Nutrition: Boron (B)

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Boron function

Boron (B) has several roles as a plant nutrient. Boron:

- Is necessary for all new cell growth where it affects the movement of plant hormones and sugars
- Is essential for fruit set as it helps with pollen viability and pollen tube growth
- Is a key component of cell walls and helps calcium (Ca) move to the cell walls

Boron behaviour in the soil and plant

Boron is highly soluble in soils and it is very easily leached. Boron has limited mobility within the tree. There must be a ready supply available from the soil and sufficient irrigation to enable B uptake by the plant. Boron uptake may also be slowed during periods of cold weather. Small amounts are required during all growth phases, but the majority is required during pollination and early fruit development. As it is needed in small quantities, it is easy to go from deficiency to toxicity.

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Boron deficiency

Leaves

- ‘Shot hole’ – small holes surrounded by a light-green halo (Figure 1: top-left)
- Lop-sided growth, curved, sickle-shaped leaves and ragged edges

Flowers

- Panicles are kinked or bent at the tip (Figure 1: right image)

Fruit

- Fruit may have a lumpy or bumpy appearance (Figure 1: bottom-left image). The variety R2E2 is particularly susceptible to low B levels

Trunk and branches

- Bark may crack and weep a black, gummy sap, known as gummosis

Figure 1. **Top-left image:** ***‘Shot holes’ in leaves are a common symptom of Boron deficiency;*** **Bottom-left image*****: Lumpy or bumpy R2E2 fruit;*** **Right image*****: Flower panicles that are kinked or bent at right angles.***

Boron toxicity

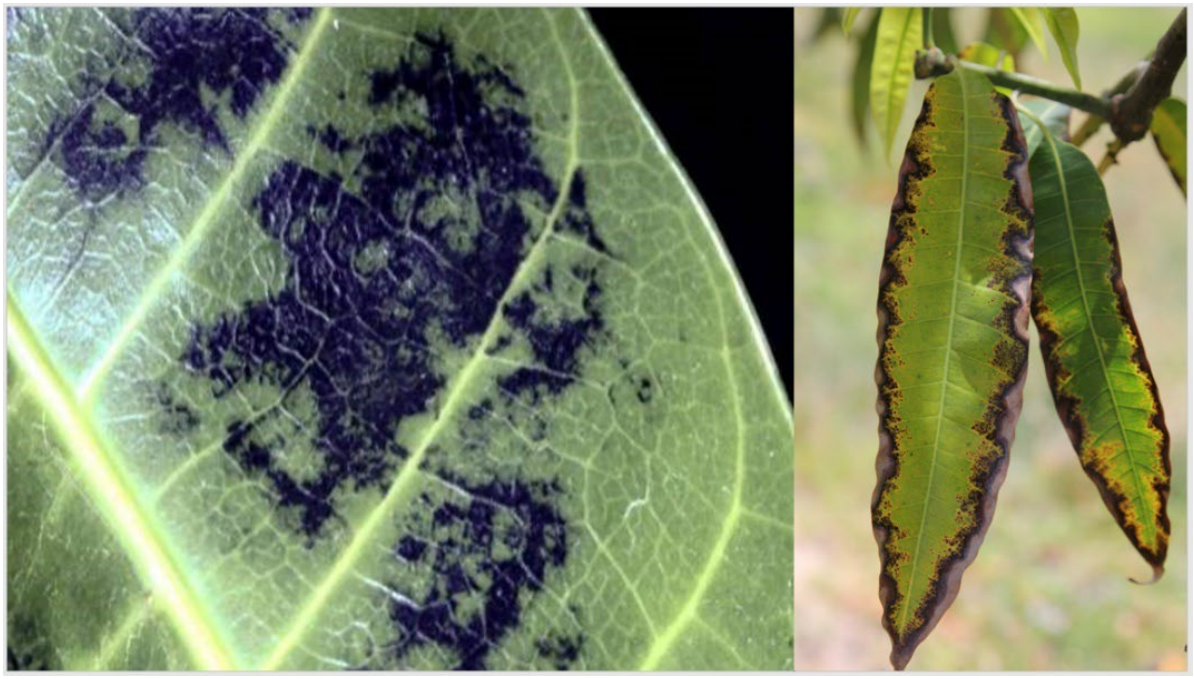
Boron toxicity is induced by excessive B fertilisation and is not uncommon, especially on light soils. Boron toxicity symptoms are a dark brown to black discolouration between the leaf veins or a wavy burn pattern along the leaf margins of older leaves, starting at the leaf tip (Figure 2). Leaf drop may also occur, sometimes for several vegetative flushes. Boron toxicity may last for several years.

