Nutrition: Potassium (K)

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Potassium function

Potassium (K) plays several key roles in a mango plant. Potassium:

- Regulates water uptake by roots and water loss by leaves. This affects the uptake of other nutrients
- Plays an important role in photosynthesis and food production including starches and proteins
- Is required for cell growth and development of thick cell walls that help with resistance to insect pests and pathogens
- Influences fruit development and quality including flavour, texture, fruit size, skin colour and shelf life

Potassium behaviour in the soil and plant

Plant-available potassium is a cation, or positively charged nutrient, that bonds to negatively charged sites on soil particles. Soils high in clay content and organic matter have more negatively charged sites, meaning they can hold more potassium as well as other positively charged nutrients such as calcium and magnesium. Sandy, granitic or acidic soils have few negatively charged sites and less ability to hold these nutrients. The amount of positively charged nutrients a soil can hold is expressed as its cation-exchange-capacity or CEC.

As with calcium, potassium forms weak bonds with soil particles, making it highly soluble and easily leached. Heavy applications or natural soil concentrations of other positively charged nutrients, such as calcium and magnesium, compete with bonding sites on soil particles, displacing potassium and reducing plant uptake.

Unlike calcium, potassium moves readily around the plant, usually from old leaves to young growing tissues. This is why deficiency symptoms often appear in older leaves first.

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Potassium deficiency

Where K leaf levels are low, tree growth and yields can be reduced before there are any visible signs of deficiency. If deficiency symptoms do develop, they first appear in older leaves as the tree moves K from older areas to growing tissues. Initially, deficiency presents as random yellow spots and necrotic (brown or dead) areas along leaf margins (edges) which extend from leaf tip towards leaf base (Figure 1). The non-necrotic parts of the leaves may be dull, yellowish to light green.

Potassium deficiency may result in reduced fruit size and quality.

Figure 1. Necrotic areas starting at the leaf margins and tip, are indicative of potassium deficiency.

Potassium toxicity

Potassium toxicity is generally not seen in mangoes. However, K competes with the other cations; Ca, Na, and Mg for uptake by plant roots, which can lead to deficiencies, particularly Ca. As a result, it is important that excessive amounts of K are not applied early in the fruit development period in order to minimise potential deficiencies in other elements.

Optimum potassium levels

It is recommended to aim for leaf potassium concentrations between 0.75 % - 1.2 % and 0.25 – 0.40 meq/100g K (exchangeable) in soil.

Common potassium fertilisers

There are numerous fertiliser blends containing potassium (Table 1). The three main potassium fertilisers used in the mango industry are:

- potassium sulphate - sulphate of potash (K_2SO_4)
- potassium chloride - muriate of potash (KCl)
- potassium nitrate (KNO_3)

It is recommended to use sulphate of potash (potassium sulphate) rather than muriate of potash (potassium chloride), due to the following reasons:

- The sulphate form has been shown to produce firmer fruit of higher quality than the muriate form
- The muriate form can alter soil pH
- The muriate form contains chlorides which can be harmful to tree health
- The muriate form should be avoided where salinity is a problem

Table 1. Common Potassium (K) fertilisers and their chemical composition

Fertiliser	Chemical symbol	K content (%)	Other nutrients (%)
Potassium nitrate	KNO_3	38	13 N
Potassium chloride – muriate of potash	KCl	50	-
Potassium sulphate – sulphate of potash	K_2SO_4	41	16.5 S
CK 55 (S)		11.9	12.8 : 14.2 : 6.5 N:P:S
CK 77 (S)		13.5	13.3 : 2.2 : 19.6 N:P:S
CK 88®		11.5	15.1 : 4.4 : 13.6 N:P:S
Nitrophoska Special®		14.1	12 : 5.2 : 8 : 1.2 N:P:S:Mg Trace amounts of B

Application rates, frequency and methods

The application rate and frequency should be determined by: tree growth stage (phenology), soil type, leaf test results, crop load, tree size and fertiliser history of the orchard.

