POTASSIUM

1. INTRODUCTION

Potassium (K) is one of the three major nutrients required for plant growth, the others being nitrogen (N) and phosphorus (P). Potassium is required in larger amounts than any other mineral element with the exception of nitrogen. In a few crops, e.g. banana, and cotton during the boll filling period, demand for potassium can exceed that of nitrogen. Plant vigour, yield and quality may suffer if potassium is deficient.

The incidence of potassium deficiency and use of potassium fertilisers in Australia is increasing. This is attributable to various factors, including increased crop and pasture yields (often in response to other fertilisers) and certain soils become depleted in potassium through insufficient or no potassium having been applied.

Potassium has been a regular component in fertiliser programs in horticulture and sugarcane, but it is less commonly used in other crops. Much of the growth in demand for potassium in Australia has been in dairy pastures to balance increased nitrogen inputs, allowing higher pasture yields and milk production to be achieved and sustained.

In legume-based pastures, potassium deficiency results in reduced clover yield and persistence (due to poor seed set). If the deficiency is severe, the clover can disappear completely from the sward. Ultimately, grass production falls as well.

Responses to potassium are also obtained in hay and silage crops, where nutrient removal is high, and in maize. There is also evidence of potassium deficiency in cotton in some areas. Apart from maize, there has been little use of potassium in cereals and other grain crops until recently. In Western Australia, responses to potassium have been obtained in grain crops on sandy soils.

More recently, evidence of potassium deficiency has been observed in eastern Australia in grain crops grown on heavier soil types that were once considered to be reasonably well endowed with potassium. Potassium reserves in the subsoil in some of these soils are low.

2. POTASSIUM IN THE SOIL

Potassium is quite abundant in soils, typically ranging from 0.5 to 4.0%. Of this, only a small part is present in water-soluble and exchangeable forms, and readily available for plant uptake, usually less than 1% of the total.

About 98% of the total soil potassium is fixed **within** the crystal lattice of primary and secondary clay minerals. This is **relatively unavailable**, as these minerals must weather (or decompose) to release potassium (K^+) before it can be taken up by plant roots. A further 1-10% is held **between** crystal lattice layers in expanding clay minerals. Potassium ‘fixed’ in this way is only **slowly available**, i.e. it is converted to available forms over the long term.

Potassium in soils exist in three distinct forms: unavailable, slowly available and readily available.

- **Unavailable Potassium:** Soil type dependant accounts for 90-98% of the of the total soil K is found in this form. Overtime the primary minerals that contains K weather, and the K is released. This process is quite slow and cannot supply the requirements if crops.

- **Slowly available Potassium:** This form of potassium is referred to as fixed K as is trapped between the layers of clay minerals. Plants cannot access much of the slowly available K during the growing season. The amount of fixed K in the slowly available forms varies with the type of clay and minerals that dominate a particular soil.

- **Readily available Potassium:** Is potassium that is dissolved in soil water and that is held on the exchange sites of clay particles (exchangeable K) is considered readily available for growth.

As potassium is taken up by plant roots from the soil solution, it is replenished from the exchangeable, and in turn, slowly available forms, so that the equilibrium is maintained.

Potassium in the soil solution is subject to leaching. Leaching is most likely to occur on sandy soils in high rainfall areas. Elsewhere, on heavier textured soils, there may be an issue with the immobility of potassium and getting it to leach deeper into the soil where reserves in the subsoil are low.

Years of cropping have seen potassium drawn by plant roots from the subsoil, and returned in litter, so that it becomes concentrated or stratified at or near the soil surface. Potassium fertilisation increases potassium concentrations in the topsoil or plough layer, but it remains low at depth. This may result in plants not getting enough potassium when the surface layers of soil dry out and the roots are drawing soil moisture and feeding for nutrients from deeper in the soil profile.

3. POTASSIUM IN THE PLANT

3.1 Plant Uptake

The uptake of potassium by plant roots largely depends on the movement of potassium ions (K^+) in the soil solution to the plant roots. Diffusion rates and potassium uptake are greatest:

- on soils with high available potassium levels.

- where soil moisture is high.

- on light textured soils, since potassium diffuses faster through coarse than fine textured soils. Such soils, however, are more likely to be low in “readily available” potassium and store less moisture.

- in plants with a large root surface area, e.g. plants with a large number of fine roots.

