UREA

Urea, at 46% nitrogen (N), is the most concentrated solid nitrogen fertiliser. This means there is less to freight and handle. It is also one of the most economical nitrogen fertilisers. These factors have seen urea become the world's most popular nitrogen fertiliser.

Urea can be applied on its own, or in blends with products such as MAP and Muriate of Potash. It can be applied pre-plant, or in side dressing and top-dressing programs. There are limits to how much urea can be safely applied at planting without harming germinating seeds or young seedlings.

Urea is soluble. It can be applied in fertigation programs and as foliar sprays. Urea is also used a non-protein nitrogen supplement for ruminants, e.g. sheep and cattle. Urea allows ruminants to make better use of low protein roughages, e.g. dry grass, during dry weather and the onset of drought.

1. MANUFACTURE AND SUPPLY

Urea is a naturally occurring soluble organic compound. It is found in some moulds and fungi and in urine. The dark green growth responses in urine patches in poorly growing pasture and forage crops are often attributable to a response to nitrogen compounds such as urea.

Urea is manufactured synthetically in large quantities around the world for use as a nitrogen fertiliser and in industry, e.g. resins and glues. The first step in the manufacture of urea is to react natural gas, atmospheric nitrogen and water together at high temperature and pressure to produce ammonia (NH_3) and carbon dioxide (CO_2). These gases are then reacted at high temperature and pressure to produce urea [$CO(NH_2)_2$].

$$2NH_3 + CO_2 \rightarrow CO(NH_2)_2 + H_2O$$

Incitec Pivot Limited manufactures urea in Brisbane, using natural gas from southwest Queensland. This product is sold into northern New South Wales and southern and central Queensland. To supplement local production, urea is imported through various ports along the eastern and southern seaboards.

Various grades of urea are available.

1.1. Granular urea

This is the most used urea fertiliser, and is the preferred product where urea is applied dry to the soil.

Granular Urea has good storage and handling characteristics, and being a granular product, its particle size is more evenly matched with that of other granular fertilisers, such as DAP, MAP and Gran-am, and coarse crystalline grades of Muriate of Potash. This minimises segregation when used in blends. Urea is incompatible in dry blends with ammonium nitrate-based fertilisers, e.g. Cal-Am, and superphosphate.

1.2. Prilled urea

Prilled urea has a smaller particle size than granulated urea, making it quicker to dissolve. It is preferred where urea is applied in solution (dissolved in water), e.g. in fertigation programs, foliar sprays, and the preparation of stock licks (non-protein nitrogen supplements for ruminants).

Prilled Urea is imported into north Queensland, and is available ex Mackay, Townsville and Cairns. An alternative product, **Stockfeed Urea**, is available, ex Brisbane. This product is obtained by screening undersized granules from the granular urea that is manufactured on site.

1.3. Low biuret urea

Low biuret grades of urea, containing less than 0.4% biuret, are used in foliar sprays in high value horticultural crops and where urea is sprayed repeatedly at high rates. Granular grades of urea for soil application typically contain up to 1.5% biuret. Note. There is no need to use a low biuret grade of urea when formulating livestock supplements. Biuret is only of importance when urea is used in foliar sprays.

2. PHYSICAL PROPERTIES

2.1. Regulatory requirements

Urea is not classified as being a Dangerous Good or as Security Sensitive, as is ammonium nitrate, nor is it classified as a Poison.

2.2. Bulk density

Urea has a Specific Gravity of 1.33. The Bulk Density is typically in the range of 700 – 780 kg per cubic metre.

2.3. Granule size

Urea granules are typically in the range of 2 – 4 mm.

2.4. Solubility

Urea will dissolve in its own weight of water but becomes more difficult to dissolve as the concentration increases. Urea is endothermic. As urea dissolves, it causes the temperature of the solution falls, so a practical limit of 25 – 30% w/v (25 to 30 kg of urea in 100 litres of solution) is suggested.

