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Urease inhibitors:

how they help protect N fertiliser

Fertiliser prices are climbing, and the high prices are here to stay for this season. Fertilisers are a major cost in cotton production and the increase in price will add pressure to farming budgets. In this fact sheet, we look at a particular type of enhanced efficiency fertiliser (EEF): urease inhibitor, and how it may help improve your return on fertiliser investment.

Enhanced efficiency fertilisers (EEFs)

EEFs are fertilisers which either physically or chemically delay the release of nutrient from the fertiliser into the surrounding environment. This fact sheet will focus on nitrogen (N) fertilisers as many of the commercially available EEFs are N-based. There are three main EEFs used in cotton systems:

- **Polymer coated urea (PCU).** Urea granules are coated with a polymer that breaks down over time allowing water to enter, dissolve the urea, and then leak out. The rate of release is controlled by the properties and thickness of the coating, along with moisture and temperature.
- **Urease inhibitor.** A chemical additive is applied to urea before application, usually before it is to be broadcast. This inhibitor prevents the conversion of urea to ammonium by the process of hydrolysis, which uses an enzyme called urease.
- **Nitrification inhibitor.** A chemical additive is either added directly to urea or in the soil band with urea. After the urea has hydrolysed to ammonium in the soil, the inhibitor prevents the further conversion of ammonium to nitrite and nitrate by suppressing the Nitrosomonus bacteria within the soil.

Broadcasting urea (risks, losses)

Considering our cotton crops are now established and we are entering the period of in-crop fertiliser applications, along with timely rainfall events, the application of fertiliser by broadcasting can be a useful tactic. When urea is broadcast in-crop and followed within one or two days by irrigation, the N losses via ammonia volatilisation are very low and this method provides a good alternative to applying N through fertigation or by side-dressing which can have associated compaction issues when conducted in wet soil.

When urea is spread on the soil surface, there is the potential for N losses via two pathways:

- Urea runoff. If rainfall after the application of urea exceeds the rate of water infiltration into the soil, runoff will result and can carry the dissolved urea out of the field.
- Ammonia volatilisation. Once dissolved, urea converts to ammonium via hydrolysis, a chemical process that creates a short-lived highly alkaline zone around the urea granule, which can result in the gaseous emission of ammonia gas. This is why broadcast urea should be followed by irrigation (or rainfall of greater than 20mm)—to get it into contact with more soil volume that helps trap much of the ammonium before exiting the soil. Broadcasting onto wet soils without rain or irrigation leaves the newly-formed ammonium at the surface and more vulnerable to loss as ammonia.

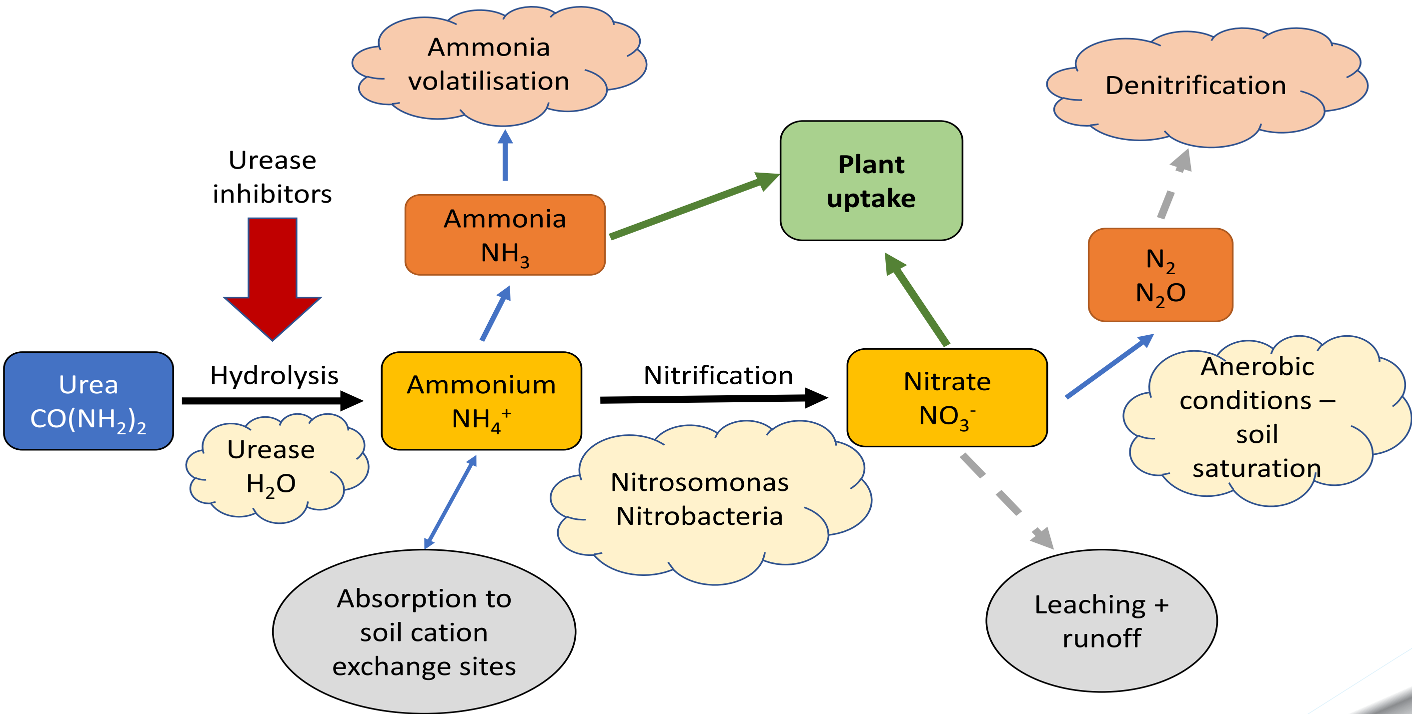
Best Practice

The potential loss of N is exacerbated by factors including rainfall less than 20mm, high humidity or heavy dew, presence of crop residues, open canopies, high temperatures and wind (conditions with high soil surface evaporation), high soil pH and soils that have low cation exchange capacity (CEC).


