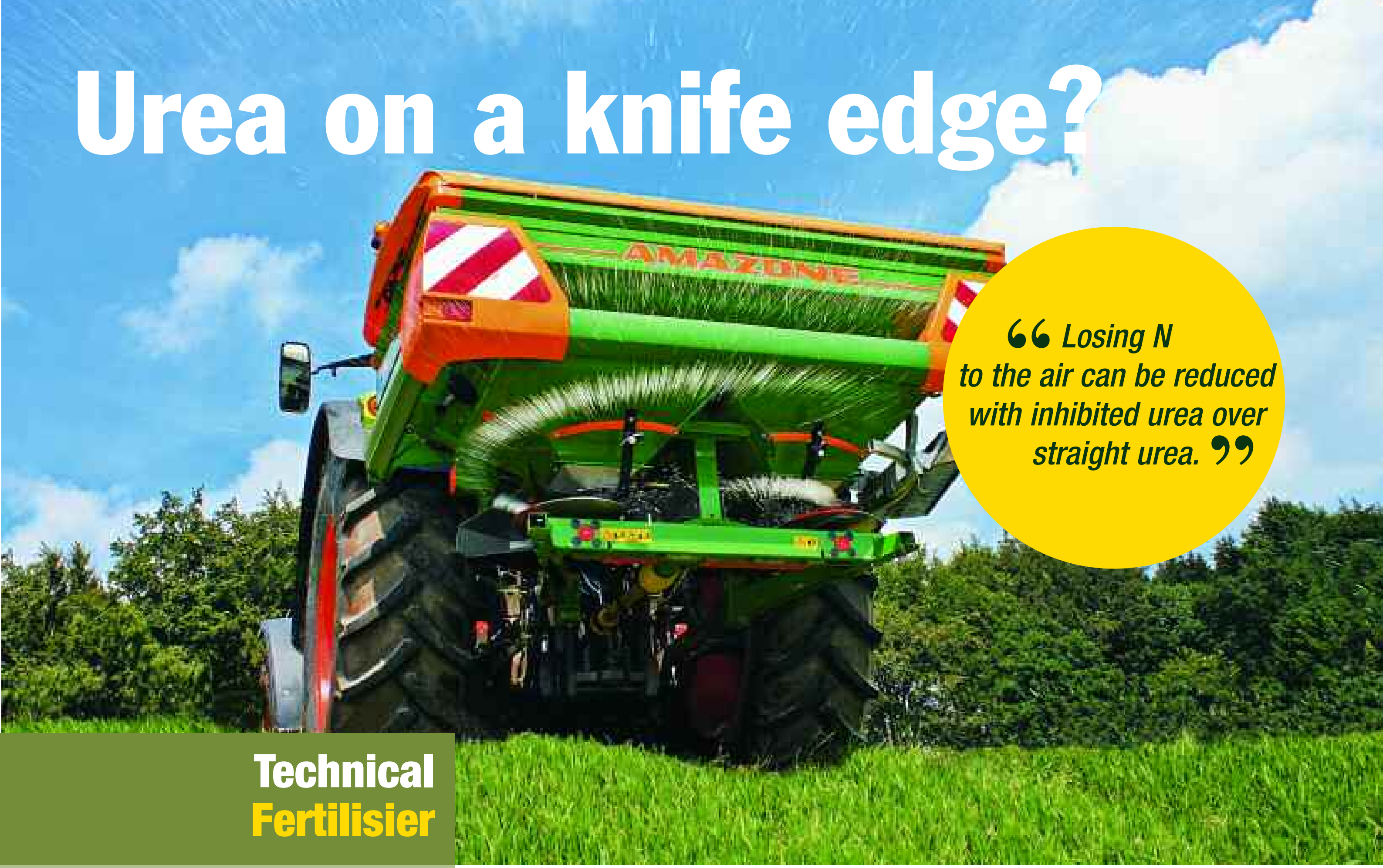
Urea on a knife edge?



"Losing N to the air can be reduced with inhibited urea over straight urea."

Technical
Fertilisier

The urea versus ammonium nitrate debate has always been a fiery one and strongly divides opinions. Proposed government measures to deal with greenhouse gas emissions has added fuel to the fire. *CPM* reports.

By Lucy de la Pasture

The new Agriculture Bill and the associated Clean Air Strategy announced earlier this year may be languishing in Westminster while Brexit dominates proceedings, but once it resumes its passage through Parliament the implications to farming may be rapid.

