TECHNICAL NOTE – MARCH 2019
UREASE INHIBITOR FACTFILE
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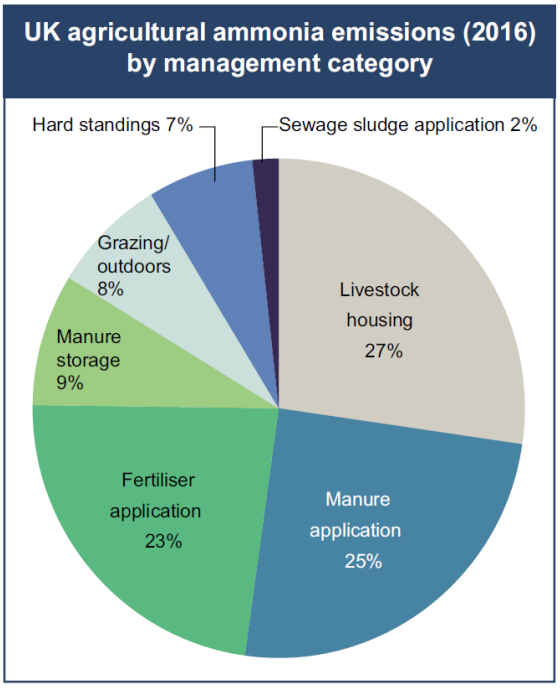
Introduction

Some of you will have heard of the Clean Air Strategy 2019; this was a document drawn up by DEFRA detailing their plans to reduce air pollution and emissions from all contributing industries. The focus for agriculture in this strategy is to reduce UK Ammonia (NH_3) emissions, with the claim being that farming practices alone make up 88%[1] of UK emissions. Almost a quarter of this 88% is due to fertiliser application[1].



(Source Clean Air Strategy [1])

The danger of excess ammonia pollution is that ammonia reacts in the atmosphere to produce particulate matter (PM) which has significant health impacts including cardiovascular and respiratory disease.[7] Alternatively, ammonia can be removed from the air as acid rain, consequently increasing the acidity of plants and soil and causing high nitrogen concentrations in water bodies[1] and land based environmentally sensitive areas. Added nitrogen (ammonia is a nitrogen gas) results in decreased biodiversity as many organisms are unable to tolerate the acid/increased nitrogen conditions and other, more tolerant species thrive and outcompete, dominating the local environment[3]. Excess nutrient loss to air is something that the new Farming Rules for Water (2018) also sets out to manage. Both the Farming Rules for Water and the Clean Air Strategy are the drivers for new regulations being introduced.

As a direct consequence of the increased risk to human health the Clean Air Strategy suggests that DEFRA may specifically legislate on urea-based fertiliser use[1] as this has proven to be one of the worst offenders when it comes to excess ammonia emissions. It is likely that growers' options will be restricted to inhibited urea and ammonium nitrate (AN) based fertilisers. So, what are the alternatives?

Ways to Reduce Emissions from Urea Fertiliser Application

There are a few options for growers using straight urea fertilisers at present. The easiest and most expensive is switching to straight AN fertilisers. Whilst the losses as ammonia from straight AN are around 2% compared to up to 45% from urea fertilisers[1,7] (depending on conditions at application), the cost per kg N in AN is considerably more at 81p, compared to 60p per kg N in urea (using February 2019 AHDB fertiliser prices)[6]. Ammonia losses from Calcium Ammonia Nitrate (CAN) are claimed to be lower at less than 1%. Another, on the face of it, less expensive option, compared to AN, to reduce ammonia emissions is to use urea with an inhibitor added.

Urease Inhibitors

Urease inhibitors are chemical compounds which slow down the rate of urea breakdown into ammonia by

occupying/inhibiting the urease enzymes. If left uninhibited the soil born urease enzymes enable, via a hydrolysis reaction, the release of ammonia from soil surface urea. The chemical reaction associated with ammonia emissions from urea is more clearly explained using the equation below:

Urea + Urease Enzyme + Soil Moisture → Ammonia + Carbon Dioxide

If urease inhibitors take the urease enzyme out of the above equation, ammonia cannot be produced at the same rate. Urease inhibitors are only effective for between 7 and 14 days, during this period rain, irrigation or incorporation into the soil would be required to prevent ammonia release thereon[2]. Once urea is within the soil profile ammonia emissions are reduced considerably.

Urease inhibitors are typically applied by the fertiliser manufacturer during production and, at present, are priced in the middle ground between straight urea and AN. Urea with inhibitor would more typically be priced at same cost as AN.

The most recent large UK dataset[8], quantified mean ammonia emissions from inhibited urea at 6% compared to 24% for straight urea.

It should be noted that a move to urease inhibitor treated urea from straight urea will not cut emissions to a level that could be achieved by a switch to AN or CAN based fertilisers.

The pros and cons of using urease inhibitors compared to straight urea are:

Pros

- Can reduce ammonia losses by 50-90% compared to an untreated urea application[2]
- Research has shown a yield benefit to using urease inhibitors in strip, conventional and no till systems compared to crops grown without the inhibitor[5]. The yield advantage is due to the greater nitrogen retention in the soil. This yield benefit can only be realised if there is a nutrient requirement for the maize[2].
- The use of urea and urease inhibitor would roughly equal the cost of using AN, but is more likely to be compliant with any new regulations.

Cons

- If rules are put in place demanding urease inhibitor use with urea fertiliser, prices are likely to increase, meaning that there is a chance that AN would be cheaper to buy.

