RESEARCH FACT SHEET

Ballance agri-nutrients

VOLATILISATION LOSSES FROM UREA

Research report: Ammonia emissions following urea fertilisation and irrigation

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Abstract

Ammonia volatilisation contributes to reduced nitrogen efficiency, even in pastoral settings, where relatively low (30-60 kg N/ha) rates of nitrogen are used.

Ammonia losses can be reduced by an average of 50% through the action of a urease inhibitor, as found in SustaiN Green. Losses can also be reduced by rainfall soon after urea application; a 50% reduction can be achieved by 10 mm rain within 8 hours for urea applied at 30 kg N/ha. As a rule, less rain, or later rain, is not as effective at reducing ammonia losses.

From a practical, on-farm viewpoint, we therefore recommend that, to minimise nitrogen-use inefficiency caused by volatilisation, SustaiN Green be used in preference to urea, unless it is raining at the time of application.

Introduction

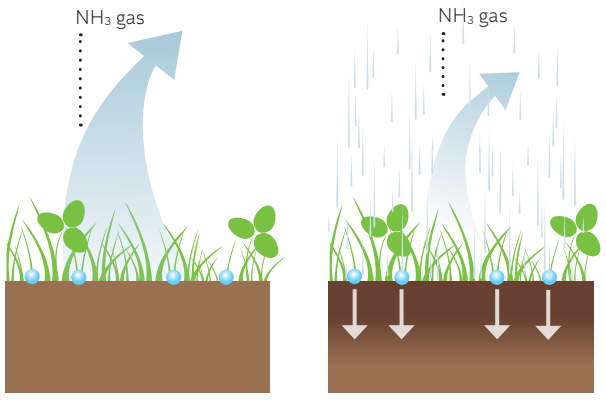
Ammonia volatilisation is an internationally recognised inefficiency in the nitrogen cycling pathway of urea. Previous work in New Zealand has shown that the actual amount of ammonia volatilisation that occurs, as a percentage of the nitrogen applied, is variable. In pastoral situations, losses range from 0-42%, with the typical loss being 10-20% of the nitrogen applied.

The extent of volatilisation is influenced by the rate of urea application, timing and rate of rainfall or irrigation after application, pasture cover, crop canopy cover, soil properties (pH, moisture content, cation exchange capacity), temperature, wind speed, and by the mode of application (surface versus sub-surface). Losses can be reduced by the use of a urease inhibitor, such as found in SustaiN Green.

Since introducing SustaiN Green, Ballance has taken a conservative approach and recommended that SustaiN Green be used in preference to urea if <10 mm of rainfall is expected within 24 hours of application. However, earlier research had indicated that volatilisation losses occurred very soon after application of urea, so research was commissioned to determine ammonia losses from pastoral rates of urea, and to investigate mitigation of these losses by rainfall/irrigation and the use of SustaiN Green.

Methods

Ammonia volatilisation losses from urea (30 kg N/ha and 60 kg N/ha) and SustaiN Green (60 kg N/ha) were compared to those from a control (0 kg N/ha) on a Tokomaru silt loam soil under permanent ryegrass/clover pasture. Each treatment was assessed to determine the effect of rainfall, simulated by applying 5 mm or 10 mm of irrigation, at 8, 24 or 48 hours after the application of the nitrogen fertiliser.



10 mm rain within 8 hours

A 50% reduction in volatilisation loss can be achieved if 10 mm rainfall occurs within 8 hours of urea application (at 30 kg N/ha)

Results

The results confirmed previous work showing a relationship between rate of urea applied and extent of volatilisation losses, and also confirmed the average 50% reduction of loss achieved by the use of SustaiN Green (see Figure 1).

When averaged across all rainfall treatments, the average loss for urea applied at 30 kg N/ha was 19%; for the 60 kg N/ha treatments the average loss was higher, at 22%. In contrast, SustaiN Green (60 kg N/ha) showed an average loss of 12%.

The effect of the timing and rate of rainfall on urea applied at 30 kg N/ha is shown in Figure 2. Applying 5 mm rain within 8 hours restricted ammonia losses to 15%, but when the amount of rainfall was doubled, ammonia losses reduced to around 8%. Delaying the application of rainfall for 24 or 48 hours resulted in higher rates of ammonia volatilisation and negated any effect of the volume of rainfall applied.