Excess boron fertilisation may be counteracted by applying:

- Irrigation to leach B from the root zone
- Lime to increase soil pH
- Nitrogen fertiliser to stimulate growth

These actions may have other impacts on crop production, so it is recommended to seek agronomic advice before implementation.

Figure 2. **Left image:** ***Black discolouration between the leaf veins from boron toxicity;*** **Right image:** ***Wavy burn pattern along leaf margins that starts at the tip is indicative of excess boron application.***



Optimum boron levels

It is recommended to aim for leaf B concentrations between 50 – 70 mg/kg and soil boron concentrations of 1 – 2 mg/kg.

Application methods, rates & frequency

Boron is needed each time there is a new growth event.

1. Apply small amounts frequently, particularly on lighter soil types to avoid losses due to leaching.
2. Foliar applications can only be absorbed by soft tissue, new flush or flower panicles. Using a small amount of N will help with absorption or uptake.
3. Applications at flowering will help pollination as B helps in the development of the pollen tube.

Boron fertiliser application rates are critically defined by plant leaf levels and by the orchard soil type.

Boron can be toxic to mangoes at high levels and care should be taken when applying this fertiliser, so adhere to the recommended rate.

Boron is usually applied in multiple applications within a year, in order to maintain optimum plant levels during key growth periods, to minimise nutrient losses, and to prevent accidental plant toxicity. Boron can be applied in three main forms:

1. as a liquid solution to the soil via fertigation or through a calibrated boom sprayer
2. as a foliar application to the canopy
3. as a granular product to the soil

Mango farmers often use a combination of these soil and foliar application methods, within their annual boron management programs. One of the most practiced boron application programs in Australia is a combination of foliar application at flowering/early fruit development and fertigation at other times of the year. This may involve over eight (8) boron applications/year.

Liquid soil-applied products

Boron is commonly applied to the soil in multiple small applications as a liquid (e.g. Solubor®, Boric Acid, RapiBor®) often via fertigation, but can also be applied using a calibrated boom sprayer. Fertigation is now widely adopted by many mango growers and provides a low-cost method to safely and regularly apply small amounts of boron to the orchard throughout the year. Boom sprayers are an alternative method, particularly where fertigation systems are not used. In these cases, boron may be added to a herbicide mix and applied to the soil in the same operation.

Liquid foliar-applied products

Foliar applications of boron (e.g. Solubor®, Boric Acid, RapiBor®) to the tree canopy are most commonly conducted during flowering and early fruit development, when the boron can be actively absorbed by these soft plant tissues. Foliar application at other times should only be conducted when the leaf flush is soft, as plant uptake is usually poor on mature leaves. The flowering and early fruit development period is the most crucial period for boron use by the plant. Mango growers may conduct a boron foliar spray every 2 – 3 weeks during flowering and then every month during early fruit development.

Granular products

Boron can be applied to the soil as a granular product, although care should be taken to avoid causing boron toxicity. Granular products (e.g. Granubor®), are usually split into two applications/year for heavy soils and four applications/year in sandy soils. Controlled release granulated boron products (e.g. OrganiBor®) may only need to be applied once per year or less and have less risk of inducing boron toxicity. A range of NPK compound fertilisers (e.g. Nitrophoska Special®) also contain trace levels of B and can provide small amounts of B to the orchard over time. Older crystalline products (e.g. Borax) are difficult to apply and are no longer commonly used in commercial orchards.

