Nutrition: Nitrogen (N)

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Nitrogen function

Nitrogen is the driver in plant processes and plays a significant role in determining mango yield and fruit quality. Nitrogen:

- is the most important element for growth, yield, and fruit quality
- is required for the manufacture of plant hormones, which control tree growth
- is essential for manufacture of chlorophyll (the green pigment in leaves) which in turn produces the sugars required for tree growth and development
- when combined with potassium (K), may improve flowering, but excess nitrogen can lead to vegetative growth instead of flowering and fruiting
- has an important interaction with calcium (Ca), with excess nitrogen redirecting calcium from fruit to leaves and causing fruit quality issues
- can increase the plant's susceptibility to pests and diseases, if applied in excess

Important positive effects of well-timed, sufficient quantities of nitrogen (N) include:

- increasing tree vigour
- stimulating flowering, in conjunction with K
- improving fruit set, retention, yield, size and brix or fruit sweetness

It is recommended that leaf sampling for N levels is conducted at least once, but preferably twice a year: immediately after harvest & pre-flowering.

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Nitrogen behaviour in soil and plant

Nitrogen is readily translocated in the tree and this can be seen when flush 'yellows off' as it pushes out flower panicles.

Nitrogen is lost or removed from the soil in four main ways:

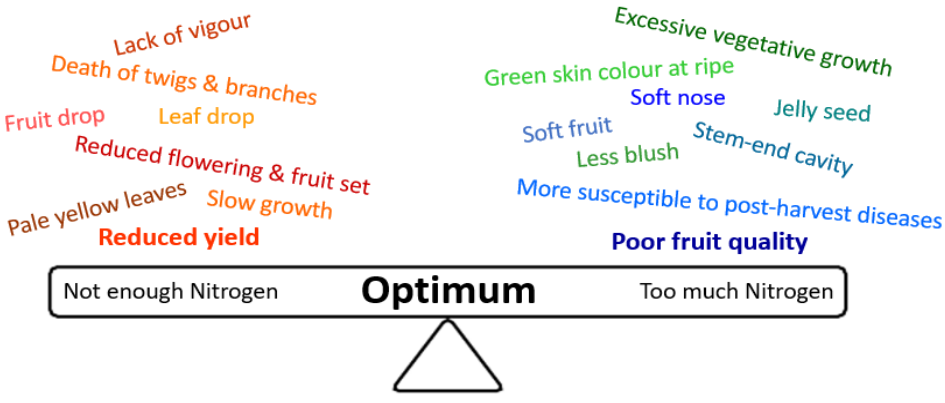
1. **Removal of the crop or vegetation**: approximately 8.5 kg of elemental nitrogen is removed in every 10 tonnes of fruit
2. **Nitrate leaching**: nitrate-N is a highly soluble nutrient that is easily leached from the soil with the drainage of water through the profile
3. **Ammonia volatilisation**: this occurs at the soil surface when the ammonium in certain fertilisers (e.g. urea) is converted to ammonia gas. Losses are minimal when fertiliser is incorporated into the soil but can be high when fertiliser is surfaced applied. Applying irrigation to water-in surface applied fertiliser can minimise losses from volatilisation.
4. **Nitrate denitrification**: a biological process that converts nitrate-N to nitrogen gases, releasing them to the atmosphere. This occurs in low oxygen conditions such as waterlogged soils.

Approximately 30-50% of applied nitrogen is lost due to leaching and volatilisation. Assuming 17 kg of nitrogen is removed in fruit in a block yielding 20 t/ha, to replace the nitrogen removed in fruit and account for losses; 42 kg of element N/ha (which is equivalent to 91 kg urea/ha) would need to be applied.

The nitrogen conundrum

'The nitrogen conundrum' provides a representation of the positive and negative effects of nitrogen (N) in mangoes and how they interact (Figure 1).

Figure 1. The nitrogen conundrum: Applying the right amount of nitrogen (N) fertiliser at the right time, is critical to ensure optimum fruit yield and quality.



Excessive or poorly timed nitrogen (N) application can negatively impact mango quality by promoting excessive or unwanted vegetative flush, which can divert calcium (Ca) away from the fruit and lead to issues such as:

- Reduced blush
- Soft fruit
- Fruit failing to colour properly when ripe
- Increased susceptibility to post-harvest diseases and disorders
- Lower fruit yields

Not enough nitrogen reduces photosynthesis and leaf growth, leading to problems such as:

- Lack of tree vigour
- Slow growth
- Twig and branch dieback
- Reduced flowering and fruit set
- Leaf drop
- Fruit drop
- Lower fruit yield

Nitrogen deficiency

Symptoms of nitrogen deficiency include low-vigour trees with pale yellow foliage, often resulting in poor fruit retention. Nitrogen is mobile within the plant, meaning older leaves turn yellow first as nitrogen is redirected to younger leaves, which remain green. A nitrogen deficiency can also impair the uptake of other nutrients.

