Recovery of Surface Applied Urea is Maximized Through Spring Application and Agrotain® Use

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IMPACT STATEMENT

*Ammonia **(NH_3)** volatilization is a critical factor affecting fertilizer-N recovery (FNR) by winter wheat. Urease inhibitor **Agrotain® is effective in reducing volatile losses from surface applied urea** during cold weather months. **However, m**aximum benefits to FNR and grain protein are achieved when fertilizer-N is applied during spring rather than late-fall or winter timings.*

SUMMARY

Surface applications of urea are susceptible to volatilization as NH_3, and management strategies are needed to enhance FNR. The objective of this study was to determine the effect of application timing (late-fall, winter, and spring) and urease inhibitor Agrotain® on FNR and winter wheat grain protein. FNR was greater for spring (46.1%) than late-fall (31.7%) and winter (34.1%) applications. Addition of Agrotain® to urea improved FNR of all timings, but the response was greater for late-fall and winter compared to spring applications. The greater FNR of spring timings resulted in higher protein concentrations (0.6-0.8% points) relative to late-fall and winter applications. Management strategies to enhance FNR in Montana should consider delaying surface application of urea until the spring or addition of Agrotain® for late-fall and winter timings that are more susceptible to NH_3 volatilization.

INTRODUCTION

Urea is currently the most common fertilizer-N source used by Montana growers, comprising approximately 86% of total N consumption. In winter wheat systems, urea is often surface broadcast in a separate operation following seeding. The timing of these applications varies, but can occur from late-fall to early spring. Although urea is a low-cost fertilizer-N source, it is susceptible to volatility as NH_3 gas, affecting FNR and crop productivity. Previous MSU trials have shown that NH_3 volatilization will vary greatly with application timing; losses can be quite large (>20% of applied N rate) following urea applications in the late-fall and winter (i.e., Nov to March). Volatility can be decreased by 60-65% with the addition of Agrotain® (active ingredient N-(n-butyl) thiophosphoric triamide, NBPT). Similarly, NH_3 loss can be mitigated by applying urea to dry soil surfaces in advance of large (≥0.5 inch) precipitation events that are more likely to occur in early spring than late-fall or winter. The goal of fertilizer-N management should be to minimize N loss and produce the highest FNR by the crop. Given the importance of application timing and Agrotain® on NH_3 loss from urea, this study was conducted to determine the impact of these two parameters on FNR and grain protein.

PROCEDURES

Field trials were conducted near Denton, MT during the 2011/12, 2012/13, and 2013/14 seasons. The experiments were located in large fields (> 150 acre) that were under no-till, crop-fallow management with winter wheat being the dominant crop. We applied fertilizer-N at three different times (late-fall, winter, and spring) and used two N sources (urea and urea+Agrotain®). The late-fall application was made in late-November to early-December at approximately soil freeze up. The winter application occurred in

