

Mitigation of Ammonia Loss from Urea Applied to Moist Soils by Agrotain®

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Introduction

Urea fertilizer is often surface applied on dryland winter wheat fields during the late fall, winter, or early spring if the snowpack is shallow (e.g. ≤ 6 inch). In Fertilizer Fact Sheet 59 we reported that ammonia (NH_3) losses from cold soils (e.g. <40 °F) average about 20% of applied N, but can exceed 30% if soil surfaces are moist when fertilized. One approach to mitigate these losses is to treat urea with Agrotain®, a nitrogen fertilizer stabilizer that contains the urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT). In 2008, we began a study to quantify NH_3 volatilization from surface-applied urea and to evaluate the effectiveness of Agrotain® to mitigate losses. This fact sheet shares a portion of the results from this project. Specifically, we focus on six trials where NH_3 losses from urea exceeded 20% of the N application rate. These trials were characterized by surface-applications of urea to high water content soil surfaces (Trials 3, 4, 5 and 10), and soils covered with modest snowpack (≤ 5 inches; Trials 9 and 16). Also, precipitation events were light (< 0.2 inch) over the first month following fertilization. Hence, fertilizer N remained near the surface as the soil dried, a worst-case scenario for NH_3 loss.

Methods

Ammonia losses from urea and Agrotain® treated urea were quantified using a micrometeorological mass-balance approach with circular plots (0.3 acre), a center mast, and samplers that provided for continuous measurement of NH_3 losses. Field trials were conducted on private farms in Hill, Fergus, and Gallatin Counties. Soil emissions of NH_3 were measured during the 8 to 10 weeks following fertilization. Urea was applied at a rate of 90 lb N/acre and was treated with a liquid Agrotain® (25% a.i.) formulation at the rate of 3 quarts per ton of fertilizer.

Results

Measureable NH_3 losses from urea were observed over 8-10 weeks following fertilization (Figure 1). Total cumulative NH_3 losses, expressed as a percentage of applied N, averaged 12% for urea treated with Agrotain® compared to 33% for untreated urea, an almost 2/3 reduction in NH_3 loss (Table 1). A similar reduction in loss was observed at trials where NH_3 losses from urea were $< 20\%$ of the N application rate. Typically, NH_3 loss protection by Agrotain® was limited to 2 weeks following fertilization at field sites with acidic soils (Trials 3, 4, 5, and 16). This was very evident in the high NH_3 loss trials 3 and 5. Ammonia loss protection by Agrotain® on the high pH, calcareous Brocko soil was observed over 10 weeks in Trial 9 (Figure 1), and 7 weeks in Trial 10 (data not shown). The longer duration of protection in Trials 9 and 10 is evidence that NBPT degradation occurs slower at high soil pH.

Summary and Recommendations

This study demonstrated that Agrotain® reduced volatilization losses from surface-applied urea by approximately 2/3 in Montana. Volatilization mitigation by Agrotain® has been attributed to a number of factors including a moderation of the soil pH rise that comes from the production of ammonium carbonate as urea hydrolyzes; reduction in NH_4^+ and NH_3 concentration in the soil solution near the surface thereby reducing losses; and delay in hydrolysis that provides more time for precipitation to occur, thereby allowing urea to infiltrate deeper into the soil where the N is less susceptible to volatilization.

Coating urea with Agrotain® adds approximately \$50 to a ton of urea fertilizer. If urea is priced at \$500 per ton, the addition of Agrotain® raises the price of N by 10%. Hence, coating urea with Agrotain® is justified from a cost standpoint where the potential exists for

Fertilizer Facts

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large NH₃ losses. Our research has shown this occurs when urea is applied to soil surfaces high in water content without accompanying precipitation that washes urea into the soil. This includes soils that are cold or frozen at the time of application, or covered with a modest snowpack. Under these conditions, NH₃ losses to the atmosphere can be very large particularly as the surface thaws and dries.

Fertilizer Facts

- Agrotain[®] reduced NH₃ volatilization losses from urea by approximately 2/3 over untreated urea.
- Volatilization protection from Agrotain[®] is approximately 2 weeks on acidic soils, but is longer on calcareous soils.