- It is easily leached so preferably apply small amounts often, particularly in lighter soil types
- Most K (>60%) is needed by mangoes during the fruit filling period
- Monitor your crop load and apply more with a heavier crop

Rates

Potassium needs to be applied annually to the crop to replace losses from harvested fruit and from losses to the environment. It is estimated >40% of applied potassium may be lost due to leaching. Assuming 12.9 kg of potassium is removed in fruit in a block yielding 10 t/ha, to replace the potassium removed in fruit and allow for the loss through leaching, a minimum of 22 kg of elemental K/ha (54 kg/ha of potassium sulphate) would need to be applied per year.

Frequency

Potassium is mostly required by the plant during cell division, particularly during vegetative flushing (20% of K needs), flowering (20% of K needs) and especially fruit filling (60% of K needs). Potassium availability differs between soil types. High cation exchange capacity (CEC) soils, such as those high in clay content or organic matter are able to hold more K than sandy, granitic or acidic soils. Potassium is also easily leached so should be applied in multiple applications at these times to match peak needs. In many orchards, potassium is often applied in amounts in excess of normal annual K requirements in summer (vegetative flush) and winter (flowering) within complete fertiliser products which are primarily targeting nitrogen application. All of this K is unlikely to persist in the soil through to the time of peak needs (fruit development), so it is important to add additional K at this time. This can be done through single/split applications of a granular potassium product (e.g. sulphate of potash) or via regular fertigation and foliar sprays.

Methods

Potassium is best applied to soil as it is taken up in soil water through the roots. Granular potassium fertiliser products (e.g. sulphate of potash) or complete NPK fertiliser products (e.g. Nitrophoska Special®, CK77S) are applied onto tree rows using a tractor-mounted spreader/spinner.

Fertigation is used widely to apply potassium during the flowering and fruit development stages. This is generally conducted at two to three-week intervals, however some growers may apply small amounts of potassium every week from fruit set through to harvest.

Foliar sprays are also a good method to rapidly apply potassium at critical times during flowering and fruit development. Potassium nitrate is a commonly used product, applied at pre- and early-flowering (20g/L) to stimulate greater flowering and provide a rapid supply of N and K. Potassium foliar sprays are however primarily a supplement to granular or fertigation application, as it generally not possible to meet the complete plant demand for this macronutrient using foliar sprays alone.

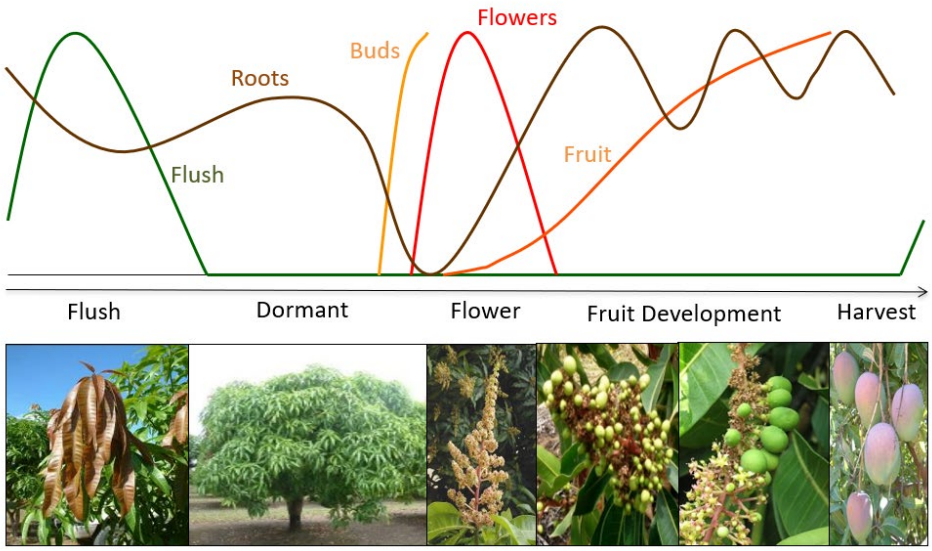
Timing fertiliser application to growth phases

Mango trees grow through a series of growth phases. The study of these growth phases is known as phenology (Figure 2). These events are influenced by season, environmental variability, variety, and your management - this in turn impacts on productivity.