Urea with a small particle size will dissolve more quickly and require less agitation. Granular urea will take longer to dissolve on account of its larger particle size and hardness. Once dissolved, there is no difference in the agronomic efficacy of any of the products. Those with a smaller particle size are simply easier to dissolve. Nutritionally, the products are identical.

For reference, the solubility of urea in water, in saturated solutions, in kg urea per 100 L of water is given below. These concentrations are not realistically achievable on farm (without heating and agitation).

Table 1: Urea Solubility (kg/100 kg water).

Temperature (°C)	Solubility (kg/100 kg)
10	84
20	105
30	133
40	166

Urea is used in the manufacture of UAN (Urea Ammonium Nitrate) solutions, e.g. Easy N. The solubility of urea and ammonium nitrate are mutually enhanced in the presence of each other, allowing a concentrated nitrogen solution to be prepared.

2.5. Compatibility

Urea is compatible with most other fertilisers in dry blends, e.g. Gran-am (granulated ammonium sulphate), DAP, MAP and Muriate of Potash. Urea is incompatible in dry blends with ammonium nitrate fertilisers, e.g. Cal-Am, and superphosphate. Compatibility with metallic sulphates, e.g. zinc sulphate, is limited.

In solution, urea is compatible in solution with most other soluble fertilisers. Urea is compatible with most weedicides, insecticides and fungicides. However, their compatibility with urea should be checked on the product label before use. Urea solutions are alkaline, which may affect some products.

3. UREA IN THE SOIL

3.1. Soil transformations and root uptake

Although urea can be taken up directly by some plants, the nitrogen in urea is more readily available to plants after mineralisation in the soil to nitrate (NO_3^-).

Firstly, urea is converted to ammonium (NH_4^+) compounds by the action of urease, an enzyme present in the soil. This process is known as ammonification and is usually completed within a few days of urea application. Bacteria then convert the ammonium to nitrate. This process is called nitrification and is usually completed within a few weeks of application. Being a biological process, nitrification is moisture and temperature dependent. It occurs most quickly under warm moist soil conditions.

Most plants take up the bulk of their nitrogen in the nitrate form, though some is taken up as ammonium, particularly in the seedling stages, e.g. from planting fertilisers such as MAP.

In flood irrigated rice, nitrogen is taken up in the ammonium form, as the conversion of ammonium to nitrate is blocked under anaerobic conditions (when soil air, and oxygen, are excluded from the soil).

3.2. Nitrogen loss mechanisms

Of the essential plant nutrients that plants derive from the soil, nitrogen is the only element that exists as a gas (N_2) in its natural state. The nitrogen in urea is derived from the atmosphere.

Once urea is converted to the ammonium and nitrate forms, the nitrogen it contains may be lost back to the atmosphere in gaseous forms, as ammonia, nitrous oxide compounds (NO_X) or molecular nitrogen (N_2).

Urea is soluble in water, and once dissolved, moves with water. Nitrogen, as ammonium, is strongly sorbed onto soil colloids, but once converted to nitrate, is one of the more mobile nutrients in the soil and moves freely with soil moisture. If the soil is wetted below the root zone, nitrate can be lost through leaching.

Volatilisation

Ammonia gas may volatilise from the soil surface when urea is surface-applied without incorporation. After application, urea [$CO(NH_2)_2$] dissolves in water (H_2O) and in the presence of urease, forms ammonium carbonate [$(NH_4)_2CO_3$].

$$CO(NH_2)_2 + 2H_2O \rightarrow (NH_4)_2CO_3$$

The ammonium carbonate then decomposes in water to from ammonium hydroxide (NH_4OH) and carbon dioxide (CO_2).

$$(NH_4)_2CO_3 + H_2O \rightarrow 2NH_4OH + CO$$

The carbon dioxide is liberated as a gas to the atmosphere, leaving a weak aqueous ammonia or ammonium hydroxide (NH_4OH) solution behind. The ammonium hydroxide dissociates to form ammonium (NH_4^+) ions and hydroxyl (OH^-) ions.

