POLYMER COATED UREA AFFECTS ON WHEAT YIELD

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BACKGROUND:

University of Kentucky fertilizer recommendations call for fertilizer N to be applied in one or two applications between early greenup (Feekes 2) and first node formation (Feekes 6) for wheat. Growers with wheat on wetter soils know and understand these recommendations but also must deal with the reality that soil conditions often do not permit fertilizer N application at optimal times. They often apply fertilizer N earlier, when the surface soil is frozen, in an attempt to have N nutrition available when the crop begins to break dormancy. Unfortunately, there is the potential for serious losses of these early applications, resulting in reduced N availability. The resulting crop is N stressed for the remainder of its growth period. A product, used in the turf industry for several years, is becoming available at prices that are competitive in the agricultural market, and holds the potential to reduce N loss associated with early application. Polymer coated urea (PCU) is urea coated in a plastic membrane. Release of the urea is controlled by diffusion through the membrane, and the rate is dependant on soil temperature (higher temperature faster release). If this product works, it might allow N to be applied earlier without the risk of denitrification or leaching losses. An ideal product would be one that could be applied in the fall with P and K fertilizers. This system would save at least one application charge, and the farmer would not have to worry about wet soil conditions in the spring. A study was initiated in the fall of 2002 to determine the effectiveness of fall applied PCU as a nitrogen source for wheat.

RESEARCH APPROACH:

The study was initiated in the fall of 2002 on imperfectly drained soils at Lexington and Princeton. The objective was to compare application timing of PCU (product name is ESN manufactured by Agrium Inc.) and urea for wheat production. Because we wanted to see differences between the two products, a less than optimal rate of nitrogen was used (60 lb N/a) for all treatments. Fall treatments consisted of incorporated and non-incorporated PCU, urea, or ammonium nitrate. Other plots received top-dressed PCU or urea applied in January (dormant application), February (Feekes 3), or March (Feekes 5). A blend of 1/3 urea and 2/3 PCU applied at Feekes 3 and was compared to a split application of urea 1/3 Feekes 3 and 2/3 Feekes 5 for a total of 14 treatments plus a 0 lb N/a control. The fall ammonium nitrate treatments were included to determine if fall N loss was due to ammonia volatilization. Pioneer 25W60 and 25R47 was grown at Lexington and Princeton, respectively. Data collected included dry matter and N uptake at Feekes 10.5 (flowering) and grain yield, moisture, test weight and grain N content at maturity. Nitrogen removal was calculated by multiplying pounds of grain by N% and nitrogen use efficiency (NUE) was calculated by subtracting N removal in the check plot from N removal in the treatment and then dividing by applied N (60 lbs/a). Higher NUE means that more of the applied N was taken up by the crop.

RESULTS AND DISCUSSION:

Results for the Lexington site are given in Table 1. There was a high amount of variability in the dry matter and N uptake measurements taken at flowering, so the least significant difference (LSD) is high for both parameters. Generally, N uptake at this stage was higher for PCU than urea when comparing pre-plant application treatments. Although usually not significant, post-plant applications of nitrogen generally produced higher dry matter and N uptake than pre-plant application. Considering that only 60 lbs N/a was applied to the plots, grain yield for this study was very high. Yield of the pre-plant PCU was significantly higher than pre-plant urea or ammonium nitrate indicating that the polymer coating did prevent at least some N losses. Urea applied in February produced lower yields than urea applied in either January or March indicating some of the February urea was lost via denitrification, leaching, or ammonia volatilization. Regardless of the loss mechanism, February PCU yields were not statistically different than January or March yields; indicating that the PCU was not subject to as much loss. Nitrogen removal in the grain for the split application of urea was statistically higher than the treatment that received a mix of urea and PCU applied in February. This observation is probably related to N loss mechanisms discussed with the other February applications.

At this site NUE followed similar trends as yield. Nitrogen use efficiency was higher in the fall PCU compared to the other fall treatments. Very low NUE was observed for the fall urea and ammonium nitrate treatments with an average of only 25% of the applied N in the grain at harvest; while the fall applied PCU had more than 50% of the applied N in the grain at harvest. A maximum NUE of 88% was measured at the Lexington site when urea was applied prior to spring green-up.

Results for the Princeton site are given in Table 2. Dry matter and N uptake at flowering were highly variable and were not statistically different. Like the Lexington location we were surprised by the high yields with only 60 lbs N/a. The yields of all treatments were statistically higher than the no N check. Overall yields of the pre-plant treatments were not much than different the post-plant treatments, indicating that conditions at Princeton during this growing season were not as conducive to N loss mechanisms. Of the pre-plant applications, grain yield of the incorporated ammonium nitrate was higher than the non-incorporated PCU treatment. The overall highest yielding treatment was the split product (1/3 urea – 2/3 PCU) application, and it was significantly higher than all of the other post-plant applications except for urea applied in March. At this site, the yield of the urea/PCU mix was over 8 bu/a higher than the traditional split application of urea. In addition to the yield increase, the producer (using the blended product) would have also saved the charge for the second nitrogen application – making this treatment even more economical.