When nitrogen was applied at 60 kg N/ha (either as urea or as SustaiN Green), the effect of the volume of rain after application was less evident, but the effect of the timing of that rainfall was clear: early rainfall (8 hours after application) resulted in less ammonia loss than did later rainfall (24 or 48 hours after application). When the nitrogen was applied as SustaiN Green, losses were approximately half of those seen for the equivalent rate of urea (see Figure 3).

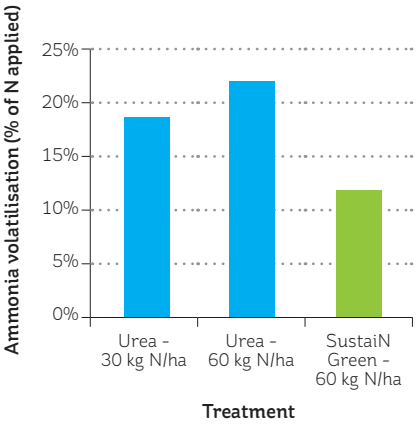


FIGURE 1
Average ammonia volatilisation losses from three different fertiliser treatments averaged across all rainfall rates and timings.

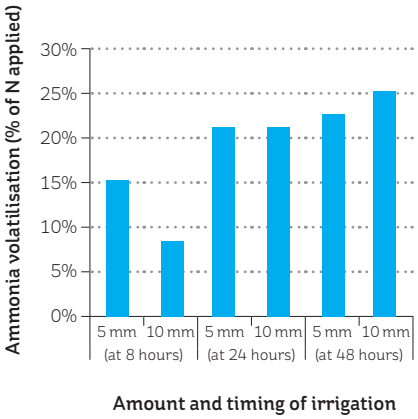


FIGURE 2
The effect of rainfall amount and timing on ammonia volatilisation losses from urea applied at 30 kg N/ha.

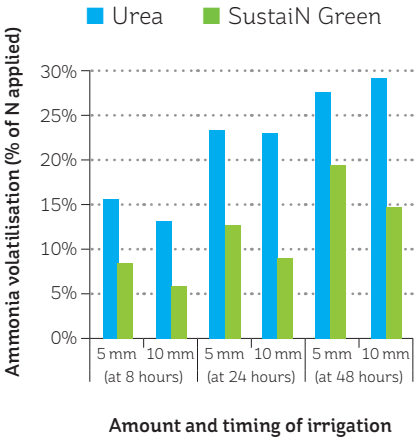


FIGURE 3
The effect of rainfall amount and timing on ammonia volatilisation losses from urea and SustaiN Green applied at 60 kg N/ha.

DISCUSSION

Volatilisation is a naturally occurring process and results in the loss of nitrogen as ammonia. It begins when urea is degraded by the enzyme urease, which produces ammonia and carbamate, raising the pH in the immediate locality in the process. Hydrolysis then results in the formation of ammonia, water and carbon dioxide.

$$(NH_4)_2CO_3 + H_2O \rightleftharpoons 2NH_3\uparrow + 2H_20 + CO_2\uparrow$$

ammonium carbonate — water — ammonia — water — carbon dioxide

As the urease enzyme degrades urea very quickly, especially in moist conditions, volatilisation losses begin soon after urea is applied. As soil moisture increases towards field capacity, ammonia volatilisation increases (Black et al., 1987). Thus, urea surface-applied to moist soil will exhibit higher ammonia losses than if applied to the same dry soil.

The reactions occur when urea is surface applied and when it is incorporated, but the potential for loss is much lower when the urea is below the soil surface. Application of sufficient rainfall to move the surface-applied urea deeper into the soil should thus reduce volatilisation losses.

Work by Black et al. (1987) showed that volatilisation losses were reduced when rainfall was applied earlier (3 hours vs 8 hours) after urea application. Data generated in the current research supports this finding and suggests that beyond 8 hours after application of urea, the amount of rainfall has little impact on suppressing ammonia loss from that urea. Ideally, 4 mm of rain should occur within 3 hours of application, or 10 mm within 8 hours.

Since SustaiN Green reduces volatilisation losses by an average of 50%, in practical terms it is wise to use this product in preference to urea unless it is raining at the time of application.

References: Black, AS, Sherlock, RR & Smith, NP (1987), Effect of timing of simulated rainfall on ammonia volatilisation from urea, applied to soil of varying moisture content, *J. Soil Sci.* 38: 679-87

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