$$NH_4OH \rightarrow NH_4^+ + OH^-$$

The ammonium (NH_4^+) ions are attracted to and tightly held (adsorbed) on the surface of soil colloids, i.e. clay and organic particles (humus). As such, they are resistant to loss. If the urea is applied, washed or incorporated into the soil, there will be more than enough adsorption sites for all the ammonium to be retained in the soil. If the urea is left on the soil surface, there may be insufficient adsorption sites to hold all the ammonium, and some may be lost as ammonia gas. This occurs as the soil dries, e.g. in the heat of the day. The aqueous ammonia evaporates, with water vapour (H_2O) and ammonia gas (NH_3) being lost (volatilised) to the atmosphere.

$$NH_4^+ + OH^- \rightarrow NH_4OH \rightarrow NH_3\,(g) + H_2O\,(g)$$

The above reaction is dependent on the presence of hydroxyl ions (OH^-). It proceeds most rapidly under alkaline conditions (high pH).

Leaching

Leaching is the vertical, downward movement of water containing dissolved salts, deeper into the soil, and beyond the reach of plant roots.

Ammonium is not subject to leaching, as it tightly sorbed onto soil colloids. Leaching can occur once the ammonium is converted to nitrate, which is not strongly sorbed onto soil colloids. Nitrate is most likely to be leached in sandy soils, under high rainfall conditions, and where excessive irrigation water is applied.

Denitrification

Denitrification describes the process in which nitrates (and nitrites) are reduced to the gaseous nitrogen compounds, i.e. NO, N_2O and N_2, which are then lost to the atmosphere. Denitrification occurs under waterlogged or anaerobic soil conditions. Soil bacteria, deprived of their normal source of oxygen from the soil air, take oxygen (O) from nitrate (NO_3^-), reducing it to gaseous forms (NO_x).

Denitrification is most likely to occur on poorly drained heavy textured clay soils, and where conditions favour soil microbial activity, i.e. high temperatures and soil organic matter. These loss mechanisms (volatilisation, leaching and denitrification) are discussed in more detail in the “Nitrogen” Agritopic.

3.3. Preventing nitrogen losses

Under unfavourable conditions, losses of nitrogen from urea (and other nitrogen fertilisers) can be as high as 80%. Such losses can be minimised if the loss mechanisms are properly understood; and local soil, climatic and managerial factors are taken into consideration.

Volatilisation

Gaseous losses of ammonia to the atmosphere (volatilisation) can be suppressed by soil coverings of 3 cm. This can be achieved by:

- placing urea into the soil, e.g. annual crops;
- applying urea with the irrigation water (fertigation); or
- irrigating the urea in soon after application (preferably on the same day).

This may not always be possible, e.g. with raingrown pasture, forage or tree crops. In these cases, keep an eye on the weather, and apply urea when rain is forecast. A urease inhibitor may also be added to the urea, e.g. Incitec Pivot Green Urea NV.

Urease inhibitors inhibit the activity of the urease enzyme which is responsible for the conversion of urea to ammonium. If this process can be blocked and the nitrogen kept in the form of urea, it is not subject to volatilisation loss.

The use of a urease inhibitor allows more time for rain to come and wash the fertiliser into the soil. Green Urea NV may provide protection against volatilisation losses for up to two weeks. The length of time over which the urease inhibitor remains effective may be considerably less than this. The effectiveness of urease inhibitors is reduced where urease activity is high, e.g. in trash blankets in ratoon sugarcane.

Leaching & Denitrification

In risk situations, leaching and denitrification losses can be minimised by applying nitrogen close to the time it is needed, or split applying it during the main growing season.

The urea may also be treated with a nitrification inhibitor such as eNpower® (DMPP). Nitrification inhibitors inhibit the transformation of nitrogen in the soil from ammonium to nitrate. If nitrogen is kept in the ammonium form, it is resistant to loss by leaching (in sandy soils) and denitrification (in heavy textured soils should they become water-logged).

eNpower is most effective under cool conditions. Its effectiveness is reduced under warm soil conditions. eNpower may delay nitrification for several months at soil temperatures of 10°C and below, but only for a month or less at 20°C and above.