Left - intact urea on the soil surface. Right - urea dissolved but not properly incorporated into the soil, which has a high risk of ammonia volatilisation (red circles).

Processes involved in urea conversion to nitrate
Surface broadcasting of urea granules can lead to losses due to the processes involved in the conversion of urea to nitrate. Firstly, urea along with water and the urease microbes convert urea to ammonium and/or ammonia gas. The ratio of ammonium to ammonia is dependent on the pH at the site of the reaction, which in turn is influenced by the soil's capacity to buffer the highly alkaline pH developed during hydrolysis. If the process occurs at the soil surface and without suffice incorporation of ammonium or ammonia into the soil, high losses (>20%) may occur as ammonia gas.

In all soils, ammonium is converted to nitrate by a process called nitrification, which contains two steps. The first step is when the ammonium is converted to nitrite by Nitrosomonas bacteria in the soil. Once in nitrite form the second step involves the Nitrobacter microbes converting nitrite to nitrate.



How will urease inhibitors help me?

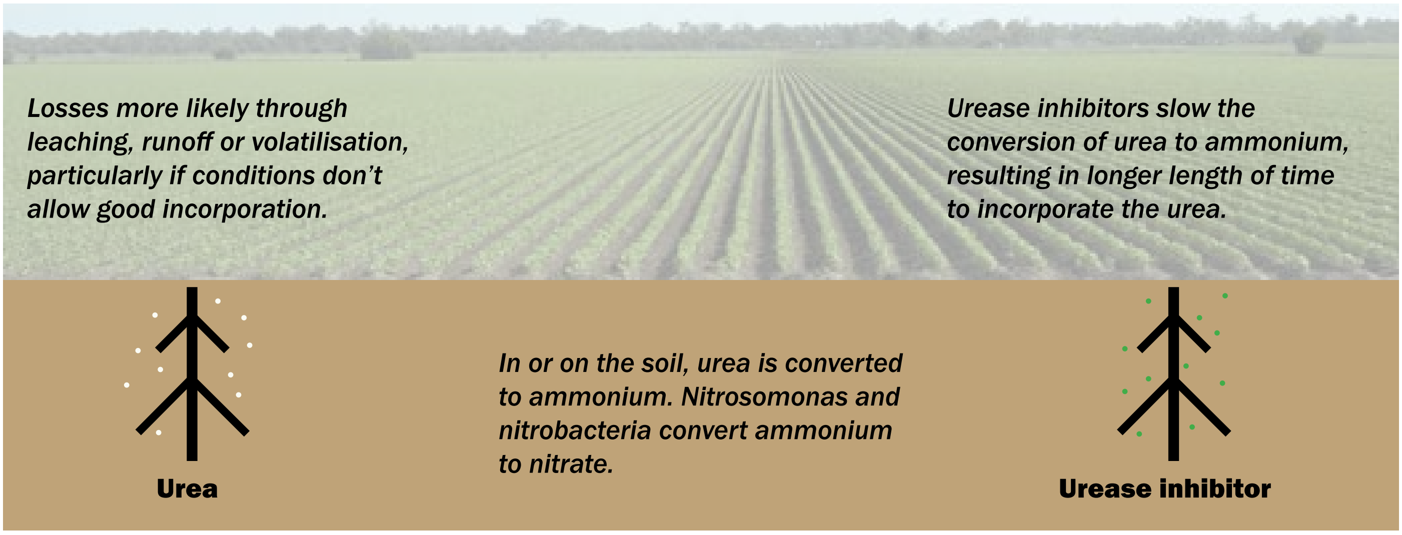
Urease inhibitors reduce the activity of the urease enzymes. Along with water, these enzymes are responsible for the breakdown of urea to ammonium and ammonia.

Protecting your urea with a urease inhibitor will delay the hydrolysis of urea, usually for one to two weeks (check product specification and recommended rate), thus reducing any losses as gaseous ammonia loss during this period. This provides additional time to receive the required rainfall or irrigation to incorporate the urea into the soil.

The use of urease inhibitors won't guarantee fertiliser N is not lost, but it gives farmers more time to ensure the fertiliser is incorporated into the soil either by mechanical means or by infiltration through irrigation or consistent rainfall (e.g. ≥20 mm). Urea is highly soluble and incorporation into soils will occur with rainfall that is constant and absorbs to a depth of 5–10 cm. Urease inhibitors will break down over time, generally lasting seven to 14 days. The exact length of activity is dependent on temperature and moisture and the applied rate of the inhibitor chemical.

Economic benefit of inhibitors

The current high price of urea fertiliser and the predicted La Niña weather pattern throughout the summer provide conditions that potentially warrant the use of urease inhibitors this season. Research showed that 10% of urea N may be lost if broadcast on the surface in several various dryland cropping scenarios. A saving of 10% of fertiliser N would equate to saving ~$100 urea fertiliser.



Further reading and information:

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https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2021/02/nitrogen-loss-pathways.-how-much-n-is-lost-when-urea-is-not-mechanically-incorporated-after-application

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