Air pollution has become a hot topic, not just because of the effects on the climate but its effect on human health. Ammonia reacts with nitrous oxide and sulphur dioxide in the atmosphere to form particulate matter which can significantly impact human health, causing respiratory disease. For a hard-pressed NHS, it's a real problem and in Oct it released a report which pointed the finger at air pollution for being responsible for 40,000 avoidable deaths each year.

One of the main objectives in Defra's draft Clean Air Strategy is to reduce the emissions of ammonia (NH_3) and agriculture is responsible for 88% of the total in the UK. The biggest offenders are organic manures and slurries but approximately 23% comes from inorganic mineral fertilisers, with urea in the spotlight and likely to be the main target of regulations to reduce emissions and the unintended consequences of air pollution.

Clean Air Strategy

The draft Clean Air Strategy document suggests a move away from urea to ammonium nitrate as one solution to reduce ammonia emissions, says CF Fertilisers arable agronomist, Allison Grundy. The alternatives are to incorporate or inject urea into the soil or to use it with an urease inhibitor.

"Since nitrogen fertiliser creates the greatest return on investment of all inputs in cereal production at around 5:1, choosing which form to use is one of the most important decisions a business can make," she says.

A key factor to consider is nitrogen fertiliser utilisation efficiency — an indicator of how much of the N applied is recovered by the crop, says Allison.

"Values can be as high as 75% in arable cropping for ammonium nitrate but are usually around 10% less when urea is used. This is because of volatilisation, where urea loses nitrogen as ammonia gas to the air."

Urea is the world's primary global mineral nitrogen source, adds Richard Corden, Business Development Manager for BASF.

"In the UK, around 20% of the mineral fertiliser used is in the form of urea with the majority of farmers using a source of ammonium nitrate, either produced in the UK or imported," he explains.

The pros and cons of using urea and ammonium nitrate are well known to growers but the recommendations within the Clean Air Strategy has created a whole new area of debate. One approach to improving the efficiency of urea is to use urease ►

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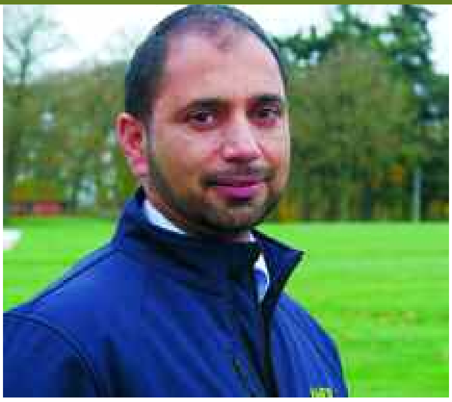


Sajjad Awan is concerned that not enough work has been carried out to assess whether there's an affect from urease inhibitors on soil biology in the longer term.

▸ inhibitors to delay hydrolysis and increase the time available for sufficient rain to fall and move surface applied urea into the soil, thereby reducing ammonia loss.

AHDB's Dr. Sajjad Awan is concerned about the long-term effects of inhibited urea use on soil health and biology.

"Scientific literature suggests that up to 30% of soil microbiome produces urease as part of their natural biochemical processes and if we manipulate this biological process it could prove detrimental to the vital balances in soil microbiology.

Speed urea becomes available to plants

Soil temperature (°C)	Time for transformation of urea into ammonium (days)
2	4
10	2
20	1

Source: Amberger und Vilsmeier (1984, in Sturm et al. 1994)

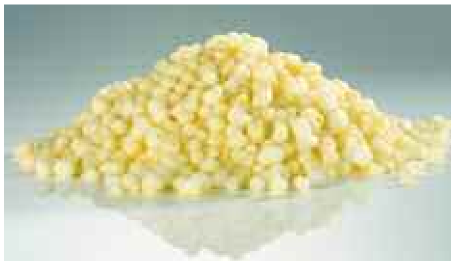
"Furthermore, if we're encouraging growers to go down more soil-friendly production routes such as min till and no-till, it is likely that more urease inhibitors will be needed in urea fertilisers in such situations."

He believes that it's imperative for the industry to carry out independent research regarding the long-term effects of using fertilisers containing urease inhibitors before their widespread use in agriculture is fully accepted.

Richard says that part of the challenge with urease inhibitors is that the technology is often misunderstood. "Urease inhibitors have been used for decades globally, with very high use rates in some markets. For example, in the USA around a third of the urea used is treated with an inhibitor and no reports of effects on soil microorganisms have been reported," he says.