Plants generally absorb the majority of their potassium in the early growth stages.

3.2 Role in Plant Growth

Potassium is required in large amounts by plants (second to nitrogen). Potassium is not a component of any organic compound in plants and is therefore very mobile within plants. It is readily transferred from old to young tissue.

Potassium is important in various physiological processes, including photosynthesis, the metabolism of carbohydrate and protein, the activation of enzymes, and the adjustment of stomatal movement and water relations. Adequate potassium helps reduce lodging, increase winter hardiness and disease resistance, and improve yields and the quality of seed and fruit.

3.3 Nutrient Removal

Between 3 and 5 kg of potassium are contained in each tonne of grain in cereal crops. Canola and lupins contain 8 to 10 kg/t K, soybeans 20 kg/t K. The demand for potassium is higher in fruit and vegetable crops, and in cotton, which contains appreciable amounts of potassium in the lint.

Demand for potassium in cotton in the boll-filling period exceeds that for nitrogen and is around 1 kg/ha K per day. However, it is in silage and hay crops, in which most of the above ground parts of the crop are harvested, that the greatest amounts of potassium are removed. Between 20 and 30 kg of potassium are removed in each tonne of lucerne hay. Consequently, large amounts of potassium are removed during the life of a lucerne crop cut for hay. About 275 kg/ha K is removed in maize silage in an irrigated crop yielding 75 t/ha. A corresponding smaller amount will be removed in rain-grown crops yielding 20-30 t/ha.

In sugarcane, there is around 200 kg/ha K in the above ground parts at harvest (cane, tops and trash), about half of which is present in the millable cane.

In pastures, much of the potassium ingested by animals is returned to the soil in urine or faeces. Where pastures are set-stocked (continuously grazed), this recycling helps to maintain soil fertility. However, significant transfers of potassium can occur within paddocks to areas where stock congregate, e.g. watering points and stock camps.

Where pastures or forage crops are strip-grazed for a few hours each day, and stock are then removed, nutrient removal rates are almost as great as where the crop is cut for hay or silage. On dairy farms, where small night paddocks are often located close to the milking shed and large day paddocks further away, potassium accumulates in the night paddocks, and declines in the day paddocks.

When livestock are marketed, around 2 kg/t K (empty body weight) is removed. Milk contains about 2 kg K/1000 L, while around 17 kg/t K is removed in greasy wool, largely associated with the squint.

3.4 Agronomic Importance

Yield – Potassium is essential for plant growth and development. A minor deficiency often results in a reduction in growth (hidden hunger) and yield, before leaf symptoms are evident.

Quality – Fruit, vegetables and flowers from potassium deficient plants are usually small in size, sometimes poorly shaped, have abnormal colour, break-down quickly in storage due to increased respiration, and are of poor canning quality.

Crop Lodging – Lodging is more likely to occur in potassium-deficient crops. The effect is most noticeable where high levels of nitrogen are used. If a balanced supply of these two nutrients is used, the incidence of lodging may be reduced while yield and quality are improved.

Disease and Insect Resistance – As potassium promotes the development of thicker cell walls, deficient plants may be more susceptible to attack by disease and insects.

Pasture Species Composition – In mixed pastures, grasses are able to out-compete legumes in taking up potassium due to their finer root system. Where soil potassium is low, this may result in loss of legumes from the pasture.

3.5 Potassium Deficiency in Plants

Potassium deficiency is most likely to occur on light textured soils under high rainfall conditions, although it may occur on heavy textured soil types where the rate of removal in farm produce is high, e.g. under irrigation and where crops are cut for hay or silage.

As potassium is a very mobile element in the plant and is readily transferred from older leaf and root tissue to younger tissue at the growing points, where it is re-utilized, deficiency symptoms first appear in recently matured and older leaves.

Deficiency symptoms are best described as leaf scorch. This develops from an initial yellowing of interveinal areas near the leaf margins. This is followed by tanning and browning, and finally drying of the tissue to appear as scorching. This scorching is at first confined to the leaf margins and tips but progresses inwards as the deficiency becomes more severe, until the whole leaf may be affected. Rarely does the growing point show deficiency symptoms. Leaves from potassium deficient plants have a flaccid (wilted) appearance and the tips and margins are often frayed. Plant growth is retarded, and root systems are poorly developed.