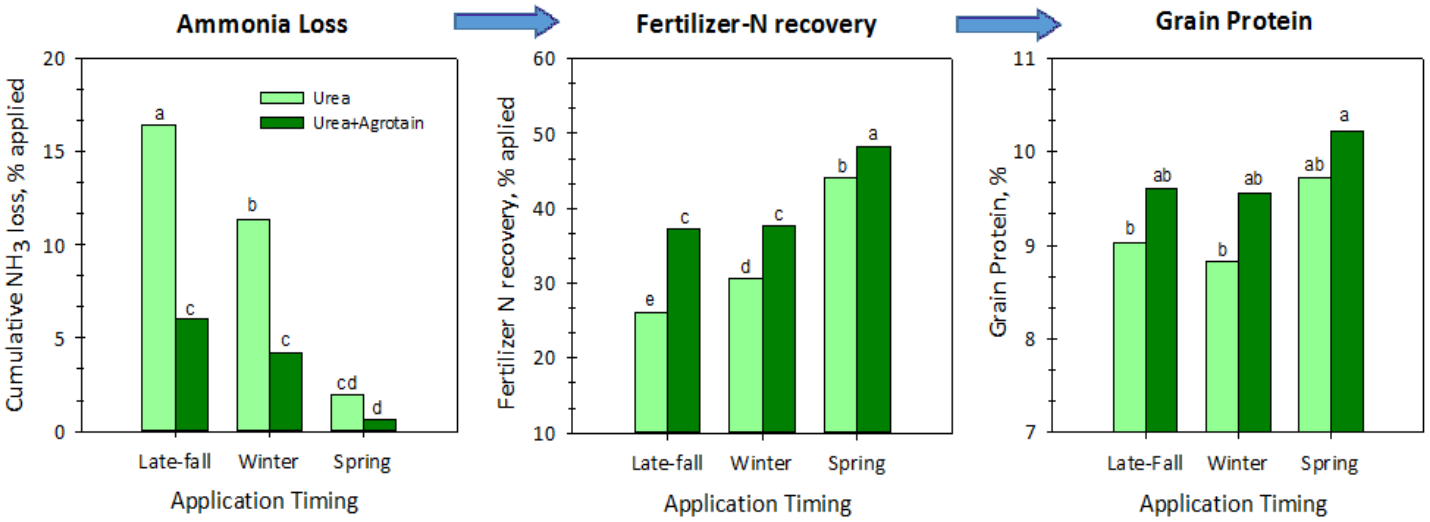

Figure 1. Ammonia loss (% of applied N at 90 lb N/ac); fertilizer-N recovery (grain plus straw) and grain protein (applied at 45 and 90 lb N/ac) as affected by urea application timing and Agrotain® averaged over three growing seasons. Different letters indicate significant difference among treatments with 95% confidence.

February onto frozen soil. The spring application was in April following ground thaw and crop green-up. Urea and urea+Agrotain® were applied at rates of 45 and 90 lb N/ac. The urea was coated with Agrotain® (0.1% rate) as a liquid formulation (26.7% active ingredient). FNR in grain plus straw was determined using ^{15}N-enriched fertilizer (at 45 and 90 lb N/ac rates) (Romero et al., 2017) and NH_3 volatility by a micrometeorological approach (only at 90 lb N/ac rate) (http://landresources.montana.edu/ureavolatilization/methodology.html).

RESULTS AND DISCUSSION

Application timing and Agrotain® both affected FNR (Figure 1). On average, spring application resulted in greater FNR (46.1%) than late-fall (31.7%) and winter (34.1%) timings. We attribute this response to the better synchrony of spring-applied N with crop-N demand and the lower volatility loss of spring-applied urea (Figure 1). We found NH_3 loss was lower for spring applied-N because large precipitation events (≥0.5 inch) followed fertilizer-N application and presumably allowed urea to infiltrate to a depth where it couldn't volatilize to the atmosphere. In contrast, precipitation events that followed late-fall and winter applications were typically light (≤0.2 inch) and scattered, and as a result urea likely remained near the surface where it was susceptible to volatility (Engel et al., 2017).

Addition of Agrotain® to urea reduced cumulative NH_3 loss by 66%. The average FNR response was greater for late-fall (by 11.3%) and winter (by 6.9%) than spring (by 4.0%) applications. Grain protein was sensitive to fertilizer-N management (Figure 1) and increased 0.6-0.8% points from spring applications or Agrotain® addition. The strong relationship between FNR and cumulative NH_3 loss is further evidence that NH_3 volatilization represents an important pathway of N loss in Montana's dryland cropping systems (Figure 2). Broadcast urea should be applied in the spring to provide the highest FNR compared with overwinter timings. Alternatively, addition of Agrotain® can improve urea FNR for broadcast applications made during cold weather months.

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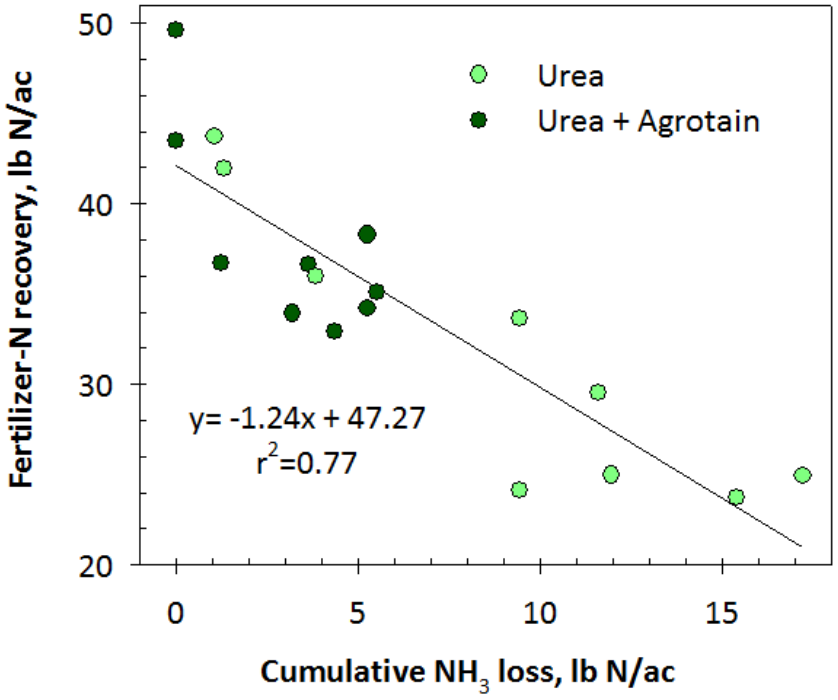

Figure 2. Fertilizer-N recovery in grain plus straw of winter wheat was directly related to cumulative NH_3 loss for the nine trials (three years x three application timings at 90 N/ac application rate).