Nitrogen use efficiency at this site varied from 34 to 82 %. The average NUE for the pre-plant treatments was 37% while the post-plant treatments averaged 56%. The maximum NUE was measured when a mix of 1/3 urea and 2/3 PCU was applied in February.

CONCLUSIONS:

Although this is the first year of this study, there is evidence that PCU reduces the chance of N loss and improves NUE of loss prone nitrogen. This research will be repeated in 2003-2004 to test PCU's performance in a second year. A second project has also been established to examine N rate, source, and timing issues for wheat grown on poorly drained soil.

Table 1. Dry matter and N uptake at Feekes 10.5 (flowering), yield, moisture, test weight, grain N and total N removal of wheat (variety 25W60) as affected by fertilizer application timing, source and incorporation (Lexington, 2003).

-------------------- Treatment --------------------			Dry Wt**	N Uptake**	Yield	Moisture	Test Weight	Grain N	N Removal	N Use Efficiency
Fertilizer*	Application Time	Incorporation	--- lbs/a ---		bu/a	%	lbs/bu	%	lbs/ac	%
Check					42.5	14.6	55.9	1.63	41.5	
PCU	Pre-plant	Yes	5328	39.9	70.9	14.0	56.0	1.56	66.8	42
PCU	Pre-plant	No	5200	43.1	80.9	14.1	55.9	1.65	80.6	65
NH_4NO_3	Pre-plant	Yes	3238	25.4	51.2	14.5	56.2	1.56	48.0	11
NH_4NO_3	Pre-plant	No	4076	33.4	63.2	14.1	55.1	1.61	61.1	33
Urea	Pre-plant	Yes	4046	36.9	58.9	14.2	55.6	1.59	56.0	34
Urea	Pre-plant	No	3943	29.8	61.1	13.8	55.3	1.50	55.1	23
PCU	January	No	5729	50.0	78.3	14.0	56.4	1.70	80.0	64
Urea	January	No	5677	69.2	80.1	13.5	52.9	1.97	94.6	88
PCU	February	No	4448	44.4	73.4	14.0	56.2	1.67	73.4	53
Urea	February	No	3172	25.0	64.8	13.9	56.0	1.60	62.2	35
PCU	March	No	4953	54.9	79.2	14.1	55.8	1.85	88.0	77
Urea	March	No	5032	50.1	80.0	13.2	54.8	1.78	85.8	74
PCU/Urea	67/33% Feb	No	4805	41.6	76.8	14.2	55.6	1.64	75.4	57
Urea	33% Feb 67% March	No	4925	50.2	82.0	13.5	55.1	1.82	89.7	80
		$LSD_{(0.10)}$	1443	16.3	8.6	NS	0.7	0.12	11.5	19

* All treatments except the check received a total of 60 lbs N/a.

** Dry matter and N uptake at Feekes 10.5.

Table 2. Dry matter and N uptake at Feekes 10.5 (flowering), yield, grain N, total N removal and N use efficiency of wheat (variety 25R47) as affected by fertilizer application timing, source and incorporation (Princeton, 2003).

-------------------- Treatment --------------------			Dry Wt**	N Uptake**	Yield	Test Weight	Grain N	N Removal	N Use Efficiency
Fertilizer*	Application Time	Incorporation	--- lbs/a ---		bu/a	lbs/bu	%	lbs/ac	%
Check					68.3	59.0	1.45	59.3	
PCU	Pre-plant	Yes	9911	90.4	89.2	58.9	1.48	79.7	34
PCU	Pre-plant	No	7444	65.9	88.8	58.9	1.60	85.3	43
NH_4NO_3	Pre-plant	Yes	9133	94.3	95.9	58.5	1.59	91.4	53
NH_4NO_3	Pre-plant	No	9137	85.6	94.3	59.0	1.59	90.3	52
Urea	Pre-plant	Yes	8186	78.9	91.4	58.0	1.61	88.2	48
Urea	Pre-plant	No	7436	74.6	89.7	58.0	1.59	85.8	44
PCU	January	No	8145	70.8	85.3	58.5	1.61	81.1	36
Urea	January	No	9862	93.2	89.7	58.9	1.59	84.2	41
PCU	February	No	8470	82.7	87.1	59.3	1.59	84.4	42
Urea	February	No	7441	62.7	89.7	58.4	1.58	83.4	40
PCU	March	No	7819	78.2	92.9	58.8	1.56	96.8	62
Urea	March	No	8470	81.6	95.8	58.9	1.61	92.3	55
PCU/Urea	67/33% Feb	No	8169	92.8	101.3	58.7	1.78	108.5	82
Urea	33% Feb 67% March	No	8169	77.7	92.5	58.7	1.65	91.7	54
		$LSD_{(0.10)}$	NS	NS	6.3	1.2	0.07	8.4	14

* All treatments except the check received a total of 60 lbs N/a.

** Dry matter and N uptake at Feekes 10.5.