Nutrition: Calcium (Ca)

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Calcium function

Calcium (Ca) is the building block of plant cells, where it has three main roles. Calcium:

- strengthens cell walls
- is essential in all new growing points of mangoes including roots and root hairs, leaves, flowers and pollen tubes
- keeps the cell walls elastic and allows the cells to expand as they grow.

Calcium, unlike N, does not move within the plant, so it stays in old tissues. Uptake by young roots is passive and soil must be moist for uptake to occur. Potassium, magnesium (Mg) and sodium (Na) compete with Calcium for uptake through the roots. Calcium is difficult to get into fruit and uptake speed depends on particle size, with smaller particle sized calcium achieving better uptake. As calcium is important for all growth phases it needs to be available all year round.

It is especially important for Ca to be readily available to the plant in the first 6-10 weeks of fruit development or until the seed starts to harden. During this period calcium is drawn into the flesh via water that is lost through the stomates, the pores in the skin of the fruit and leaves. The end of this time coincides with when the stomates on the fruit turn into lenticels and transpiration is reduced. Calcium is important for fruit firmness, shelf life, ripening and internal quality.

Calcium deficiency

Fruit deficiency symptoms are not visually evident on the tree but will show up in the fruit. Calcium deficiencies are linked to internal disorders like soft nose, jelly seed and reduced shelf life (figure 1).

Figure 1. *Top image:* Internal defects of fruit are associated with calcium deficiency; *Bottom-left images:* Soft nose (left) and jelly seed (right); *Right image:* stem-end cavity is another indicator of calcium deficiency.

Calcium toxicity

Calcium (Ca) toxicity is not seen in mangoes. However, calcium competes with uptake of other nutrients such magnesium (Mg), zinc (Zn), boron (B), copper (Cu) and phosphorus (P) causing deficiency symptoms for these nutrients to appear if calcium is applied in excess amounts.

Optimum calcium levels

Once the orchard is established, monitor plant calcium by annual leaf analysis and soil calcium and soil pH by regular soil analysis. Optimum calcium levels are:

- soil: 3 – 5 meq/100 g
- leaf: 2.0 – 3.5% in acid soils and 3.0 – 5.0% in alkaline soils

Application methods, rates & frequency

Calcium is needed in large amounts and must be taken up from the soil.

- The form of Ca to apply depends on soil pH. If the soil is too acidic, apply as either lime or dolomite, if the soil pH is acceptable, apply as gypsum.
- Moisture is needed for Ca uptake, so apply either towards the end of the wet season, as this reduces leaching losses, or apply prior to, or with, irrigation.
- Fine mesh liquid or powder forms of Ca are absorbed quicker so apply these during flowering and early fruit development.

- As the majority of Ca is taken up by new roots, time your applications to that of root flushes.
- Calcium fertilisers should be applied well before planting and incorporated with soil cultivation.
- Foliar sprays of calcium products targeting young developing fruit have little or no effect on calcium levels

Common calcium fertilisers

The most commonly used products to improve the calcium status of soils are lime, dolomite and gypsum (table 1). Care must be taken not to overuse these materials as excessive rates may significantly change the chemical and physical characteristics of the soil and subsequently affect plant growth.

Table 1. Common calcium fertilisers and their chemical composition

Fertiliser	Chemical symbol	Calcium (%)	Other nutrients (%)
Calcium ammonium nitrate (CAN) e.g. Cal Am®		8	27 N
Calcium nitrate	$Ca(NO_3)_2$	18-19	15 N
Dolomite (calcium & magnesium carbonates)	$CaMg(CO_3)_2$	12-15	8-12.5 Mg
EASY Cal® (liquid)		18.1	12.6 N
Gypsum (calcium sulphate)	$CaSO_4 \cdot 2H_2O$	18-20	14-18 S
Lime (calcium carbonate)	$CaCO_3$	35-40	
Yara calcinit (liquifert soluble solid)		19	15.5 N

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 3). These phases 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

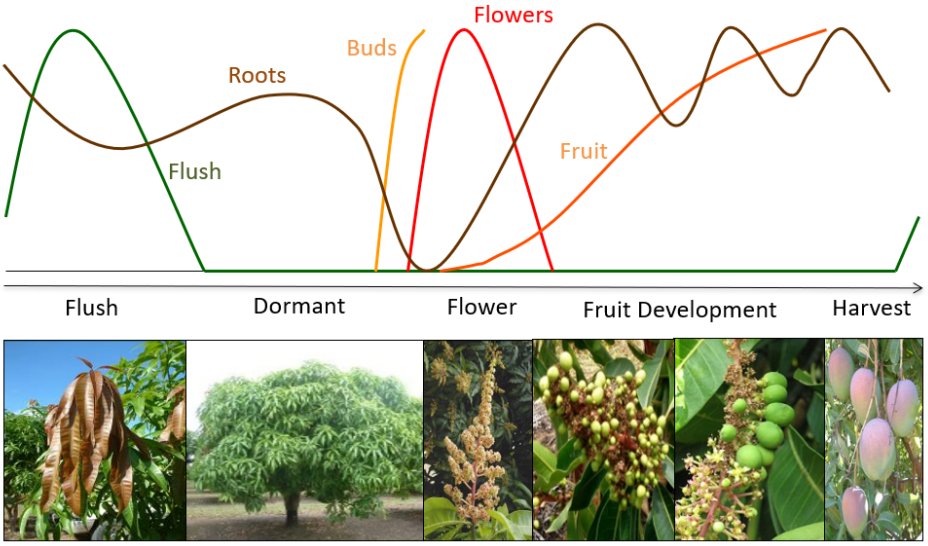


Figure 3. Mangoes grow through a series of growth phases. To get the most out of your orchard, match your fertiliser program to these phases to ensure the trees have the nutrients they need, when they need them.