"Furthermore, urease inhibitors are only effective in the soil that immediately surrounds the fertiliser. It's in this location where urea is first hydrolysed into ammonia. If the build-up of ammonia is not diluted by rainfall/irrigation or natural diffusion into the soil, a localised spike in the soil pH can occur around the site of application.

"It's this pH spike that causes the ammonium to change to ammonia which can then be lost to the atmosphere. Urease inhibitors work by temporarily stopping the urease enzymes, effectively preventing the pH spike, increasing the time



The formulation technology used in BASF's new urease inhibitor, Limus, resolves some of the problems associated with storing inhibited urea products.

available for enough rain to fall and move surface applied urea into the soil," he explains.

"Once washed into the soil the transformation of urea to ammonia begins and because the concentration is much more diluted the pH spike no longer occurs. This ensures that there is no delay in uptake of nitrogen by the plants of an inhibited urea when compared to standard urea," he adds.

Yara's technical manager Mark Tucker says that if you put all other arguments aside and just consider ammonia emissions alone then moving to an ammonium nitrate form of nitrogen fertiliser is the sensible option.

Unknown element

Yara operates globally and produces fertiliser products based on both the main nitrogen forms (urea and ammonium nitrate) as well as an inhibited form of urea. Even so, he's in agreement with Sajjad that there is an element of the unknown as far as the effect of urease inhibitors on soil biology. He also notes that traces of dicyandiamide (DCD) found in milk in New Zealand in 2013 were reportedly linked to the use of urease inhibitors.

Mark believes such uncertainties over their use may explain the different approaches taken across Europe — while in Germany all urea will have to be inhibited from 2020, France hasn't yet moved to legislate solely for the use of urease inhibitors.

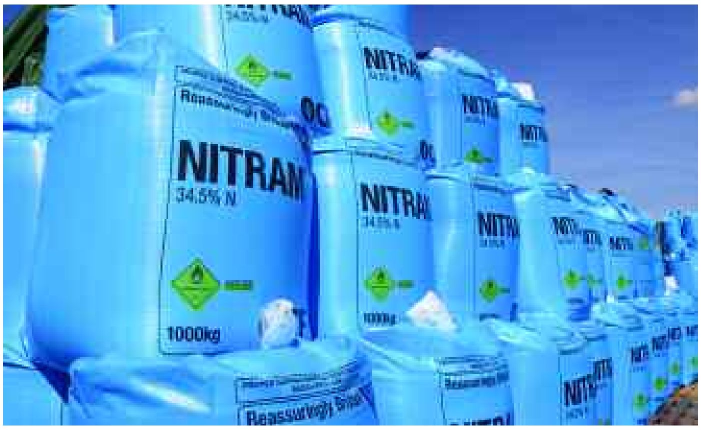
Inhibited urea products could also present somewhat of a regulatory challenge for DEFRA should the UK chose to go down the same route as Germany. "One of the problem areas is policing to make sure that inhibited urea products meet the new EU fertiliser regulations, which state the level of urease inhibitor they must contain at the point of application," he says.

That may prove problematic with some inhibited products because of historic problems with degradation during storage. Recent advances in formulation technology has led to improvements in product shelf life, with newer products now supporting at least a 12-month storage period without degradation occurring, comments Richard.

Allison remains unconvinced that urea can perform as consistently as ammonium nitrate under UK conditions.

"Losing N to the air can be reduced with inhibited urea over straight urea, but the problem of how N becomes available to plants remain constant for both options. While the N in ammonium nitrate is in forms that can be directly taken upby crops, the N in urea becomes available to the plant through the process of hydrolysis which relies on soil biology and conditions," she says.

Richard points to trials data which shows that the time taken for urea to transform into ▶



Ammonium nitrate has a proven track record under UK conditions and has an 80% share of the UK's nitrogen fertiliser market.

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ammonium is surprisingly rapid, even at low soil temperatures.

"The use of inhibited urea products was also tested as part of the Defra's NT26 research programme. These trials based over three years concluded equivalent performance of urease inhibited urea and AN in ten cereal trials."

Inhibited urea

Mark points out that there's a danger that inhibited urea could be a victim of its own success if there's a swing from traditional ammonium nitrate towards using those urease inhibitors which promise equivalent performance at a lower price.