Potassium deficient plants may also exhibit several other symptoms: -

- In legumes, the first symptom of potassium deficiency is often white freckling of recently matured leaves followed by the development of leaf scorching.

- In crops such as maize, the stalks are weak, subject to lodging and susceptible to fungal attack. The tip ends of the cobs do not fill with grain, while the kernels are poorly matured, starchy and easily infected by ear-rot organisms.

- Cotton has a particularly high requirement for potassium during boll-filling, and it is at this growth stage that symptoms appear. The symptoms of potassium deficiency in cotton contrast strongly with other plants, in which symptoms first appear in the older leaves. They include premature senescence of young leaves near the top of the canopy, with leaves turning red during the early fruiting stages of the crop. As the season progresses, the symptoms may spread further down the canopy and cause defoliation. Both lint yield and fibre quality are reduced.

Note – If potassium deficiency is suspected, its presence can be confirmed by tissue analysis of leaves showing the symptoms described (but not those that have become totally scorched). As with other nutrients, there is frequently a substantial reduction in yield before symptoms of potassium deficiency appear.

3.6 Potassium Balance

Potassium balance with other nutrients, particularly the other cations (positively charged ions) such as calcium and magnesium is of importance.

Situations where potassium itself is in excess supply rarely occur. However, too much potassium can induce deficiencies of other nutrients, while potassium deficiency may occur in soils which seem to have adequate potassium, if soil calcium and magnesium are also high.

Grass tetany (magnesium deficiency) in grazing animals can be induced in pastures fertilised with potassium.

4. CRITICAL VALUES

4.1 Soil Analysis

The average potassium content of the earth's crust is about 2.3% (23 000 mg/kg K), but soils may contain from 0.5 to 4.0% K (5 000 – 40 000 mg/kg K).

Various tests are used to assess the amount of plant-available potassium in the soil. When analysing soils, it is best to use tests for which local interpretation data are available for the crop or pasture. Critical levels vary considerably, depending on such factors as the type of crop being grown, the effectiveness of its root system in taking up potassium and its value (they are higher for short season vegetable crops), rainfall, irrigation and potential yields, and soil texture and the balance with other cations. Examples of potassium tests used in Australia are: -

- Ammonium acetate;
- Skene;
- Colwell;

- Nitric acid (BSES).

In sugarcane, two tests are used, the Ammonium Acetate (Exchangeable K) test for the amount of potassium readily available for plant uptake, the Nitric Acid (Extractable K) test for the amount of potassium in reserve in the soil.

Evidence is now mounting that such an approach warrants consideration in other crops, with a separate test (not necessarily the Nitric Acid test) for the amount of potassium held in reserve to be used in conjunction with the standard test for the region for exchangeable or available potassium.

There is also evidence that soil potassium levels are being depleted at depth, e.g. in the Burnett region in southern Queensland, and a possible need to take two soil samples, the traditional sample from the topsoil, and a second sample into the subsoil, so that the soils ability to meet the crop's demand for potassium is more fully understood.

4.2 Plant Tissue Analysis

Apart from carbon (C), hydrogen (H) and oxygen (O) that are derived from air and water, potassium is second to nitrogen in terms of the amount required by plants. In some crops, and at some growth stages, plant demand for potassium may exceed that of nitrogen, e.g. bananas, and cotton during the boll-filling stage. Optimum total potassium concentrations in plant tissue samples are usually in the range of 1.5 to 4.5% K on a dry weight basis.

5. POTASSIUM FERTILISERS

The most commonly used potassium fertilisers are Muriate of Potash (potassium chloride), Sulfate of Potash (potassium sulfate) and Potassium Nitrate. Typical analyses for these products are shown in the following table.

Table 1: Analyses of Commonly Used Potassium Fertilisers and their salt index

Product/Chemical Name		**Analysis**			**Salt index**
		% N	**% K**	**% S**	
Muriate of Potash (Potassium chloride)	KCl		50		117
Sulfate of Potash (Potassium sulfate)	KNO_3		41	18	74
Potassium Nitrate	K_2SO_4	13	38.3		46

Coarse crystalline, granular or prilled grades of these products are available for dry application to the soil. Higher purity (Solution Grade) products, which usually have a smaller particle size so they dissolve quickly, are preferred for application in solution, e.g. for use in fertigation programs. Potassium sulfate is the least soluble of the three products.

