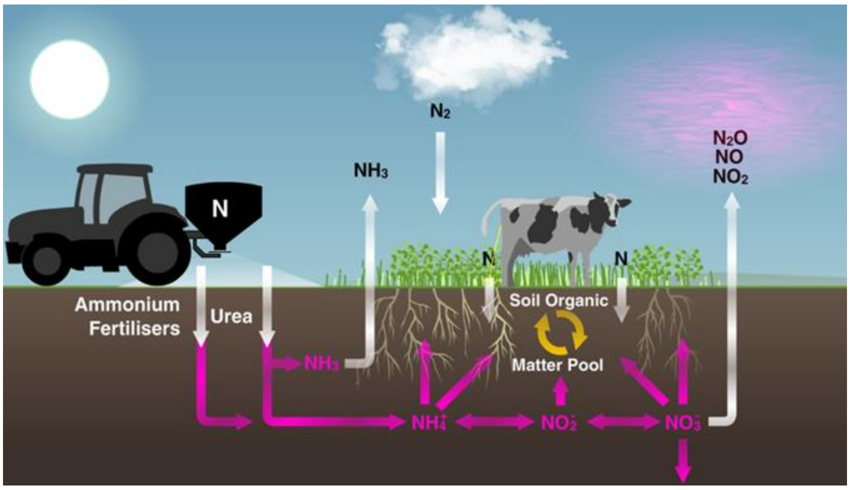
Is Nitrous Oxide an issue in low rainfall cropping systems?



WHAT IS NITROUS OXIDE?

Nitrous Oxide (N_2O) is a greenhouse gas which has worldwide agricultural, environmental and political implications. N_2O has a global warming potential (GWP) of 298 (the GWP of carbon dioxide is 1). This differential is a measure of how much heat a greenhouse gas can trap in the atmosphere. Agriculture is by far the biggest contributor to Australian N_2O emissions.

N2O is produced by three main chemical processes: nitrification, denitrification and nitrate ammonification. The presence of favourable levels of mineral nitrogen, labile (easily decomposable) carbon, soil moisture and temperature influence these processes (DAFF, 2011).

The process of nitrification requires oxygen and a moist, but not waterlogged soil in which ammonium (NH4) is converted to nitrate (NO3). N2O is produced as a by-product.

Denitrification and nitrate ammonification occur in waterlogged soils as oxygen is not required. In the case of denitrification, nitrate (NO3) can be converted into nitrogen gas (N2) with N2O as an intermediate product. Nitrate ammonification involves the conversion of NO3 back to NH4.

The main factors that control N2O emissions are:

- Soil water levels – higher losses generally associated with waterlogging events
- Soil nitrogen levels
- Labile soil carbon
- Soil temperature.

Crop management can alter these factors and as a result impact on losses of nitrogen from the system as well as overall nitrogen use efficiency.

HOW MUCH ARE WE LOSING IN THESE SYSTEMS?

Trials to date have often shown small N2O losses in low rainfall environments. Static chamber N2O losses from the Victorian Mallee during late winter & spring 2012 resulted in peak measured emissions of 4.5g N/ha/day following 10mm rainfall (83kg N/ha top-dressed and high baseline soil nitrogen). In the Upper North, peak emissions of 3.1g N/ha/day following 20mm rainfall were recorded.

In these instances it is assumed that conditions at this time were not sufficiently waterlogged to result in much larger emissions that have been recorded in higher rainfall areas.

This compares to emissions in high rainfall fertile pasture soils in south–eastern Victoria which have been shown to emit peaks in excess of 1kg/ha/day.

CAN FERTILSER MANAGEMWENT REDUCE N2O LOSSES?

The impact of fertiliser application and the use of treated fertilisers on N2O emissions under various soil conditions is the subject of ongoing research. However there are a number of products and practices available that may reduce various nitrogen losses under certain circumstances:

Upper North Farming Systems ABN 85 989 501 980
Address: Box 323, Jamestown, SA 5491 Email: unfs@outlook.com

1. Urease inhibitors

Urease activity of soil
Urea hydrolysis rates are directly related to urease activity in the soil. Urea hydrolysis increases with increasing soil temperature, being fastest at 25C and slowest at 5C.

Urease inhibitor coated on the granule.
Urease inhibitors slow the rate of urea hydrolysis by inhibiting the action of the enzyme urease, reducing the pH hotspot around the granule and lowers ammonia gas (NH_3) losses. This allows more time for urea to be washed into the soil.

Green Urea (46% N): a granular urea product coated with urease inhibitor designed to reduce volatilisation. This product delays the conversion of urea to ammonium by suppressing urease activity for a period of time, allowing the fertiliser to move into the soil where it is less susceptible to volatilisation. It is suited to situations in which rainfall immediately following fertiliser topdressing is insufficient to wash the fertiliser into the soil.

Green urea is most effective if nitrogen fertiliser is applied to the soil in the absence of follow up rainfall (conditions suited to volatilisation). By slowing the rate of urea hydrolysis urease inhibitor coated fertilisers also have the potential to impact on N_2O losses. However this impact is the subject of ongoing research.

Polymer Coated Urea (43% N): an external polymer coating around the urea granule core. Nutrients are released gradually and can be taken up as the plant grows, reducing the potential for nitrogen losses.

This product is designed to release nitrogen slowly, as a result it may not be suitable for deferred applications in season where an immediate boost to nitrogen supply is needed. It is more likely to be suited to situations when nitrogen is applied earlier in the season either at or soon after sowing where losses are likely following application.

2. Nitrification inhibitors

ENTEC (46% N): a nitrification inhibitor that slows the activity of nitrosomonas bacteria which in turn delays the conversion of ammonium to nitrite and then nitrate. Nitrogen is retained in the ammonium form longer and is therefore less prone to leaching as nitrate as well as losses as N_2O. The application of nitrification inhibitors is also the subject of ongoing research to investigate potential reductions in N_2O loss.

3. Timing of N fertiliser application

- • Post sowing nitrogen is typically applied just ahead of a rain event in order to wash fertiliser into the soil and avoid the risk of ammonia volatilisation.
- This requires efficient application techniques were large areas need to be covered in a short time.

4. N decision support tools

- Yield Prophet® can help predict both yield potential and soil N levels.
- Soil moisture probes can be used to predict plant available water and yield potential.
- Soil tests for texture, constraints, moisture and N at sowing can be used in Yield Prophet® and other decision support tools. By more strategically matching nitrogen applications to crop demand, both the farm business and the environment will benefit through improved water and N use efficiency.

Acknowledgements

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