4. SOIL APPLICATION OF UREA

There is considerable flexibility in how and when to apply urea. The best time will vary with the crop, soil type, locality and the application equipment available to do the job. Brief comments on some of the alternatives follow.

4.1. Pre-plant (annual crops)

Pre-plant applications of urea are popular in the inland cropping areas of northern NSW and Qld, in grain, cotton and forage crops. The soils are predominantly heavy clays, and the rainfall is summer dominant.

Reasons why pre-plant applications are preferred in this region are:

- In raingrown winter cereals, responses to preplant applications are more assured than to topdressed nitrogen applied during the growing season. Spring rainfall is low and unreliable, with August, the month in which topdressing is normally carried out, being on average the driest month of the year. Topdressed urea applied in the spring may be left stranded at the surface in dry soil, if little rain is received during the growing season, while the crop roots are foraging for moisture deeper in the soil profile. Topdressed nitrogen may also be lost through volatilisation if rain is not received after application.

- Being heavy textured, the soils can store a considerable amount of moisture. Applying nitrogen before planting allows it to be converted to nitrate, and carried into the subsoil by rain, where it and the conserved moisture will be able to be utilised during the growing season. The rainfall in most years is not so high that leaching losses of nitrogen below the root zone are common.

Preplant urea should be drilled or incorporated into the soil, within one or two months of planting. Where the soil is tilled, this is usually done at the time of the last cultivation before planting.

Nitrogen may be applied earlier than this, provided nitrogen losses through leaching (most likely to occur on sandy soils in high rainfall areas) or denitrification (from waterlogging) are not likely to occur. Early application is often necessary with anhydrous ammonia (Big N), to help spread the demand. It would not be possible to meet market requirements for Big N if everyone wanted to apply it at the same time.

If urea is applied pre-plant into raised beds or mounds, it should be placed into the side of the hill, rather than in the centre of the inter-row space. This allows earlier root access and improves nutrient recovery by plants. The soil in the centre of the inter-row space is more likely to be compacted, and this is the area in which leaching, and denitrification is most likely to occur in the event of wet weather.

Ensure the fertiliser band is offset from the position of the planting line, i.e. the urea is not placed directly below the intended position of the seed, to minimise root burn.

Weeds should not be allowed to grow during the fallow period. They will rob the crop of moisture and nitrogen.

4.2. Planting (annual crops)

It is generally recommended that urea not be applied at planting. There are limits to how much nitrogen can be safely applied at planting without causing root burn and delaying or reducing emergence.

Phosphorus (P), on the other hand, is best applied at planting, banded with or near the seed or planting material. Fertilisers such as MAP and DAP can be used to supply phosphorus, and starter nitrogen, either on their own, or in blends, e.g. in NPK blends for vegetable crops.

There is generally no need to apply more nitrogen that that supplied in these products (MAP and DAP) at planting. The balance of the nitrogen is best applied pre-plant, or during the growing season.

There are occasions where urea will need to be blended with MAP or DAP for use at planting in winter cereals, e.g. wheat and barley, and other crops planted at narrow row spacings, e.g. where circumstances do not allow nitrogen to be applied pre-plant.

It is generally recommended that the combined nitrogen rate (from all blend ingredients) should not exceed 20 kg/ha N at planting in winter cereals (wheat, barley, oats) sown at narrow (18-20 cm) row spacings under good planting conditions, where the seed and fertiliser are applied through the same delivery hose.

Recognising that clay soils store more moisture, and sands less, Table 2 adapts this broad recommendation.

Table 2: Suggested Maximum Nitrogen Rates at Planting in Wheat, Barley and Oats at Narrow (18 – 20 cm) Row Spacings under Good Soil Moisture Conditions.

Soil Type	**kg/ha N**
Clay	33
Loam	25
Sand	10

These guidelines were developed for combines when planting into fully prepared seedbeds. Lower limits may apply under reduced tillage conditions and at row spacings wider than 18 – 20 cm.

Urea should **not** be banded with crop seeds when soil moisture levels are low and barely adequate for germination, nor should it be banded with the seed of sensitive species such as canola. In general, the smaller the seed, the more likely it is to be harmed by fertiliser placed in direct contact with it.