The sequence of growth stages are (from harvest):

1. Shoot flush
2. Root flush
3. Shoot dormancy
4. Flowering
5. Fruit set
6. Fruit development
7. Root flush
8. Harvest

Figure 2. Mango tree growth phases.

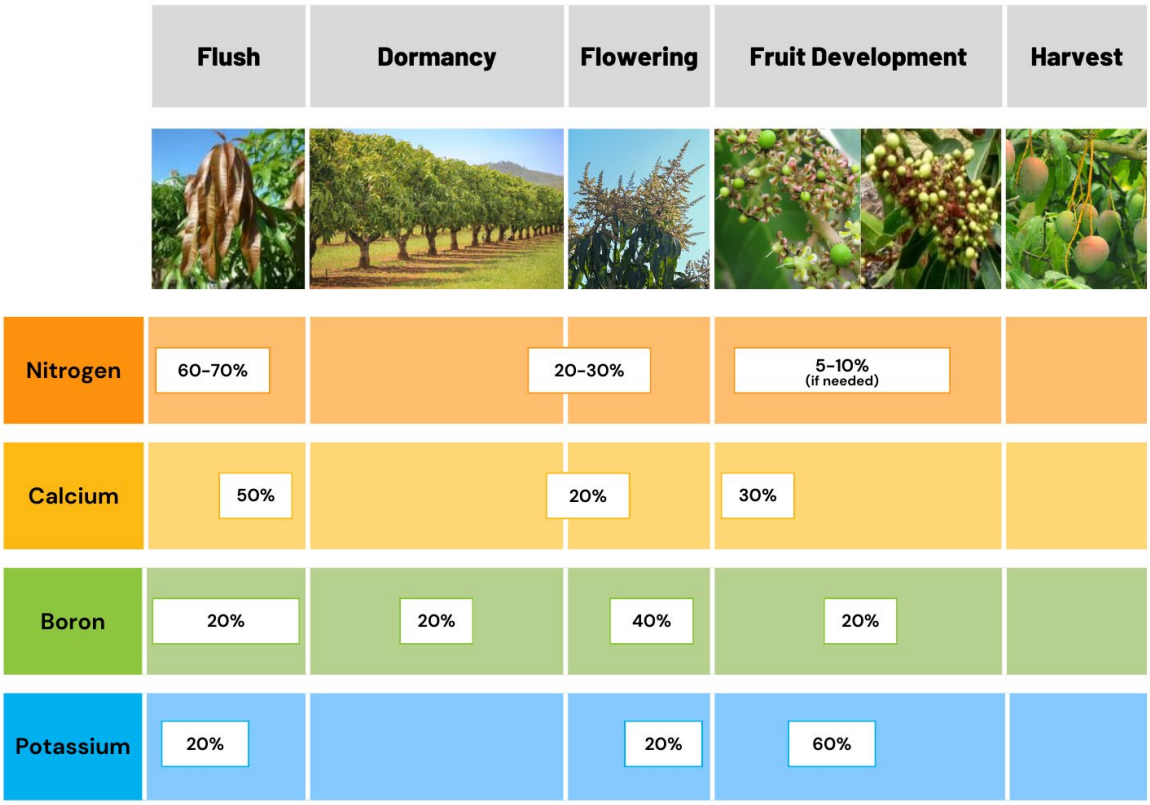


Each different growth phase has specific nutritional needs, so a key component of mango nutrition management is to match fertiliser application to demand (Figure 3).

The greatest demand for potassium is during fruit development. The majority of the potassium budget should be applied regularly throughout fruit development (60% of the total yearly application).

Additional K is needed at post-harvest flush (20% of the total yearly application) and prior to, and during, flowering (20% of the total yearly application).

Figure 3. A nutrition planner for Nitrogen, Calcium, Boron and Potassium application for mangoes.



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Further reading

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