Table 1. Percentage of applied N lost as NH₃ following broadcast applications of urea and urea treated with Agrotain[®] to moist soils (worst-case conditions).

| Trial | County | Fertilization date | Soil (pH) | Urea | Agrotain [®] |
|---|----------|--------------------|-----------------------|------|-----------------------|
| ---- % applied N lost as NH ₃ ---- | | | | | |
| 3 | Hill | 14 Nov. 2008 | Telstad-Joplin (5.5) | 31.3 | 3.8 |
| 4 | Hill | 25 Mar. 2009 | Telstad-Joplin (5.5) | 35.6 | 18.0 |
| 5 | Hill | 26 Mar. 2009 | Phillips-Elloam (6.4) | 39.9 | 18.1 |
| 9 | Gallatin | 27 Jan. 2010 | Brocko (8.4) | 24.3 | 9.3 |
| 10 | Gallatin | 26 Feb. 2010 | Brocko (8.4) | 44.1 | 11.9 |
| 16 | Fergus | 02 Mar. 2011 | Danvers (6.8) | 20.7 | 10.1 |

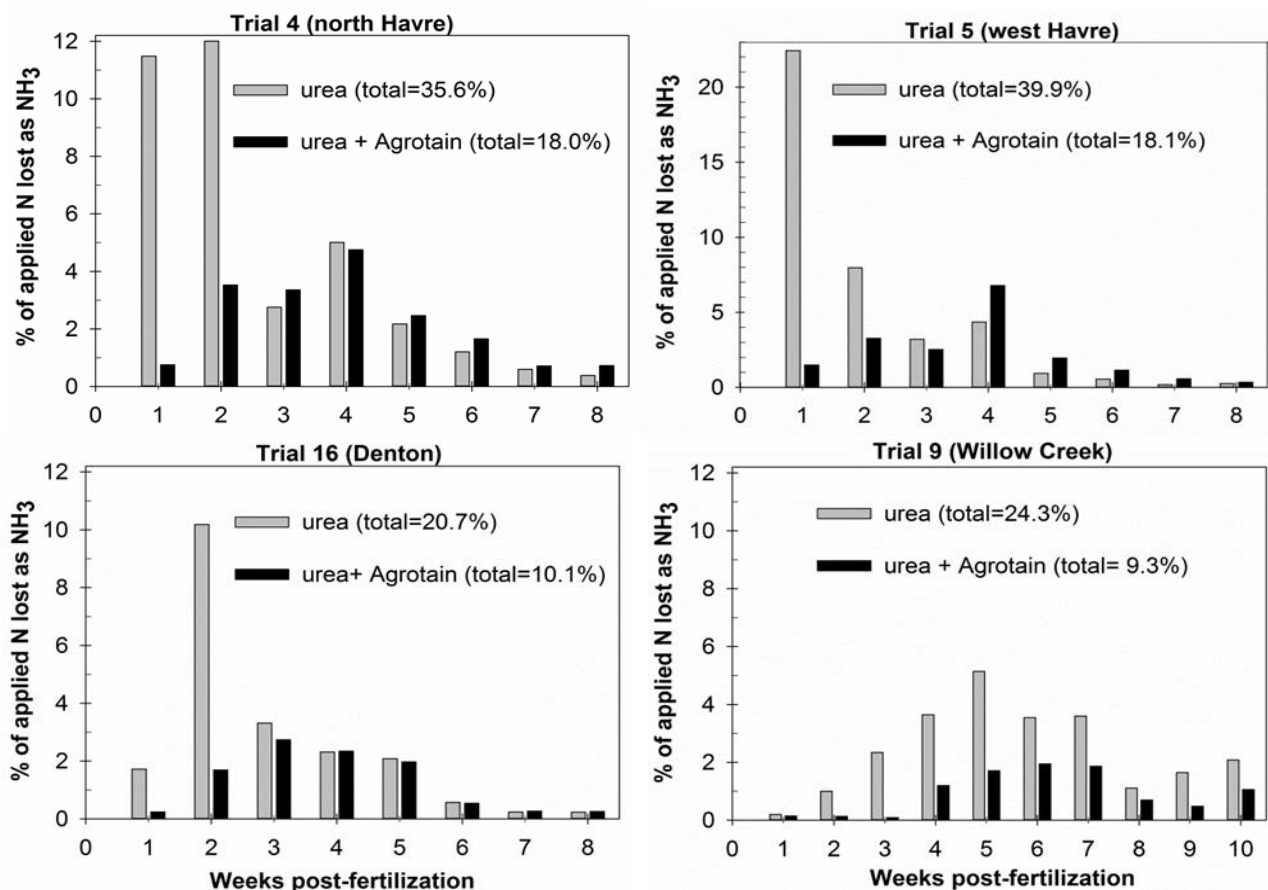


Figure 1. Ammonia losses expressed as a percentage of applied N from surface-applied urea and urea treated with Agrotain[®] at four trials. Note scale difference for Trial 5 vs. Trials 4, 9, and 16.

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