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Urease Inhibitor Reduces Ammonia Loss from Surface-Applied Urea

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Urea is the world's leading N fertilizer, and its use continues to grow. In the USA, for example, the use of urea increased 50 fold from 1955 to 1986. During that same time, its use in Kentucky increased from 214 to more than 112,000 tons per year, which was 28% of the N used in Kentucky in 1986. The increasing popularity of urea is due to advantages over other N fertilizers in its manufacture and to its use in making most N solutions, another rapidly growing form of N fertilizer. Desirable qualities of urea include the highest N content of all solid N fertilizers (45-46%), excellent handling properties, and dissolves readily in water. There is, however, a serious agronomic management problem with urea.

The Management Problem with Urea

The most important management problem associated with urea is its tendency to lose N by ammonia volatilization when surface-applied. When urea $[(\text{NH}_2)_2\text{CO}]$ is applied, it reacts with water and becomes ammonium carbonate $[(\text{NH}_4)_2\text{CO}_3]$ by the process of hydrolysis. Ammonium carbonate is unstable and some of it breaks down releasing ammonia gas (NH_3). If urea is surface-applied and not incorporated into the soil by tillage, rainfall, or irrigation, a substantial amount of its N can be lost during the hydrolysis process, which is usually complete in 4 to 7 days after application. Large N losses have been reported, but ordinarily losses are within the range of 5 to 20%.

A Possible Solution to the Problem

For urea hydrolysis and ammonia volatilization to occur, the enzyme urease must be present and active. Urease is normally abundant on the surfaces of soil, living vegetation, and plant residues, as well as in the soil. If the activity of urease could be inhibited long enough for the urea to be washed into the soil by rainfall, the efficiency of the urea should be improved. On this premise, chemicals that inhibit the activity of urease are being tested widely, but none have been released for use. One such experimental chemical, N-(n-butyl) thiophosphoric triamide (NBPT), manufactured by Enimont America Inc. has been studied for 5 years at the U.K. Research and Education Center at Princeton, KY.

Results of U.K. Research on NBPT

Yields of fescue and no-tillage corn were measured in field experiments where prilled urea and urea-ammonium nitrate solution (UAN) with and without NBPT were compared to ammonium nitrate (AN). Previous research shows that no ammonia volatilization occurs from ammonium nitrate under the conditions of our experiments.

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Fescue. Dry matter yield of fescue fertilized with urea without NBPT was 13% lower than fescue fertilized with ammonium nitrate (Table 1), indicating a significant loss of N from the urea. Yield with urea + NBPT was almost identical to that obtained with ammonium nitrate and was 13% greater than for urea without NBPT. The fescue yield response to NBPT with UAN solution was only 3%.

Table 1. Dry matter yields of fescue and grain yields of no-tillage corn as affected by N source and urease inhibitor (NBPT).

N treatments	Fescue yields [†]		Corn yields [‡]	
	% of AN	ton/ac	% of AN	bu/ac
Check (No N)	43	1.04	56	53
AN	100	2.43	100	95
Urea	87	2.12	88	84
Urea + NBPT [§]	99	2.40	103	98
UAN	84	2.04	86	82
UAN + NBPT [§]	87	2.11	93	88

[†] Sum of two cuttings per yr with 70 lb N/ac/cutting averaged over 5 yr.

[‡] Avg of 1988 and 1989 with 75 lb N/ac/yr in 1988 and 100 lb N/ac in 1989.

[§] NBPT rate = 0.70 lb/ac/cutting for fescue; 0.75 lb/ac in 1988 and 1.0 lb/ac in 1989 for corn.

No-tillage Corn. Although not statistically significant, there was a strong tendency for greater corn grain yields with ammonium nitrate than with urea or UAN (Table 1), again suggesting N loss by volatilization of ammonia from urea. The NBPT increased average grain yield by 14 bu/ac with urea and 6 bu/ac with UAN.

Summary

The NBPT effectively inhibited urease activity and decreased N loss by ammonia volatilization from urea. It appears that NBPT clearly has the potential to increase the efficiency of surface-applied solid urea on pastures, hay crops, or no-tillage row crops, but it has not had any consistent effect with UAN.

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