

Choosing the right nitrogen product

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Key points

- Urea is the cheapest and most common form of fertiliser N but it is also most prone to loss through volatilisation (loss as ammonia gas).
- Urea is best used when incorporated or banded into the soil.
- Urea with urease inhibitors can reduce volatilisation when surface broadcast, thus providing more flexibility regarding timing and can improve fertiliser utilisation over standard urea for a relatively low additional cost.
- Other nitrogen fertilisers such as Ammonium sulphate or sulphate of ammonia (SOA), calcium ammonium nitrate (CAN) or polymer coated urea (PCU) are more expensive.
- Compound fertilisers are typically used at planting and supply only some of the fertiliser nitrogen required by the crop.

A wide variety of granular nitrogen fertilisers are routinely used by arable farmers. Choice may depend on timing, purpose and preference. A common feature of these products is that they all contain inorganic nitrogen in the form of urea, ammonium or nitrate.

Urea

The most commonly used nitrogen fertiliser is urea, a manufactured organic compound. Urea has the highest concentration of nitrogen of any solid fertiliser available in New Zealand (46% N). It is also the cheapest per kilogram of nitrogen supplied. Urea is highly soluble and rapidly transformed to ammonium by the soil microbial enzyme urease. Nitrifying bacteria then convert ammonium to nitrate. Thus, nitrogen from urea is quickly available for plant use. However, when urea is converted to ammonium, localised alkaline conditions can allow the ammonium to form ammonium gas. This makes urea particularly vulnerable to nitrogen loss through volatilisation if surface broadcast. Conditions that promote volatilisation are dry, bare soils and hot, dry, windy weather. To minimise volatilisation loss, surface broadcasting of urea is best done immediately before rain or irrigation. Alternatively, consider other methods of application such as banding (side-dressing).

Urease inhibitors

Urea products containing urease inhibitors are commercially available (e.g., N-Protect and Sustain®). Urease inhibitors temporarily block the function of the urease enzyme responsible for converting urea to ammonium. As the nitrogen remains in the nonvolatile form for longer, the risk of nitrogen loss through volatilisation is reduced and fertiliser efficiency is improved. Like standard urea, these products contain concentrated nitrogen (46% N) and are slightly more expensive (around 7% more than standard urea). Urea products containing urease inhibitors have been tested on arable crops in New Zealand. In 11 trials comparing ryegrass seed yields following the application of either Sustain® or urea, where Sustain® was applied at the same rate as urea, there was an average ryegrass seed yield increase of 6%. Where dry conditions prevailed for up to two weeks after surface broadcasting, maize grain yields were

higher by around 0.8 t/ha with urease inhibited urea than standard urea applied at a standard rate. This represented an economic response to the urea containing urease inhibitors. No such response was found under irrigation, if rain fell shortly after application or when it was banded into the soil. The popularity of these fertilisers has increased recently, particularly with pastoral farmers who use surface broadcast as a placement method. Urea containing urease inhibitors provides more flexibility regarding timing of surface broadcast application than standard urea, and can provide greater utilisation for a relatively low additional cost.

Polymer coated urea (PCU)

Polymer coated urea is standard urea in a biodegradable polymer membrane. The polymer coating around the individual granules acts to slow the release of nitrogen so it is released to the plant in smaller more consistent quantities.

The nitrogen release is determined by the permeability of the polymer coatings, soil temperature and moisture. Release can be delayed by up to 90 days, depending on product. A polymer coated urea was compared with standard urea in a leaching experiment under maize. Soil nitrogen levels measured after an irrigation event designed to create drainage (97 mm) showed significantly less nitrogen moved down the soil profile with polymer coated urea plots than with standard urea plots. Despite the environmental advantages, polymer coated urea is seldom used in arable cropping as these products are significantly more expensive than standard urea (more than 60% more) and few situations justify the additional expense. Similar environmental gains can be achieved through other management strategies.

Nitrification inhibitors

Nitrification is the bacterial process that converts ammonium to nitrite and then nitrate. Nitrification can take two to three weeks in warm aerated soils. Nitrification inhibitors act to slow the bacterial process, keeping more of the fertiliser nitrogen in the ammonium form. Ammonium (NH_4^+) is a positively charged molecule and is attracted to negatively charged soil clay particles, making it less likely to be lost through leaching. The winter-active nitrification inhibitor dicyandiamide (DCD) has been developed to reduce N leaching losses in risky conditions. However, it is unlikely to give an advantage over urea on arable crops as there is a low risk of N leaching at the stage of the season when the bulk of nitrogen is applied (late spring and summer). DCD fertilisers are currently unavailable in New Zealand.

Calcined ammonium nitrate

CAN contains equal parts nitrate nitrogen (immediately available) and ammonium nitrogen (needs to be converted to nitrate by nitrifying bacteria). The nitrate component is more stable in low moisture conditions, so volatilisation risk is reduced. The cost of CAN is high (70% more expensive than standard urea) so is used primarily in high value horticulture.

Ammonium sulphate or sulphate of ammonia

Ammonium sulphate (SOA) is a very soluble crystalline product that contains both nitrogen (21% N) and sulphur (24% S). It is generally used at low rates, as at high rates the excessive sulphur inputs can be wasteful. The cost of SOA (50 % more than standard urea) means it is seldom used in arable cropping. All nitrogen fertilisers have an acidifying effect on the soil.

When ammonium is converted to nitrate, hydrogen ions are released, causing an increase in acidity. SOA has the greatest acidifying effect because of the sulphate component.

Compound fertilisers

Compound fertilisers contain a mix of nutrients within the same granule. The two most common used in arable farming are diammonium phosphate (DAP) and 12:10:10. DAP is a granular product containing nitrogen (18% N) and phosphorus (20% P). It is often used in arable farming as a fertiliser drilled at planting (up to 200 kg N/ha) as it has good handling characteristics and supplies both nitrogen and phosphorus. 12:10:10 is a compound fertiliser that contains nitrogen (12% N), phosphorus (10% P) and potassium (10% K). Some products also contain small quantities of other nutrients such as sulphur and magnesium. Like DAP, 12:10:10 is typically used as a 'starter' fertiliser for arable crops, applied through the seed drill at planting. Both are costly and generally applied at rates (200 - 250 kg/ha) insufficient to supply all the nitrogen required by the crop. The balance is normally applied as urea.

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