NITROGEN MANAGEMENT FOR NO-TILLAGE CORN AND GRAIN SORGHUM PRODUCTION

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SUMMARY

No-tillage production systems are being used by an increasing number of producers in the central Great Plains because of several advantages that include reduction of soil erosion, increased soil water use-efficiency, and improved soil quality. However, the large amount of residue left on the soil surface can make nitrogen management difficult. Surface applications of urea containing fertilizers are subject to volatilization losses. Leaching can also be a problem on course textured soils when N is applied in one preplant application. Slow-release polymer coated urea products are beginning to become available for agricultural use. The polymer coating allows the urea to be released at a slower rate than uncoated urea. The use of urease inhititors applied with urea-containing fertilizers can reduce volatilization losses. Recently, a new product that is a co-polymer of maleic and itaconic acids has become available (Nutrisphere-N) and has shown potential in reducing urea-N losses. A three-year irrigated corn study compared urea (46% N), UAN (28%) a controlled release polymer coated urea (ESN), Agrotain, Agrotain Plus+, Nutrisphere –N[1] and ammonium nitrate at 3 nitrogen (N) rates (80, 160, and 240 lbs/a). A no n check plot also was included. The study was conducted on Crete silt loam soil. The treated urea products yielded better than the untreated urea, and were similar to ammonium nitrate. There were no significant differences in yield of ESN, Agrotain, or Nutrisphere-N. In the corn experiment that included UAN (28%), yield of UAN treated with Agrotain Plus or Nutrisphere-N was greater than that of untreated UAN. A two year study was also conducted to compare banding and broadcasting of urea-containing fertilizers. With both urea and UAN banding resulted in greater yields than broadcasting on the soil surface. The use of fertilizer additives however, still resulted in additional yield increases even when banding. If producers wish to broadcast urea-containing fertilizer on the soil surface in no-tillage production systems banding is more effective than broadcasting and there are several products available that are very effective in limiting N losses and increasing N–use efficiency.

INTRODUCTION

Conservation tillage production systems are being used by an increasing number of producers in the Great Plains because of several inherent advantages. These advantages include reduction of soil erosion losses, increased soil water-use efficiency, and improved soil quality. The large amount of residue left on the soil surface in no-tillage systems can make N management difficult. Surface application of N fertilizers is a popular practice with producers. N losses due to volatilization from broadcast urea-containing fertilizers in no-tillage production systems can be significant. Depending on conditions, losses can be 10-20% of the applied N. Nitrogen immobilization can also be a problem when N fertilizers are surface applied in high residue production systems. Nitrogen leaching can be both an agronomic and environmental problem on course-textured soils. Polymer coated urea, long used in turf fertilization, has the potential to make N management more efficient when surface applied in no-tillage agricultural systems. The

[1] Mention of a specific trade name is for reader information and does not imply endorsement by the author or Kansas State University.

urea granule is coated, but allows water to diffuse across the membrane. N release is then controlled by temperature. A polymer-coated urea product is now available for crop use and is marketed under the name of ESN. The use of urease inhititors applied with urea-containing fertilizers can reduce volatilization losses. In the soil urea is hydrolyzed relatively quickly by the soil enzyme urease. Agrotain, a commercially available urease inhititor, and has in numerous studies proven to be effective in reducing N losses due to volatilization. Agrotain Plus is a product that contains both a urease inhibitor and a nitrification inhibitor (DCD). Recently, a new product that is a co-polymer of maleic and itaconic acids has become available (Nutrisphere-N) that has shown potential in reducing urea-N losses. The cation nickel is essential for the action of urease, Nutisphere-N is thought to sequester or inactivate the nickel ions rendering urease inactive. In addition Nutrisphere-N also blocks nitrification through action on soil bacteria. The objective of these experiments were to evaluate N efficiency from surface broadcast applications of urea-containing N and to try to reduce N loss and improve efficiency with the use of products designed to limit N volatilization and loss.

METHODS

Irrigated experiments were conducted at the North Central Kansas Experiment Field on a Crete silt loam soil from 2005-2007. Soil test information from the site: soil pH was 7.0; organic matter was 2.8%; Bray-1 P was 28 ppm, and exchangeable K was 240 ppm. The previous crop was corn. The corn hybrid DeKalb DKC 60-19 was planted without tillage into corn stubble in late April each year of the 3-year study at the rate of 31,000 seeds/acre. Nitrogen was applied on the soil surface immediately after planting. Treatments consisted of controlled released polymer-coated urea (ESN), Nutrisphere-N coated urea, Agrotain coated urea, urea, and ammonium nitrate applied at 3 rates (80, 160, and 240 lbs/a). A no N check plot also was included. Additional treatments included UAN (28%), Agrotain treated UAN, Agrotain Plus+ treated UAN, and Nutrisphere-N treated UAN. An additional experiment was conducted for two years (2008-2009) that included banded verses broadcast nitrogen treatments with both urea and UAN. The experimental area was adequately irrigated throughout the growing season in both experiments.

