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High broadcast urea volatilization losses occur on frozen soil

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Cumulative NH3 loss (% applied N) from broadcast urea was highest with late-fall application at 16.4%, followed by 11.4% with winter applications and 2% with spring applications. Addition of NBPT urease inhibitor reduced losses by 65.6%.

Broadcast urea is a practice that some winter wheat growers use to help manage the fall seeding workload or as a risk management strategy. The practice, though, carries the risk of urea volatilization loss, especially if urea is broadcast in the fall or winter, and onto cold or frozen soil or snow.

Several research studies have been carried out in Montana over the past decade to assess volatilization losses from broadcast urea.

Field trials were conducted in central Montana during the 2011–2012, 2012–2013, and 2013–2014 winter wheat growing seasons. Trials were located on fields larger than 150 acres that were under a no-till winter wheat/fallow rotation. Broadcast urea was applied in the fall, winter or spring, with and without the urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT; Agrotain).

The late fall application was made in late November to early December around soil freeze-up. The winter application was in February to frozen soil. The spring application was in April after the ground had thawed and the crop was greening up.

Ammonia loss was measured by the integrated horizontal flux method with samplers placed on a mast in the center of circular 65-foot (20-meter)radius plots. Fertilizer N recovery was measured using ^{15}N-enriched labeled urea. Yield and protein content were also measured.

In the ammonia loss study, urea was applied at 90 pounds N per acre (100 kg/ha) with and without NBPT. For the fall and winter application timings, ammonia loss had fluxes ranging from 0.06 to 0.71 pounds N per acre per day (3 to 33 g N/ha/hour). These emissions did not fall below nominal levels of 0.06 lbs until 87 to 103 days after application for the fall application, and 48 to 62 days after winter application. Cumulative ammonia loss was measured at 16.4%, or almost 15 lbs/ac for the fall application. The February application had a cumulative loss of 11.4% or 10 lbs/ac. By contrast, the spring application only had a 2% loss.

The intensity and duration of the losses depended on snow cover and wet/dry cycles for the fall and winter application timings.

Addition of NBPT reduced cumulative ammonia loss from urea to 6.0% in the late fall application, 4.2% with the February application, and to 0.6% in the spring application. Averaged over all the trials, NBPT reduced cumulative ammonia loss by 65.6%.

Fertilizer N recovery greatest for spring application

Fertilizer N recovery in the grain and grain plus straw was greatest for the spring application, with 36.5% of the N recovered in the grain, and 46.1% found in the grain plus straw. Late fall application had 24.9% of N in the grain, and 31.7% in the grain plus straw. Winter application had slightly better recovery than the fall application. Winter application had 26.8% of N in the grain, and 34.1% in the grain plus straw.

The addition of NBPT improved fertilizer ^{15}N recovery by an average of 11.3% for the late fall application, 6.9% for winter, and 4.0% for spring applications.

Winter wheat was very responsive to N fertilization. For example, the unfertilized control averaged 41 bushels per acre (2779 kg/ha) in 2012/13 while the 90 lbs. N fertilizer rate yielded 56 bu/ac (3728 kg/ha) in the same year.

Grain protein was highest with spring application at 10%, which was significantly higher by 0.7 to 0.8% than winter and fall applications. The application of NBPT also resulted in 0.6% higher grain protein content.

Overall, the results of these two studies show that the frequent, smaller precipitation events during the late fall and winter can result in high volatilization losses. Larger precipitation events greater than 0.5 inches (12 mm) in the spring help to reduce losses. The application of NBPT to urea also helps to reduce losses. If growers on the Northern Great Plains of the U.S. and Canada broadcast urea as a N fertilization strategy, they should delay application until the spring when the ground has thawed and significant rainfall is expected.

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Photo by Rick Engel