Local advice may be sought, and computerised decision support systems used to better determine appropriate maximum nitrogen (and fertiliser) rates with the seed.

4.3. Side-dressing (row crops)

Urea can be side-dressed into the inter-row space in crops planted in wide rows, e.g. maize, vegetables. It is best to place the urea adjacent to the row, or into the side of the hill where mounds are used, rather than centre of the inter-row space, but not so close as to cause root pruning.

This enhances fertiliser use efficiency. The crop roots will reach the fertiliser earlier, and more of them will do so. In addition, where the crop is grown in raised beds, water is more likely to pond in the furrow, increasing the likelihood of nitrogen being lost through denitrification or leaching from this area.

Urea should be side-dressed, or where split applications are made, the first application made within three to four weeks of planting/emergence, i.e. prior to the period of maximum vegetative growth. This also minimises the risk root pruning when fertiliser is placed into the soil.

Placing the urea into the soil eliminates the risk of volatilisation loss under raingrown conditions. In irrigated crops, if fertiliser is not placed into the soil, it should be applied shortly before irrigating, so that it is washed into the soil.

4.4. Top-dressing (winter cereals, forage crops and pasture)

Urea must be top-dressed on the soil surface, e.g. through a spinner broadcaster, in crops planted at narrow row spacings, e.g. winter cereals, and pasture. It is not practical to apply urea into the soil in these circumstances.

If irrigation is available, water the urea into the soil as soon as possible after applying the urea, preferably on the same day. In raingrown crops top-dress when the prospects of follow-up rain are good, i.e. rain is forecast. If rain is not received soon after top-dressing or irrigation is not applied, nitrogen can be lost to the atmosphere through ammonia volatilisation.

5 – 10 mm of rain in the one fall should be sufficient to wash urea into the soil in pasture that has recently been grazed, so there is no longer a great body of feed to intercept the rain.

4.5. Sugarcane

In plant sugarcane, urea can be side-dressed into the drill before “closing-in” and covered with soil. In ratoon cane, urea can be applied after harvest, either split stool, or drilled into the soil either side of the crop row.

Application to the centre of the inter-row space should be avoided, as it takes longer for the cane roots to grow to this area. The soil in the centre of the inter-row space may also be compacted due to vehicular movement, restricting root growth. Furthermore, denitrification and leaching are more likely to occur from the centre of the inter-row if water ponds in this area.

Where trash blanketing is practised, it is best to place the urea through the trash into the soil. Cane trash has very high urease activity, and volatilisation losses from urea applied to it can be substantial unless overhead irrigation, e.g. travelling irrigator or water winch, is applied or rain is received soon afterwards. 15 – 20 mm in the one application or fall should be enough to wash most of the urea through the trash into the soil. This will depend on the thickness and stage of decomposition of the trash.

In rain-grown situations where urea cannot be applied into the soil or irrigated in after application, the likelihood of volatilisation loss can be reduced by applying urea:

i) when rain is forecast; and

ii) delaying application until the cane is 50 cm high.

4.6. Tree crops

Use of fertiliser nutrients is improved if the fertiliser is applied to the area in which the tree roots are concentrated and most actively foraging, i.e. beneath the drip-line or edge of the canopy.

Urea can be spread around each tree, starting 30cm from the trunk to just outside the canopy. Ensure the fertiliser is spread evenly to avoid root burn. Alternatively, the fertiliser can be spread in a broad band under the drip line along both sides of each row of trees.

5. FERTIGATION

Fertigation is the application of fertiliser dissolved in irrigation water. This provides a simple and effective way to apply fertiliser, without the need for mechanical application. The tractor can be left in the shed. Fertigation allows the season's nitrogen fertiliser requirements to be split into several smaller applications. Urea is soluble and is particularly suited to application in this way.

Overall or cumulative nitrogen fertiliser rates often remain unchanged, but they may need to be:

- Increased if improved irrigation and farm management practices allow higher yields to be achieved;
- Reduced if plant recovery of applied nitrogen is improved, and nutrient losses are reduced.