Each different growth phase has specific nutritional needs, so a key component of mango nutrition management is to match fertiliser application to demand (figure 4).

Calcium is important for all growth phases, so it needs to be available all year round. Calcium needs moisture to be taken up and is most readily taken up by young roots, so aim to apply 50% of the total yearly application towards the end of the wet season and the post-harvest flush (figure 4). This is immediately prior root flush, so it is an ideal time to have calcium available for uptake. Calcium is critical for flower and fruit development and because uptake can be slow, it is best to use liquid or powder forms during these growth phases. Aim to apply 20% of the total yearly application during flowering and the remaining 30% in the first few weeks of fruit development.

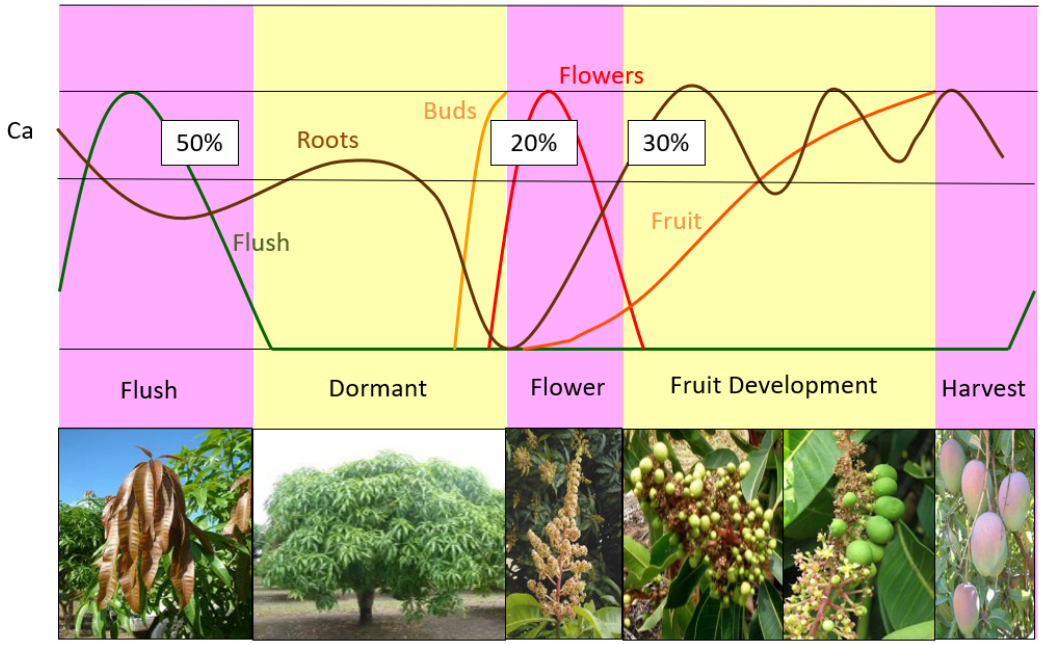
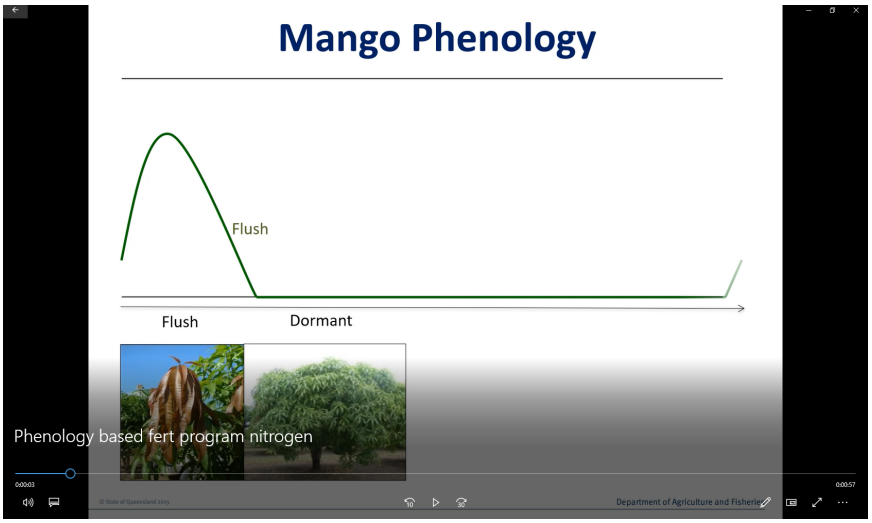


Figure 4. Time your calcium fertiliser applications to support mango growth phases with particular focus on flowering: 40% at flowering, 20% each throughout fruit development, post-harvest flush and during shoot dormancy, as this is when root flush occurs.



Powerpoint video animation of calcium fertiliser application based on phenology (in development).

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