Table 1. Common boron fertilisers

Fertiliser	Boron (%)	Other nutrients (%)	Comments
Boric Acid	17		Fine soluble products for application to soil via fertigation/boom spray or to canopy as a foliar spray
Solubor®	20.5		
RapiBor®	15	6.5 N	
Granubor®	14.3		Granulated fertiliser for dry application to soil.
OrganiBor®	10		Granulated, controlled release product for dry application to soil
Nitrophoska Special®	0.02	12 : 5.2 : 14.1 : 8 : 1.2 N:P:K:S:Mg	Granulated compound fertiliser for dry application to soil.
Borax (Sodium borate)	10		Fine crystalline product, no longer in common use

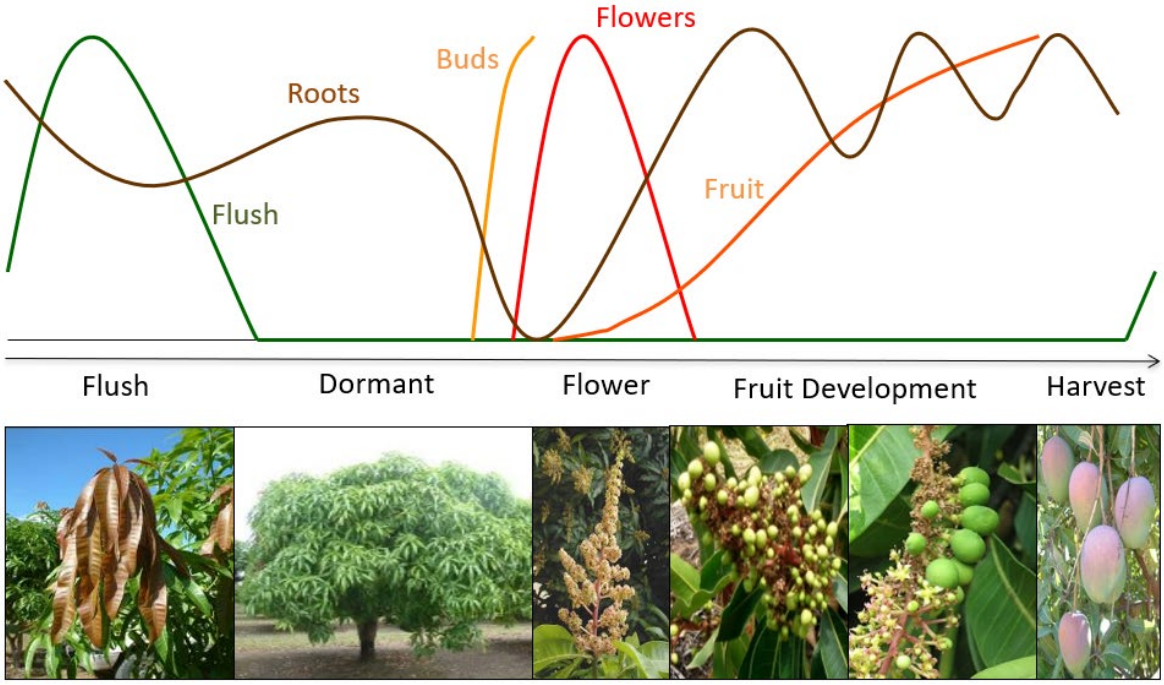
Timing fertiliser application to growth phases

Mango trees grow through a series of growth phases. The study of these growth phases is known as phenology (Figure 3). These 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 3. Mango tree growth phases