6. FOLIAR SPRAYS

6.1. Use of foliar sprays

Foliar sprays are used to supplement, but not replace soil applications of nitrogen. With few exceptions, it is impossible to feed crops their complete nitrogen requirements through the foliage without burning the leaves.

Tree and field crops with a large leaf surface area for urea absorption are the most suited to foliar applications. Citrus is an example of a crop in which foliar sprays may be used as the principal means of applying nitrogen.

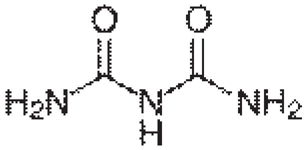
In most other crops, only limited amounts of nitrogen can be applied directly to the foliage. Urea sprays are generally only used during periods of high crop nutrient demand.

Foliar applications also offer a means of overcoming temporary nitrogen deficiency when plant growth and root uptake of nutrients is limited by external factors e.g. waterlogging or post irrigation stress in flood irrigated crops on heavy clay soils.

Urea is absorbed directly by the leaves and the active bark of trees and plants. Responses to urea applied in this way are extremely quick, as most of the urea will have entered the plant within 2 hours of application, and absorption is almost complete within 2 days.

6.2. Biuret

Biuret is an impurity formed during the manufacture of urea. Its chemical formula is $NH_2CONHCONH_2$ while that of urea is NH_2CONH_2.



At the levels typically present in urea, biuret is not harmful to plants or soil organisms when applied to the soil. It is broken down to ammonium (as urea is) and becomes part of the nitrogen cycle. Biuret, however, is a cumulative toxin when applied to foliage. It is not translocated or broken down and metabolised after absorption by the leaves. Consequently, repeat applications of urea with a high biuret content can result in biuret toxicity.

Symptoms of biuret toxicity are tip yellowing and leaf burn. This will be most evident in the older leaves. Toxicity is most likely to occur where routine sprays are applied in long-lived perennial and evergreen tree crops, e.g. citrus, rather than in annuals, e.g. vegetables and cereals.

A low biuret grade of urea should be used where urea is foliar-applied on a regular basis and/or at high rates, particularly in high value horticultural crops, e.g. perennial tree crops and vines. In short-season annual crops, e.g. grain, cotton and vegetables, where a single foliar application of urea is to be applied, normal grades of urea can usually be used without risk of biuret toxicity.

7. SPRAY CONCENTRATIONS AND RATES

A typical rate at which urea is foliar applied, where repeat sprays are made, is 10 kg/ha per application. The dilution rate in water will depend on the spray volume. The spray volume is usually not critical and merely improves the uniformity of coverage, up to the point of run-off.

In vegetable crops, a spray volume of 1 000 L/ha, containing 1 kg/100 L (1% w/v) urea will apply 10 kg/ha urea. In tree crops, more water is required, i.e. higher spray volumes, so lower concentrations of urea are used.

Higher application rates, and concentrations, are used in winter cereals, in which a single spray is all that is likely to be applied. Urea may be applied to winter cereals at 20 - 30 kg/ha, in 100 L of water. This may cause some leaf scorch but should have no lasting effects.

The following table gives examples of urea concentrations commonly used in foliar sprays for a variety of crops.

Table 3: Guide to Use of Urea in Foliar Sprays.

Crop	**Urea Concentration kg/100 L or % w/v**
Cereal Grains	20 - 30
Cotton	10 - 15
Vegetables, e.g. cabbage, cauliflower, lettuce, potato.	1
Trees and vines, e.g. citrus, pome and stone fruit, grape.	0.5

Specific local advice should be sought on spray programs for crops such as citrus and pineapple.

High volume urea sprays are also used in pineapples in southern Queensland. Pineapples are grown in wide beds, so soil application is not very practical. Nitrogen and potassium are applied through in solution through boom sprays. Much of the spray runs off the foliage to the soil, and ultimately be taken up by the roots, rather than enter the plants through the foliage.

