NITRIFICATION OF BANDED LIQUID FERTILIZERS[1]

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ABSTRACT

Field studies were conducted in 1990 at three sites to compare the relative effectiveness of ammonium thiosulfate (ATS, 12-0-0-26S), dicyandiamide (DCD), and nitrapyrin (NP, 'N-Serve 24E') as nitrification inhibitors in combination with banded urea-ammonium nitrate (UAN). Applications were banded prior to planting spring wheat, and soil samples taken 2, 4, and 8 weeks after application. ATS, DCD, and NP inhibited nitrification at all three sites. ATS inhibited nitrification at the 4 week sampling, but the degree of inhibition was less than observed for DCD or NP. NP was a stronger inhibitor of nitrification than DCD at one of three sites at the 4 week sampling. Only NP showed any nitrification inhibition after 8 weeks. There appeared to be no "synergism" by banding ATS and DCD together. This study does confirm previous findings that including ATS in fertilizer bands can slow nitrification, but NP or DCD should be used if a higher degree of inhibition is desired.

INTRODUCTION

Soil scientists have long searched for inexpensive methods of inhibiting nitrification. Slowing nitrification helps reduce nitrate leaching and denitrification, thus maximizing the economic and environmental efficiency of N application. Slowing nitrification can also promote ammonium uptake by plants, which has been shown to improve growth and/or disease resistance in some trials. Currently two nitrification inhibitors are commonly available for farm use, dicyandiamide (DCD) and nitrapyrin (NP). Recent research has shown that ammonium thiosulfate (ATS), a common liquid sulfur fertilizer, possesses some ability to inhibit nitrification when included in simulated band applications in the laboratory or field (Goos, 1985; Goos and Johnson, 1989). The first objective of our 1990 field trials was to determine if ATS will inhibit nitrification when applied with commercial application banding equipment in the field.

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The second purpose of this study was to determine if there is a "synergism" between ATS and DCD as nitrification inhibitors. One major fertilizer company has introduced both liquid and solid fertilizers containing urea, ATS, and DCD. It is felt by some European researchers that ATS, as a reducing agent, slows the chemical decomposition of DCD, thus reducing the rate of DCD needed to inhibit nitrification. These concepts have not been widely evaluated.

METHODS

Three field studies were established in the spring of 1990 in eastern North Dakota. One site was on a Hecla loamy sand soil and the other two were on Fargo silty clay soils. The individual sites were established from early to late May to give a range of environmental conditions. Liquid fertilizers, based on urea-ammonium nitrate (UAN), were applied on 14 inch centers about 5 inches deep using modified thin-profile anhydrous ammonia knives and a 7-knife applicator. The fertilizer solutions were pumped, metered, and injected using commercial fertilizer application equipment (John Blue Co.). The bands were marked with flags and the site seeded to spring wheat.

The fertilizer solutions tested were: 1. UAN, 2. UAN+ATS (25-0-0-5), 3. UAN+DCD (2.7 lb DCD/A), 4. UAN+ATS+DCD, and 5. UAN+NP (0.5 lb/A nitrapyrin as 'N-Serve 24E'). The total amount of (urea + ammonium + nitrate)-N applied varied slightly between treatments, but the amount of (urea + ammonium)-N was equal at 67 lb N/A. A control treatment where the soil was knifed without fertilization was also prepared. Individual plot size was 8 x 30 feet and the experimental design at each site was a randomized complete block with four replications.

The day after fertilizer application the bands of the control treatment and the plots receiving UAN were sampled to establish initial (urea + ammonium) levels in the band samples. All plots were sampled 2, 4, and 8 weeks after application. The fertilizer bands were sampled by taking six cores per plot of 4 inches diameter by 8 inches deep centered on the fertilizer bands. The cores were dried, ground, and mixed thoroughly before subsampling for analysis. The samples were analyzed for (urea + ammonium)-N or ammonium-N by steam distillation.

RESULTS

Similar treatment effects were observed at all three sites, thus the data presented has been averaged across sites for simplicity. The effect of fertilizer composition on residual ammonium in the soil is shown in Table 1. Little nitrification occurred during the first 2 weeks. Adding ATS, DCD, or NP to the fertilizer solutions significantly increased soil ammonium levels at one of the three locations.

Greater differentiation between the treatments occurred 4 weeks after application. The ammonium-N level in the band samples was 28 ppm with banded UAN. Adding ATS to the UAN increased soil ammonium levels at all three sites, averaging 50 ppm. Solutions with DCD were somewhat better than UAN+ATS, averaging about 65 ppm. NP was the best inhibitor, averaging 77 ppm after 4 weeks.

Neither ATS nor DCD had any influence on soil ammonium levels after 8 weeks. NP continued to slow nitrification at all three sites with about 15% of the original application still present as ammonium.

Although significant effects of ATS and DCD on soil ammonium levels were observed, no "synergism" between ATS and DCD was observed at any site.

AGRONOMIC INTERPRETATION

The degree of acceptable nitrification inhibition depends on the agronomic objectives. Minimization of N loss from a leaching or denitrification event demands a high degree of inhibition. The degree of nitrification inhibition observed in this study was NP>DCD>ATS, but all three inhibitors could be of agronomic benefit if the leaching or denitrification event occurred during the first 4 weeks after application. Only NP gave significant inhibition at the 8 week sampling.

If the objective is to obtain an early physiological response from "enhanced ammonium nutrition" (EAS), then any of the three inhibitors tested might be of benefit. For example, wheat has responded significantly to EAS in greenhouse trials (Camberato and Bock, 1990a). The yield component most dramatically influenced by EAS is tillering (Camberato and Bock, 1990b). Since spring wheat initiates its most important tiller positions 4-6 weeks after seeding, then banded fertilizers with ATS, DCD or NP might give a tillering response. If an ammonium supply is needed well into the boot stage, to possibly improve disease resistance, then a very strong inhibitor like NP would be needed.

Further research is needed to determine if banded fertilizers with nitrification inhibitors can give the benefits of "enhanced ammonium nutrition" observed in greenhouse studies (Camberato and Bock, 1990a, 1990b).

LITERATURE CITED

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Table 1. Residual (urea + ammonium) or ammonium-N in fertilizer band samples as influenced by adding ATS, DCD, or NP to UAN. Three site average, North Dakota, 1990.

Fertilizer Treatment	Weeks after application: 0	2	4	8
	ppm N			
None	4	5	4	3
UAN	113	79	28	5
UAN+ATS		84	50	4
UAN+DCD		105	64	8
UAN+DCD+ATS		100	67	7
UAN+NP		104	77	22

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