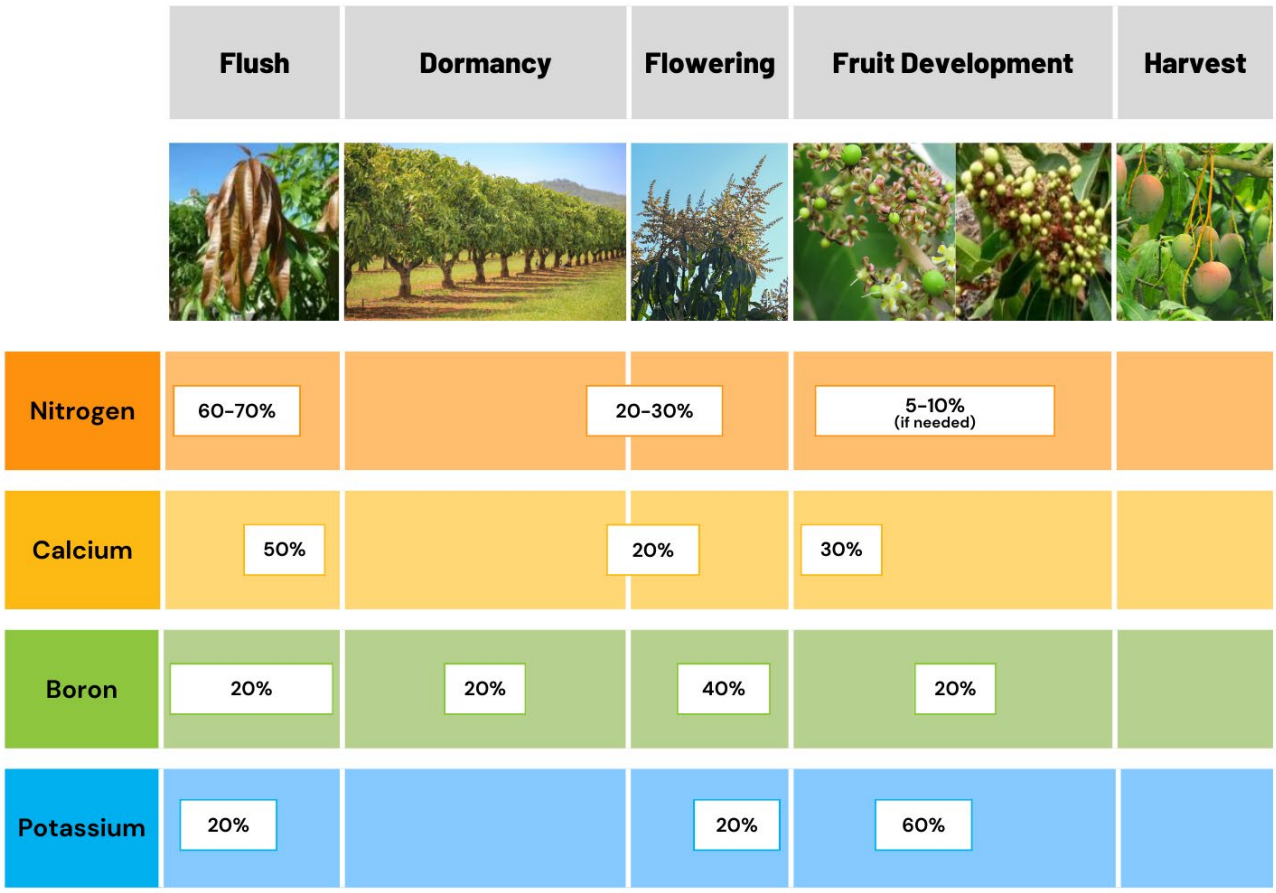


Each different growth phase has specific nutritional needs, so a key component of mango nutrition management is to match fertiliser application to demand (Figure 4).

Boron is needed throughout each growth phase as it supports new cell growth. The majority of the boron budget should be applied throughout flowering to support pollen development and improve fruit set (40% of the total yearly application).

Additional boron should be applied throughout: fruit development, the post-harvest flush and the shoot dormancy phase (20% of the total yearly application at each of the three phases).

Figure 4. A nutrition planner for Nitrogen, Calcium, Boron and Potassium application for mangoes.



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Further reading

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