7.1. Leaf burn

Urea is the most used nitrogen fertiliser for foliar sprays. Apart from being the most economical source of nitrogen, it is less likely to burn the foliage than other nitrogen fertilisers. Urea is non-ionic and therefore causes minimum osmotic (salt) damage to the crop. Phytotoxicity (leaf burn and scorch) however, is possible, if the concentration or volume of urea solution is too high.

To minimise the risk of leaf burn, urea should be applied early in the morning and not during the heat of the day, or under hot dry conditions, i.e. urea sprays should ideally be made in cool humid conditions. Crops should not be wilting as in this condition absorption of urea into plants is severely impaired.

If there is no prior experience with urea sprays in the crop, or the crop is lush or growing conditions are harsh, it may be wise to test-spray a portion of the crop to check its sensitivity. If necessary, reduce the spray concentration, and test again.

7.2. Preparation of spray solutions

Urea sprays should be used soon after preparation, particularly where surface water from dams and streams is used. They should not be allowed to stand for extended periods, e.g. overnight, as the urea may be converted to other compounds that are much more likely to harm the foliage than urea itself. For example, ammonium isocyanate (NH_4CNO) can be formed from urea through bacterial action.

If urease enzyme is present in the water, ammonium carbonate may form. In turn, at high pH, ammonium carbonate may form free ammonia, which is toxic at low concentrations to foliage.

Urea itself raises the pH of solutions to which it is added. If the water is of good quality and/or other spray additives are acidic, urea is unlikely to have a detrimental effect. However, if the pH of the water is already high, urea may compound any associated problems, and increase the potential for ammonia toxicity. A little sulphuric acid (battery acid) can be slowly added to the spray solution to reduce the pH.

Solution grade MAP (monoammonium phosphate) fertiliser may also be used as a buffering agent with alkaline fertilisers such as urea.

The addition of a non-ionic wetting agent to urea sprays greatly increases the degree of absorption by the plant parts sprayed.

7.3. Use of urea with micronutrient sprays

The addition of a small amount of urea to micronutrient (trace element) sprays helps enhance uptake of the micronutrient. It does this by helping open the stomata (pores) in the leaves, through which the micronutrient enters the plant.

As a guide, urea can be used at 1 kg/100 L (1% w/v) in field crops, 500 g/100 L (0.5% w/v) in vegetables, and 100 g/100 L (0.1% w/v) in tree crops. Higher rates are not needed, unless the crop needs extra nitrogen.

It should not be necessary to use low biuret urea with micronutrient sprays, as the urea application rate is low, and usually only one or a few sprays are required. Trace element sprays are not applied repeatedly during the growing season.

8. GRAZING MANAGEMENT

It is best to wait for three to four weeks after applying nitrogen fertiliser before grazing. Livestock may be at risk for two reasons after topdressing with urea.

Firstly, there may be direct ingestion of urea, because of fertiliser granules or dust lodging on the leaves of the pasture or forage crops, resulting in urea poisoning. This risk passes when rain is received, or irrigation is applied.

Secondly, nitrate concentrations in young regrowth may remain high for several days or weeks after the application of fertiliser, depending on when and how much rain (or irrigation) is received, and how quickly regrowth occurs. High nitrate concentrations in fresh green pick may result in nitrate poisoning and the sudden death of grazing animals. Nitrate poisoning is most likely to occur where the pasture is short, and little other forage is on offer.

If practical, it is best to remove animals from areas being fertilised, and not to readmit them until after rain is received or irrigation applied, and regrowth occurs, i.e. for three to four weeks. Stock may be able to be reintroduced to the paddock within a couple of weeks where rapid growth occurs. Where growth is slow, it may be best to wait for a month or more.

If the paddock can’t be spelled, e.g. on small holdings/acreage blocks, urea should be applied when rain is expected or before irrigating, and conditions (soil moisture, temperature) are favourable for regrowth.

Do not topdress with urea in dry weather or drought, and when there is little forage on offer to grazing animals. Stock should have access to a good body of standing feed.