Products on the Market

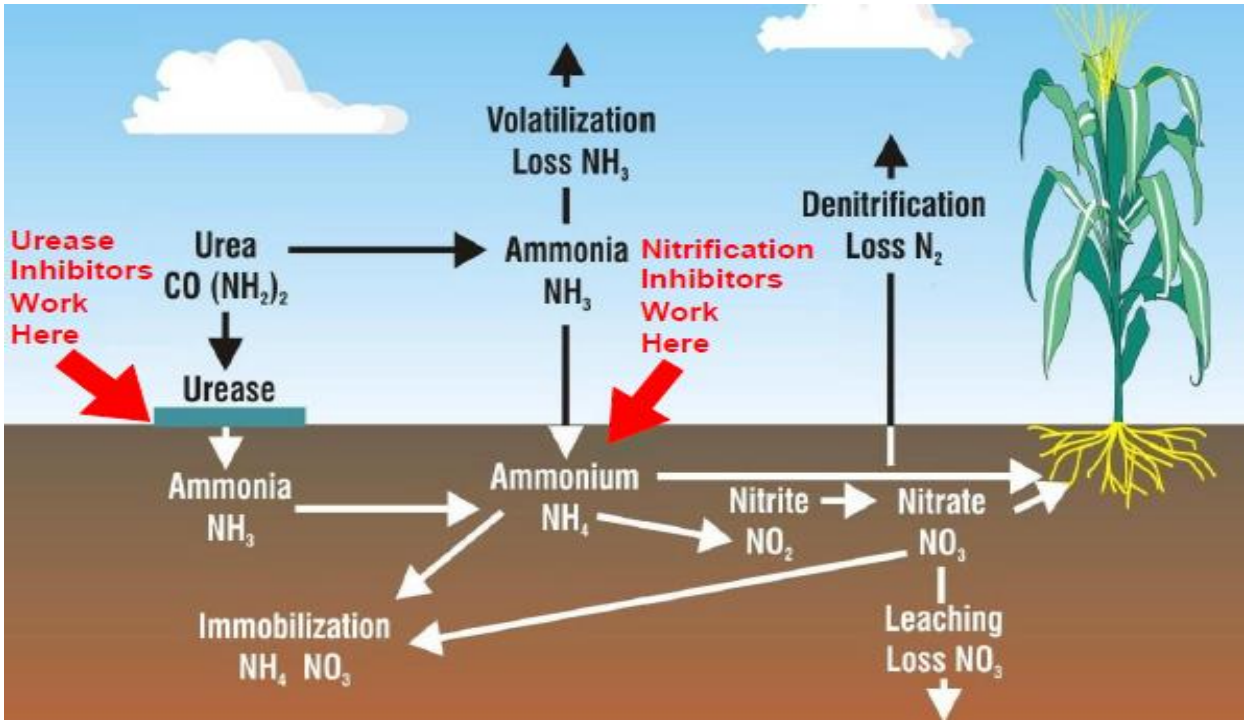
There are currently a number of urease inhibitors on the market. Some of these are listed below – others are available.

- Enhanced-N – *Origin*
- Sustain – *Origin*
- Limus – *BASF*
- Alzon neo-N – *Gleadell* (also contains nitrification inhibitors; see below)
- Piagran Pro – *Gleadell*
- YaraVera AMIPLUS – *Yara*
- N-protect (Liquid urease inhibitor for liquid fert) - *Frontier*

Nitrification Inhibitors

Urease inhibitors are not be confused with nitrification inhibitors. These work to reduce the breakdown of ammonium into nitrate by bacteria in the soil. The ammonium-form of nitrogen will not leach from the soil, as it is better able to bind to soil particles, however nitrate-nitrogen will very easily leach from the soil into watercourses, both polluting them and reducing the available nitrogen levels in the soil. Figure 1 shows where both urease inhibitors and nitrification inhibitors fit into the nitrogen cycle. It can be seen that the urease inhibitors lock more ammonia into the soil instead of allowing it to be released as a gas, whilst nitrification inhibitors ensure that ammonium stays in its form, rather than breaking down into nitrate which can be more easily lost.

Figure 1. The Nitrogen Cycle[4]



Conclusion

To conclude, with increasing attention to ammonia emissions and pollution, it may be that legislation is introduced regarding the use of urea fertilisers. Therefore, using urease inhibitors may be a comparatively low-cost method of meeting new rules, whilst potentially also increasing yields.

For more information, the following papers are available on the potentially impending rules on fertiliser use:

Clean Air Strategy

Farming Rules for Water

Code of Good Agricultural Practice for Reducing Ammonia Emissions

References

1 Defra (2019) *Clean Air Strategy 2019.* Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf

2 IPNI. *Urease Inhibitors.* Nutrient Source Specifics. (25) Available from: http://www.ipni.net/publication/nss.nsf/0/EA265C5FE184D4F285257C8300753585/$FILE/NSS-25%20Urease%20Inhibitors.pdf

3 Defra (2018) *Code of Good Agricultural Practice for Reducing Ammonia Emissions.* Available from: https://www.gov.uk/government/publications/code-of-good-agricultural-practice-for-reducing-ammonia-emissions/code-of-good-agricultural-practice-cogap-for-reducing-ammonia-emissions

4 Agrotain (2005) *Urease and Nitrification Inhibitors.* Available from: http://www.firt.org/sites/default/files/Sutton_Inhibitors%26Stabilizers_presentation.pdf

5 Monsanto (2012) *Influence of Urease Inhibitor on Corn Yield in Three Tillage Systems.* Available from: https://monsanto.com/app/uploads/2017/05/mlc-lc-influence-of-urease-inhibitor.pdf

6 AHDB (2019) *Fertiliser Information.* Available from: https://ahdb.org.uk/fertiliser-information

7 Defra (2005) *The behaviour of some different fertiliser-N Materials NT2605* Available from: http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=11983

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