Table 2: Solubility (kg/100 L) at various temperatures

PRODUCT	10^0 C	20^0 C	30^0 C
Potassium chloride	31	34	37
Potassium nitrate	21	32	45
Potassium sulfate	9	11	13

Reflecting its lower solubility, Sulfate of Potash also has the lowest Salt Index of the three products and is the least likely to cause root burn. The Salt Index compares the increase in osmotic potential brought about by the use of a fertiliser compared to sodium nitrate, which is given a value of 100. It provides a guide to but is not the sole determinant of the likelihood that a fertiliser will burn plant roots.

All three-products supply potassium, so the differences in the Salt Index come down to the concentration (potassium chloride has the highest potassium content) and the behaviour of the companion ions (chloride, nitrate and sulfate) in the soil.

Chloride (Cl^-) and nitrate (NO_3^-) are monovalent, so at the same potassium rate, there will be twice as many of their ions as there will be for sulfate (SO_4^{2-}), which is divalent, i.e. has two positive charges. In addition, chloride and nitrate are mobile in the soil, while sulfate is more likely to be sorbed onto soil colloids.

Chloride may also have direct toxic effects on plants.

Muriate of Potash

Muriate of Potash is the most concentrated and economical potassium fertiliser, and therefore is the product of choice in most situations. Its drawbacks are its high salt index (which may cause root burn) and the chloride it contains.

The chloride is normally not an issue but may be of concern in saline soils, where poor quality irrigation water is used, and in crops that are sensitive to chloride or fertiliser burn. Muriate of Potash should not be used in foliar sprays as the chloride will burn the foliage.

Sulfate of Potash

Sulfate of Potash, having a lower Salt Index than Muriate of Potash, and is often preferred in crops that are sensitive to chloride or fertiliser burn, where the soil is saline, and where poor-quality irrigation water is used. Sulfate of Potash is often used in planting fertilisers for French bean, and for shallow-rooted tree crops such as avocado and macadamia.

Potassium Nitrate

Potassium Nitrate is also known as Nitrate of Potash and Saltpetre. It is not widely used as a soil applied fertiliser, on account of its cost, but is usually the product of choice for foliar application. Potassium nitrate is classified as a Dangerous Good (Class 5.1 Oxidizing Agent).

Potassium Thiosulfate (KTS)

Potassium thiosulfate (KTS) is used where concentrated potassium solutions are required for application to the soil. It has the chemical formula of $K_2S_2O_3$.

A typical analysis of KTS solutions, on a weight/volume basis, is:

- 30 % Potassium (K) w/v (300 g/L K)
- 25 % Sulfur (S) w/v (250 g/L S)

This is a higher potassium concentration than can be obtained by dissolving soluble fertiliser salts, e.g. potassium chloride and potassium nitrate, in water.

KTS has a specific gravity at 20^0 C of 1.47 – 1.50. KTS can be applied directly to the soil, or used in fertigation programs. Undiluted KTS should not be sprayed onto or allowed to come into contact with plant foliage, as it will burn the leaves.

KTS is often used in combination with Urea Ammonium Nitrate (UAN) solution, e.g. Incitec Pivot EASY N. KTS is compatible with UAN at ratios above 4:1 and below 1:4. This means that desired N:K ratio cannot always be achieved. This may necessitate applying UAN and KTS separately in fertigation programs, in alternate irrigation shifts.

6. SOIL APPLICATION OF POTASSIUM FERTILISERS

Potassium application rates are extremely variable, depending on the crop or pasture to be grown, expected yields, and soil type. Typical soil application rates (per crop or year) are listed in the table below.

In extensive pasture, potassium is usually broadcast as a single application at the start of the main growing season. In intensive dairy pastures and irrigated forage crops, the potassium may be split into a number of applications and applied in combination with nitrogen throughout the growing season. This avoids luxury uptake and improves utilization.

In winter cereals, e.g. wheat and barley, potassium, where required, is normally applied pre-plant.

In row crops, e.g. vegetables, plant sugarcane, and maize, potassium is usually applied at planting in combination with other nutrients, i.e. as an NPK fertiliser. The fertiliser needs to be applied through separate delivery hoses to those used for the seed, so as to place the fertiliser in bands 5 cm to either side of and 5 cm below the seed or planting material. This minimizes the risk of fertiliser root burn, which would occur if the fertiliser and seed were applied through the same delivery hose, in direct contact with each other in the soil.