9. RUMINANT SUPPLEMENTATION

Urea is the most economical and commonly used non-protein nitrogen supplement for ruminants. Supplementation is likely to be beneficial once the crude protein content of the diet falls below 8%. The urea should not be administered on its own, but in combination with other supplements and feedstuffs, e.g. urea molasses licks.

In pasture, at the onset of the dry season or in the early stages of drought, urea can be used to stimulate the appetite of ruminants and improve the use of dry low-quality feed. Ample roughage is essential for this to occur.

For beef cattle, a typical urea rate is 60 grams (g) per head per day. Cattle should be introduced to urea slowly by building up to this rate. Start with 15 grams/head/day initially and increase by this amount weekly until the desired rate is reached. This not only applies to stock being introduced to urea for the first time, but also when there has been a break in the feeding program, e.g. due to wet weather.

For cattle being finished in feedlots, a rule of thumb is that non-protein sources of nitrogen should not make up more than one-third of the crude protein in the diet, and that urea should not be added at more than 1% of the diet for palatability reasons.

10. UREA POISONING

Death from urea poisoning is rapid (generally within 2 hours of ingestion of the urea). By the time symptoms appear (severe abdominal pain, shivering, excessive saliva, rapid breathing, unstable gait, bellowing and bloat), it is often too late.

To have any chance of being effective, treatment must be quick. Vinegar (acetic acid) needs to be administered at quite high dose rates (2 to 4 litres as a guide for cattle) repeating the treatment if necessary. The vinegar makes the ruminal contents more acidic and delays uptake of ammonia by the blood.

11. CARE OF EQUIPMENT

Following the application of urea, machinery should be thoroughly cleaned by pouring sufficient water through it, to dissolve any urea particles or residues. Moving parts should be lubricated as recommended by the manufacturer.

Urea is relatively non-corrosive to metal piping. However, where urea is applied through an irrigation system, the system should be flushed with clean water after use. Irrigate with water only for some time after the urea has been applied. Metering devices should be dismantled and thoroughly cleaned.

12. FURTHER READING

Other Agritopics are available, including those on Nitrogen, Fertigation, Foliar Fertilisers and Mineral Supplements for Ruminants, which provide more detail on these topics.

12. SAFETY DIRECTIONS

Refer to the Safety Data Sheet (SDS) for more detailed safety advice. Before use, read the Product Label and the SDS. Use safe work practices and avoid contact with the eyes and skin. Avoid ingestion and inhaling dust. Protective clothing, eyewear and dust masks should always be used when dealing with this product. Observe good personal hygiene, including washing hands after use. Avoid loss of fertiliser to waterways.

13. WARNING

This document contains information of a general nature. Before using fertiliser seek independent agronomic advice. Fertiliser programs may need to be varied depending on the plants being grown, climatic and soil conditions, application methods, irrigation, agricultural and livestock management practices, the soil's fertility, and cultural practices. ('Unforeseen Elements')

Fertiliser may burn and/or damage crop roots or foliage. Foliar burn to the leaves, fruit or other plant parts is most likely to occur when fertilisers are foliar applied at high concentrations and/or on a regular basis, different products are mixed and sprayed together at cumulatively high rates, the water is of poor quality, or the spray is applied under hot dry conditions, e.g. in the heat of the day.

Fertiliser and supplements may affect animal health. Seek independent advice before using any supplements in livestock rations.

14. DISCLAIMER

As Unforeseen Elements are beyond the control of Incitec Pivot Limited, in no event Incitec Pivot Limited and its related bodies corporate be liable or accept any responsibility whatsoever for any direct, indirect, punitive, incidental, special or consequential damages (including but not limited to loss of revenue, crops and livestock), in respect of the illness, injury or death of a person, damage to property (including of a third party), or any other loss whatsoever arising out of or connected with the use or misuse of this fertiliser, or its transport, storage, handling or application. Where Incitec Pivot Limited and its related bodies corporate's liability cannot be lawfully excused, it and its related bodies corporate's liability shall be limited to the replacement of, or cost of the fertiliser supplied. The buyer accepts and uses this product subject to these conditions.

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