 bu per acre yield for a zero N treatment would be evidence for mineralization. However, increasing the amount of available fall N (Treatment 3) did not improve the leaf N ratio or yield without adding N at greenup. Applying urea at Feekes growth stage 6 instead of greenup (Treatments 7 and 5, respectively) improved the leaf N ratio at anthesis but not yield.

One must also consider, did the fall PCU fertilizer blends without spring N yield less because N was lost before crop uptake? This scenario was unlikely since temperatures were low enough that all of the PCU-N should not have been released and vulnerable to loss. Even if all the N was available before greenup, N loss conditions did not occur until well into grain fill, after the period of rapid N uptake by the crop. The evidence of respectable yields for the Zero N Treatment also suggests that N losses were not high. Fall check treatments of urea with equivalent N rates to the fall PCU treatments would help to answer the amount of N loss in future studies.

Differences were not detected among treatments for harvest moisture or number of heads (Table 2). The overall harvest moisture mean was 14.7%. Number of heads ranged from 54 to 65. Even though statistical differences were not detected among treatments for number of heads, treatments receiving larger amounts of urea at greenup had the most. The lower number of heads for Treatment 7 may have been caused by tractor damage from an application at a later growth stage than other treatments. Field conditions were marginal because of limited dry days at application time. This may also have affected yields for this treatment. However, tractor tracks or height reduction in the track region were not evident at harvest time.

Conclusion

Data from one year would suggest lower wheat yields for programs that rely on fall PCU compared to spring programs that rely on urea. This study did not compare fall PCU to fall urea. Supplementing PCU in the fall with ammonium sulfate did not increase yields over spring urea programs. Fall PCU programs were similar to only spring urea programs with supplemental urea at greenup. In programs using fall PCU, a larger yield response occurred with supplemental urea at greenup than later growth stages. This study suggests that a faster N release of the PCU material may be needed for adequate N during rapid N assimilation (jointing to head emergence). Even though small amounts of N during grain fill may provide some yield benefit, the bulk of N uptake by the roots occurs during stem elongation. This high demand for N may be satisfied by a faster N release rate by PCU or by using supplemental urea at greenup. Additional studies would be needed to determine the ideal N release rate for PCU or the ideal combination of fall PCU and spring urea.

Table 1. Time of application and source for wheat N treatments.

Treatment Number	Fall†			Greenup Urea	Feekes 6 Urea
	DAP	AS	PCU		
	-----	-----	lb $acre^{-1}$	-----	-----
1	0	0	0	90	0
2	20	0	0	70	0
3	20	30	40	0	0
4	10	0	80	0	0
5	20	0	40	30	0
6	20	0	20	50	0
7	20	0	40	0	30

†DAP=diammonium phosphate; AS=ammonium sulfate; PCU=polymer-coated urea (44% N).

Table 2. Grain yields, harvest moistures, and number of heads in wheat for N source and N application time.

Treatment	N Rate, Source, and Application Time[†]	Yield (@14%)	Moisture	Heads
	----------------lb acre^{-1}----------------	---bu acre^{-1}---	---------%--------	square-feet^{-1}
2	20 DAP + 70 UG	87.0^{a}	14.7	65
6	20 DAP + 20 PCU + 50 UG	86.6^{a}	14.6	59
1	90 UG	86.3^{a}	14.7	65
5	20 DAP + 40 PCU + 30 UG	85.1^{a}	14.7	59
3	20 DAP + 30 AS + 40 PCU	80.5^{b}	14.7	59
4	10 DAP + 80 PCU	80.4^{b}	14.9	56
7	20 DAP + 40 PCU + 30 UF	80.3^{b}	14.7	54
LSD[‡]		3.8	ns	ns

[†]DAP=diammonium phosphate applied prior to planting, UG=urea applied at greenup, PCU=polymer-coated urea applied before planting, AS=ammonium sulfate applied before planting. UF=urea applied at Feekes growth stage 6.

[‡]Means with the same letter are not significantly different ($P \leq 0.05$).

Table 3. Yields and chlorophyll meter values in wheat at different Urea-N rates.

N Rate[†]	Yield @14%	Leaf N Ratio[‡]		Meter Values	
		Feekes 6	Anthesis	Feekes 6	Anthesis
-----lb acre^{-1}----	----bu acre^{-1}----				
100	90.3^{a}	0.99^{a}	0.94^{a}	46.0^{a}	42.7^{a}
80	91.9^{a}	0.96^{ab}	0.94^{a}	44.9^{ab}	42.8^{a}
60	91.3^{a}	0.94^{b}	0.92^{a}	43.7^{b}	42.1^{a}
40	85.7^{b}	0.89^{c}	0.84^{b}	41.1^{c}	38.6^{b}
20	79.5^{c}	0.83^{d}	0.80^{c}	38.6^{d}	36.5^{c}
0	64.7^{d}	0.74^{e}	0.73^{d}	34.5^{e}	33.2^{d}
LSD[§]	3.4	0.03	0.04	1.4	2.0

[†]Urea-N applied at greenup. All treatments received 20 lb urea-N acre^{-1} in the fall.

[‡]Divide the treatment meter value by the meter value from the high N check strip to calculate leaf N ratio. In this study the check strip received 20 and 120 lb urea-N acre^{-1} in the fall and at greenup, respectively.

[§]Means with the same letter in a column are not significantly different ($P \leq 0.05$).

Table 4. Chlorophyll meter values in wheat for N source and N application time.

Treatment Number	N Rate, Source, and Application Time[†]	Leaf N Ratio[‡]		Meter Values	
		Feekes 6	Anthesis	Feekes 6	Anthesis
	------------------lb acre^{-1}-----------------				
1	90 UG	0.97[a]	0.95[a]	45.2[a]	43.1[a]
2	20 DAP + 70 UG	0.97[a]	0.95[a]	45.0[ab]	43.0[ab]
6	20 DAP + 20 PCU + 50 UG	0.94[b]	0.91[b]	43.3[b]	41.4[bc]
7	20 DAP + 40 PCU + 30 UF	0.89[c]	0.90[b]	41.2[c]	41.0[cd]
5	20 DAP + 40 PCU + 30 UG	0.88[c]	0.87[c]	41.0[c]	39.7[d]
3	20 DAP + 30 AS + 40 PCU	0.85[d]	0.82[d]	39.3[d]	37.5[e]
4	10 DAP + 80 PCU	0.83[d]	0.83[d]	38.9[d]	37.5[e]
LSD[§]		0.02	0.03	1.2	1.6

[†]UG=urea applied at greenup, DAP= diammonium phosphate applied prior to planting, PCU= polymer-coated urea applied prior to planting, UF = urea applied at Feekes growth stage 6, AS=ammonium sulfate applied before planting.

[‡]Divide the treatment meter value by the meter value from the high N check strip to calculate leaf N ratio. In this study the check strip received 20 and 120 lb urea-N acre^{-1} in the fall and at greenup, respectively.

[§]Statistical differences not detected between means with the same letter within a column ($P \leq 0.05$).

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