In vegetables, the basal NPK fertiliser may also be applied in a broad band shortly before planting along the intended position of the row, which is then cultivated into the soil.

CROP	kg/ha K per crop or year
Vegetable and tree crops	50 – 100
Grapes	0 – 75
Banana	250 – 500
Sugarcane	50 – 120
Raingrown pasture	25 – 50
Irrigated pasture *	50 - 75

* Potassium may be used at rates of 150 kg/ha K on irrigated ryegrass, i.e. up to 5 kg/ha K for every 10 kg/ha N on soils low in potassium.

Where high rates of potassium are required at planting on sandy soils, increasing the likelihood of fertiliser root burn, where leaching may occur during the growing season, or where fertigation is practised, apply one-third to two-thirds of the potassium at planting, and the balance during the growing season.

In ratoon sugarcane, potassium is normally applied in a single application with nitrogen and phosphorus soon after harvest, e.g. as a blend of Urea, DAP and Muriate of Potash. Biodunder is used as a potassium fertiliser in some mill areas.

In tree crops, potassium can be applied at the start of the growing or bearing season, i.e. spring in many crops. However, it is customary to split it into a number of smaller applications through the growing season, applying it in combination with nitrogen and other nutrients.

In tree crops, the fertiliser should be spread evenly under the canopy out to a point 30 cm past the drip line, and no closer than 20 cm to the trunk.

7. FOLIAR APPLICATION

Unlike the trace elements, plant demands for the macronutrients, i.e. those required in large amounts, like potassium, cannot be met entirely through foliar sprays, without burning the foliage. Foliar applications are used to supplement, but not replace soil applications of potassium. They are applied during peak demand periods, or in times of stress. Plant demand for potassium is highest during the active growth stages in vegetables, and fruit filling.

Potassium nitrate is normally recommended where potassium is to be foliar applied. Leaf uptake of potassium as potassium nitrate is generally considered to be superior to that when applied in other forms.

Potassium nitrate supplies potassium and nitrogen, both of which are likely to be required in foliar spray programs. Crop responses to fertiliser may be enhanced, and the likelihood of leaf burn reduced, as no unnecessary ions or nutrients are applied.

Muriate of Potash (potassium chloride) should not be used in foliar sprays as the chloride can burn the leaves.

Sulfate of Potash (potassium sulfate) is less soluble than potassium nitrate, so less concentrated solutions can be prepared. This is of importance where low volume sprays are used, e.g. cotton.

Application guidelines for foliar application are detailed below.

Potassium Nitrate

Apply 5 - 10 kg/ha of potassium nitrate per application, on a one-to-two-week spray interval. It may be necessary to use lower rates in sensitive crops.

In tolerant tree and field crops, e.g. cotton, and where one or two sprays only will be applied during the entire growing season, it may be possible to increase the rate, e.g. up to 20 kg/ha/application of potassium nitrate.

If potassium nitrate is used in conjunction with other fertilisers in multi-nutrient foliar sprays, ensure that the combined fertiliser rate does not exceed these amounts.

As a guide, indicative potassium nitrate spray concentrations for foliar sprays are shown in the table below.

Potassium nitrate solutions are alkaline, whereas for foliar sprays, the pH of the fertiliser solution is best in the range of 5.0 - 6.5. Solution Grade MAP (monoammonium phosphate) can be used as buffering agent in foliar sprays containing potassium nitrate, provided other products with which MAP is incompatible are not to be used as well. About 2 - 3 kg of MAP are required for each 100 kg of potassium nitrate.

Expressed another way, this equates to about 250 g/100 L of MAP in the more concentrated sprays used in cotton (5 - 20 kg/100 L potassium nitrate), while in high volume sprays used in horticultural crops containing 0.5 - 2 kg/100 L potassium nitrate, 50 - 100 g/100 L of MAP may be adequate.

Table 3: Indicative concentrations for potassium nitrate in foliar sprays.