"Whatever the UK regulators decide, it will be obvious whether the regulations are working in time. If ammonia emissions don't decrease, then there's a problem and it's possible that a rise in the use of inhibited urea at the expense of ammonium nitrate will see an overall increase in emissions because inhibited urea fertilisers still lose more ammonia to the air (6-7%) than ammonium nitrate (2-3%)."

Reducing ammonia emissions is going to be a challenge for the whole sector but with targets in place there's a growing sense of urgency, adds Mark. "I'm picking up that governments across Europe are getting frustrated by the slow speed of change in agriculture, so things really are on a knife-edge at the moment."

Allison believes the debate will continue, but in her opinion the position of AN remains agronomically strong.

"You simply can't avoid the fact that AN has a proven track record in all manner of growing conditions gained across many years and it's known to perform reliably in the UK's maritime conditions. I don't believe there's the same body of evidence for any form of inhibited urea.

"When we're all being encouraged to focus on mitigating risks and using inputs as efficiently as possible and with N use being such a critical element of modern production, inhibited urea may be a leap of faith too far for some growers." ■

Cancer risk from sulphur shortage

Growers may not be applying sufficient sulphur to wheat and potatoes to avert the risk of high levels of acrylamide in processed foods.

Inadequate levels of sulphur applied to UK crops could raise the prospect of dangerous levels of acrylamide in processed foods. This was the warning given by scientists at the first ICL Technical Agronomy Symposium near Grantham last month.

Dr Tanya Curtis from Curtis Analytical at Rothamsted explained that acrylamide is a neurotoxin and a probable carcinogen that forms during frying, roasting and baking potato and cereal-based products at a high temperature. Concerns over a lack of awareness among consumers has led to new risk-management measures imposed on food manufacturers, including requirements to monitor acrylamide levels and implement mitigation measures.

"Free asparagine and reducing sugars such as glucose, fructose and maltose are established precursors for acrylamide formation," said Tanya. "Free asparagine is the key parameter in wheat and it accumulates at high concentrations in response to a number of biotic and abiotic stresses. Sulphur deprivation in particular causes a massive accumulation in the wheat grain."

Dr Steve McGrath of Rothamsted Research echoed these findings, presenting a number of AHDB-funded and other independent studies that have shown routine applications of sulphur to cereals and oilseeds consistently result in yield and quality benefits. "The risk of deficiencies relates to soil type and overwinter rainfall," he added.

But data he presented from the British Survey of Fertiliser Practice (BSFP) show that over a quarter of wheat crops and around 75% of potatoes do not receive S.

Soil analysis data from Lancrop Laboratories indicates an increasing trend of soil sulphur deficiency, with 85% of arable samples tested in 2019 found to be deficient. What's more, sampling of cattle slurries suggest organic manures are not delivering the levels of S to the crop indicated by RB209, said Lancrop's Jon Telfer.

"Timely use of leaf analysis allows for in-season assessment and adjustment, while post-harvest grain analysis evaluates the efficiency of your nutrient strategy," he concluded.

A series of recent proprietary and independent trials results using ICL's PotashpluS, PKpluS and Polysulphate fertilisers were presented. These showed the material, derived from the world's only commercial polyhalite mine in N Yorks, performed well across a range of crops.

PKpluS performed better than TSP and MOP applied over replicated plots in an autumn fertiliser trial on KWS Zyatt winter wheat, carried out at Agrii's site at Sanction, E Yorks. Low and high rates were applied in the autumn, with P and K then balanced in the spring.

"The addition of sulphur from the PKpluS was useful," concluded Agrii's Tom Land. "It improved crop biomass and NDVI in Nov and gave a slight edge in yield compared with a TSP/MOP blend. Spring was the most responsive time for nutrient weighting."

First year sales of PotashpluS, which has joined ICL's family of polyhalite-derived fertilisers, exceeded expectations said the company's Howard Clark. "The feedback from customers and farmers has been really positive. Our agronomy trials programme, which includes our own and independent trials, shows all Polysulphate-based products performed as well and often better than traditional products."

A naturally occurring mineral, Polysulphate releases its nutrients to the crop over an extended period of time. It contains sulphur, potassium, magnesium and calcium, has a carbon footprint of 0.033 kg CO_2e/kg (claimed as the lowest footprint of any equivalent fertiliser) and is approved for use in organic systems. At 37% K_2O, PotashpluS has a higher content of potash.