RESULTS

In the first experiment, grain yield of irrigated corn plots receiving untreated urea were lower than plots receiving urea treated with Agrotain, ESN or Nutrisphere-N at all levels of applied N (Table 1). Yields achieved with Agrotain, ESN, and Nutrisphere were equal to those of ammonium nitrate. Yield of UAN (28%) was also lower than those of UAN treated with Agrotain, Agrotain Plus+, or Nutrisphere-N. When averaged over N-rates, yields of all treated N products were greater than untreated urea or UAN (Table 2). There were no significant differences in yields of Agrotain, Agrotain Plus+, ESN, and Nutrisphere-N. The lower yields with urea and UAN indicate that volatilization of N may have been significant problem.

In the second experiment that included comparisons of broadcast verses banded urea and UAN, there were no significant differences in yield of ESN and Nutrisphere-N, however, urea+Agrotain Plus+ did not perform as well. In 2008 there were no differences in performance of the three products, but in 2009 the yields obtained with the urea+ Agrotain Plus+ were significantly less than that of the other two products. Conditions after application in 2009 were very dry and that may have affected the efficacy of the Agrotain Plus+. Yield of UAN treated with Agrotain Plus+ or Nutrisphere-N was greater than that of untreated UAN. Banding urea containing products was more effective than broadcasting, but greatest yields were achieved with the use of the additive products. If producers wish to broadcast urea-containing fertilizer on the soil surface in no-tillage production systems there are several products available that are very effective in limiting N losses and increasing N–use efficiency.

Results of this study suggest that the efficiency of surface broadcast urea-containing fertilizers in no-tillage production systems can be improved by use of several products that are effective in reducing N volatilization losses.

Table 1. Effects of N source and rate on corn grain yield, earleaf N, and grain N, Scandia, (2005-2007).

N Source	N-Rate	Yield	Earleaf N	Grain N
	lb/acre	bu/acre	%	%
	0-N check	152.2	1.72	1.13
Urea	80	152.0	2.30	1.22
	160	169.3	2.65	1.26
	240	183.1	2.68	1.30
ESN	80	171.6	2.89	1.28
	160	186.6	2.95	1.32
	240	196.9	3.05	1.40
Nutrisphere-N	80	165.8	2.89	1.29
	160	187.7	2.94	1.36
	240	196.9	3.06	1.41
Urea+Agrotain	80	171.6	2.91	1.30
	160	179.7	2.96	1.36
	240	196.6	3.04	1.38
UAN (28%)	80	156.6	2.45	1.24
	160	167.0	2.69	1.28
	240	180.8	2.74	1.27
UAN+Agrotain	80	170.5	2.88	1.30
	160	191.2	2.98	1.35
	240	195.8	3.03	1.39
UAN+Agrotain Plus+	80	168.2	2.90	1.31
	160	185.4	2.99	1.38
	240	195.8	3.08	1.42
UAN+Nutrisphere-N	80	170.5	2.87	1.30
	160	192.0	3.01	1.38
	240	195.8	3.04	1.41
Ammonium Nitrate	80	173.9	2.86	1.30
	160	187.8	2.96	1.35
	240	195.8	3.05	1.40
Average(not including check)		181.1	2.88	1.33

Table 2. Effects of N (av. over rate) on corn grain yield, earleaf-N and grain-N, Scandia (05-07).

Treatment	Yield,bu/acre	Earleaf-N, %	Grain N, %
No N check	152.0	1.72	1.13
Urea	168.1	2.52	1.26
ESN	185.0	2.96	1.33
Nutrisphere-N	183.5	2.96	1.35
Urea+Agrotain	182.6	2.97	1.35
UAN	168.1	2.62	1.26
UAN+Agrotain	185.8	2.96	1.35
UAN+Agrotain Plus+	183.1	2.99	1.37
UAN+Nutrisphere-N	186.1	2.97	1.36
Ammonium Nitrate	185.8	2.96	1.35
LSD (0.05)	6.2	0.09	0.04
CV%	6.8	4.5	4.9

Table 3. N-Rate and granular N-source effects on corn grain yield (2008-2009).

N-Rate	Urea	ESN	Urea+NSN	Urea+Agrotain+
		bu/acre		
80	204.4	243.4	244.7	233.0
160	233.3	262.6	267.8	255.3
240	246.2	272.5	272.8	263.4
Average	**227.9**	**259.5**	**261.8**	**250.6**
LSD(0.05)=10.3				
CV%=4.1				

No N Check=154.9 bu/a

Table 4. N-Rate and liquid N-source effects on corn grain yield (2008-2009).

N-Rate	UAN	UAN+NSN	UAN+Agrotain+
		bu/acre	
80	224.3	245.9	234.9
160	233.4	271.9	258.1
240	252.7	273.4	263.9
Average	**236.8**	**263.7**	**252.3**
LSD(0.05)=10.3			
CV%=4.1			

No N Check=154.9 bu

Table 5. N-Rate and method of application effects on corn grain yield (2008-2009).

N-Rate	Urea, Broadcast	Urea, Band	UAN, Broadcast	UAN, Band
		bu/acre		
80	204.4	211.0	224.3	227.0
160	233.3	246.3	233.4	241.6
240	246.2	257.6	252.7	262.8
Average	**227.9**	**238.3**	**236.8**	**243.8**
LSD (0.05)=10.3				
CV%=4.1				