Situation	Concentration	Comments
Cotton - Air - Ground	 10 - 20 kg/100 L (10 - 20%) 5 kg/100 L (5 %)	 3 - 8 sprays with insecticide after first bloom.
Vegetables - pre-flowering - post-flowering	 0.5 kg/100 L (0.5 %) 1 - 2 kg/100 L (1 - 2 %)	 Apply with crop protection sprays during active growth and fruit filling stages, through to harvest.
Tree crops	0.5 - 1 kg/100 L	2 - 5 sprays.
Flowers	0.5 kg/100 L	Apply with crop protection sprays.

Potassium Sulfate (Sulfate of Potash)

In combination with urea, potassium sulfate is used in the preparation of liquid fertilisers for use in high volume sprays in pineapples, e.g. 4 - 5 000 L/ha. While sprayed over the plants, a lot of the spray runs off to the soil. Some nitrogen and potassium are absorbed through the foliage, but most is taken up by the plant roots. Seek district advice from industry specialists on application rates.

In other crops, potassium nitrate is recommended. If potassium sulfate is to be used as a foliar spray, application rates of up to 10 kg/ha/application are suggested. Typical spray concentrations are 1 - 2 kg/100 L (1 - 2 % w/v) in vegetables, and 0.5 - 1 kg/100 L (0.5 - 1 % w/v) in flowers and tree crops.

Potassium Thiosulfate (KTS)

KTS may be applied in foliar sprays, but precautions need to be taken to minimize the risk of leaf burn. KTS must not be applied neat (without dilution in water) by mister or boom-spray as the fertiliser solution will burn the leaves. In field crops, e.g. vegetables, a minimum spray volume of 500 L/ha should be used, and at least 1 000 L/ha in tree crops.

This requirement makes KTS unsuitable for use in aerial applications and ground application where low volume sprays are used.

A typical application rate for KTS in high volume foliar sprays is 5 – 10 L/ha per spray.

KTS should not be used in foliar sprays in sensitive crops such as strawberry or applied as a foliar spray in the seedling stages.

Spray Guidelines

Foliar burn may occur at the concentrations detailed above for potassium nitrate, potassium sulfate and KTS, particularly in crops such as strawberry, French bean and Navy bean. Spray concentrations may need to be reduced in sensitive crops. If burn occurs or past experience indicates it is likely, reduce the concentration, e.g. to half these rates. Higher rates may also be tolerated in some crops and circumstances.

Many factors affect the susceptibility of crops to foliar burn, including the type of crop being grown, its growth stage, prevailing weather conditions, the time of day that the fertiliser is applied, spray concentrations and volumes, frequency of application, water quality and application equipment.

Because of the many variables involved, the maximum rate at which fertilisers can be safely applied varies and cannot be accurately predicted in advance. The expression of symptoms may vary from year to year, week to week, and farm to farm. Burn may occur under both lush and harsh growing conditions.

If applying foliar potassium sprays for the first time, or applying to a new crop, in combination with other fertilisers, or should application procedures and equipment change, test spray on a few plants or trees first, and observe for three to four days for signs of phytotoxicity, before spraying the rest of the crop.

The best time to spray is usually in the early morning. Sprays can also be applied in the late afternoon or evening, or under cloudy conditions, provided the temperature is low and humidity is high. Do not spray in the heat of the day when the temperature is high and/or humidity is low, particularly in summer when evaporative conditions are at their highest. Avoid spraying when the temperature exceeds 25^0 C.

If urea is not already being used in the spray program, it is recommended that a small amount be added to the spray mixture. Urea helps promote leaf uptake of other nutrients. Addition rates are:

- 500 g/100 L in vegetables, or
- 100 g/100 L in tree crops.

Add a wetting agent at label recommended rates.

8. MIXING AND COMPATIBILITY IN SOLUTION

Potassium chloride and potassium nitrate are compatible in solution with most other fertilisers including urea, ammonium nitrate, ammonium sulfate, monoammonium phosphate (MAP), monopotassium phosphate (MKP), calcium nitrate, magnesium sulfate, sodium borate, sodium molybdate, metallic sulfates and chelates.

Potassium sulfate cannot be mixed with soluble calcium fertilisers, e.g. calcium nitrate, as insoluble calcium sulfate (gypsum) will be formed as a precipitate. The solubility of potassium fertilisers in water is detailed in the table in Section 5 (Page 6). These are the maximum concentrations (for a saturated solution) that can be achieved. For potassium chloride and potassium sulfate, a more practical figure, if it is necessary to prepare a concentrated fertiliser solution, e.g. for use through fertigation injection equipment, is one-half to two-thirds of these concentrations, i.e. 20 kg/100 L of potassium chloride and 8 kg/100 L of potassium sulfate. With good agitation higher concentrations might be achieved.

With potassium nitrate, it should be possible to prepare a 20 kg/100 L (20 % w/v) potassium nitrate solution at water temperatures around 20^0 C or higher. The addition of Urea will increase the solubility of potassium nitrate, but urea and potassium nitrate both cause the water temperature to fall on dissolving. If high concentrations are required, heating the water, if practical to do so, will make the fertiliser easier to dissolve.

Potassium chloride and potassium nitrate should not be used at concentrations above 10 kg/100 L (10% w/v) if sulfates, e.g. magnesium sulfate, are included in the tank mix. Potassium sulfate, which is less soluble than both potassium chloride and potassium nitrate, will be produced as a reaction product at higher concentrations.

When preparing fertiliser solutions, fill the tank to near capacity, leaving space for the added fertiliser, which should then be added slowly while agitating. Do not pre-mix, as is the practice with many pesticides, e.g. wettable powders. The fertiliser will not dissolve completely if added to a small amount of water. Fertiliser solutions should be prepared just prior to use, and not allowed to stand for an extended period, to minimise sediment formation and settling in tanks. If fertiliser is to be applied in combination with crop protection sprays, the chemicals should be added to the spray tank first, followed by the fertilisers.

Potassium nitrate is the most commonly used potassium fertiliser in foliar sprays. Potassium nitrate is compatible with many, but not all crop protection products.

Crop protection product labels should be checked for information on compatibility with fertilisers prior to use. If such information is not available, mix a small batch in a glass jar, and observe for signs of stability (settling or phase separation). It may also be necessary to spray a few plants and wait a few days to observe for signs of phytotoxicity and/or efficacy, before spraying the entire crop. As many agricultural chemicals are affected by alkalinity (high pH), the chemicals should be added to the spray tank first, followed by the fertilisers.

Add MAP, if being used, before adding potassium nitrate. This will minimise any pH changes and exposure of crop protection chemicals to high pH.

FERTIGATION

Fertigation can provide a convenient and labour-saving means of fertiliser application and allows seasonal requirements to be split during the growing season. Seasonal potassium rates will be similar to where fertilisers are applied dry to the soil.

Potassium chloride is usually the product of choice to apply potassium in fertigation programs in most crops, as it costs less per kg of potassium.

Potassium nitrate can be used to supply potassium, and part of the crop's nitrogen requirement. The nitrogen in potassium nitrate is present in a non-acidifying form. This may be of importance where drip, trickle or under-tree sprinklers are used, and soil acidification around the emitters is of concern. Other nitrogen fertilisers, such as urea and ammonium nitrate, may cause the soil pH to gradually fall in the zone in which the fertiliser is applied.

KTS can also be used to supply potassium in fertigation programs. Do not pre-mix potassium nitrate dry with chlorite or hypochlorite before addition to water. The resultant mixture is unsafe. Cleaning agents must be added separately to the water, not mixed beforehand with potassium nitrate.

9. POTASSIUM IN IRRIGATION WATER

In some areas, particularly where water is sourced from underground, irrigation water may contain an appreciable amount of potassium, which may reduce the need for fertiliser potassium, e.g. the Burdekin Delta in north Queensland. In these situations, a water test should be taken, and the results taken into consideration when determining potassium fertiliser requirements.

10. POTASSIUM IN ANIMALS

The body contains 2 g/kg K live weight, making potassium the third most abundant mineral in the body. However, while essential, it is regarded as a non-critical element for ruminants (cattle and sheep) as the concentration of potassium in most feedstuffs is usually well in excess of animal requirements. An exception to this rule is cereal grains, which are low in potassium. Hence animals which are fed largely on a grain diet, e.g. in feedlots, may need potassium supplements.

FURTHER READING

Further information on the application of fertilisers in solution is provided in the Agritopics on "Fertigation" and "Foliar Fertilisers".

WARNING

The information contained in this publication is for use as a guide only. The use of fertilisers and livestock supplements are not the only factor involved in producing a top yielding pasture or crop, or for livestock production. Local soil, climatic and other conditions should also be taken into account, as these could affect pasture or crop responses to applied fertiliser, and animal responses to supplements.

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