Figure 2. Yellowish leaves associated with nitrogen deficiency.

Nitrogen toxicity

Nitrogen toxicity is rarely seen in mangoes; however, signs of excess nitrogen may be exhibited as trees with dark green leaves and excessive vegetative growth at the cost of flowering and fruiting.

Trees that appear ‘too green’ are often attributed to excessive nitrogen application, but other nutrients such as manganese (Mn), magnesium (Mg), and zinc (Zn), as well as the use of Paclobutrazol, can also contribute to this condition. Leaf tests, rather than soil tests, are the most reliable way to assess a tree’s nitrogen status.

Optimum leaf nitrogen levels

Experience and research have shown different mango cultivars have different requirements for nitrogen (N). For each of the commonly grown mango cultivars in Australia suggested leaf N levels are shown below in Table 1.

Table 1. Optimum leaf N levels for different mango cultivars.

Cultivar	Optimum leaf nitrogen level (%)
Asian cultivars	1.2 – 1.4
Calypso	1.0 – 1.5
Honey Gold	1.3 – 1.4
Keitt	1.0 – 1.2
Kensington Pride	1.1 – 1.3
R2E2	1.3 – 1.4

Common nitrogen fertilisers

Table 2. Common nitrogen fertilisers and their chemical composition.

Fertiliser	Chemical symbol	Nitrogen (%)	Other nutrients (%)
Urea	$CO(NH_2)_3$	46	-
Potassium nitrate	KNO_3	13	38 K
Calcium nitrate	$Ca(NO_3)_2$	15	18-19 Ca
Calcium ammonium nitrate (CAN)		27	8 Ca
Ammonium sulphate (Gran-Am®)	$(NH_4)_2SO_4$	27	23.6 S
CK 55 (S)		12.8	14.2 : 11.9 : 6.5 P:K:S
CK 77 (S)		13.3	2.2 : 13.5 : 19.6 P:K:S
CK 88®		15.1	4.4 : 11.5 : 13.6 P:K:S
Nitrophoska Special®		12	5.2 : 14.1 : 8 : 1.2 P:K:S:Mg Trace amounts of B

Controlling the release of nitrogen fertiliser can be achieved with the use of enhanced efficiency fertilisers (EEF). There are two main types of EEFs – polymer coated fertilisers (e.g. Agrocote®) and ammonium stabilised fertilisers (e.g. ENTEC® Urea and ENTEC® Gran-am). Polymer coated fertilisers have a plastic coating designed to break-down over time, releasing urea more slowly than straight urea. The ammonium stabiliser ENTEC® works by disabling but not harming, the soil bacteria responsible for converting ammonium to nitrate, for a period of time, delaying the conversion of ammonium to nitrate nitrogen.

Application methods, rates & frequency

The application rate and frequency of application should be determined by:

- leaf test results
- soil type – for light soils: apply smaller amounts, more often
- crop load – more N is required for heavier crops

A good way to calculate nitrogen (N) application rate is by the amount required per m^2 of canopy, that is, the area shaded by the tree. Research conducted on Honey Gold indicate rule of thumb application rates for N, as shown below in Table 3.

Table 3. Rule of thumb application amount of nitrogen per m^2 of canopy, based on measured leaf levels.

Leaf nitrogen (%)	N rate g/m^2 of canopy	N rate g/tree (4m x 4m = 16m^2)	N rate kg/ha (208 trees/ha)
<1.0	8	128	27
1 – 1.2	4	64	14
1.3 – 1.5	None required	None required	None required
>1.5	Levels too high	Levels too high	Levels too high

Nitrogen is a key nutrient for mango production and is generally applied in the form of a granular complete NPK fertiliser (e.g. Nitrophoska Special®, CK77S) to tree rows with a tractor-mounted spreader/spinner. (Much of the crops annual potassium and phosphorus needs are also met at the same time using these complete fertiliser products). An annual nitrogen nutrition program in Australia usually includes three granular applications; one large application in summer immediately after harvest, followed by a smaller application in winter at flowering and if required a small amount in spring during early fruit development. Orchards with fertigation may choose to supplement or replace the winter and spring applications with soil-applied liquid N fertilisers. Foliar N applications may also be conducted to supplement N application at these times. Potassium nitrate is a commonly used product applied as multiple foliar sprays at pre- and early-flowering to stimulate greater flowering and provide a rapid supply of N and K.

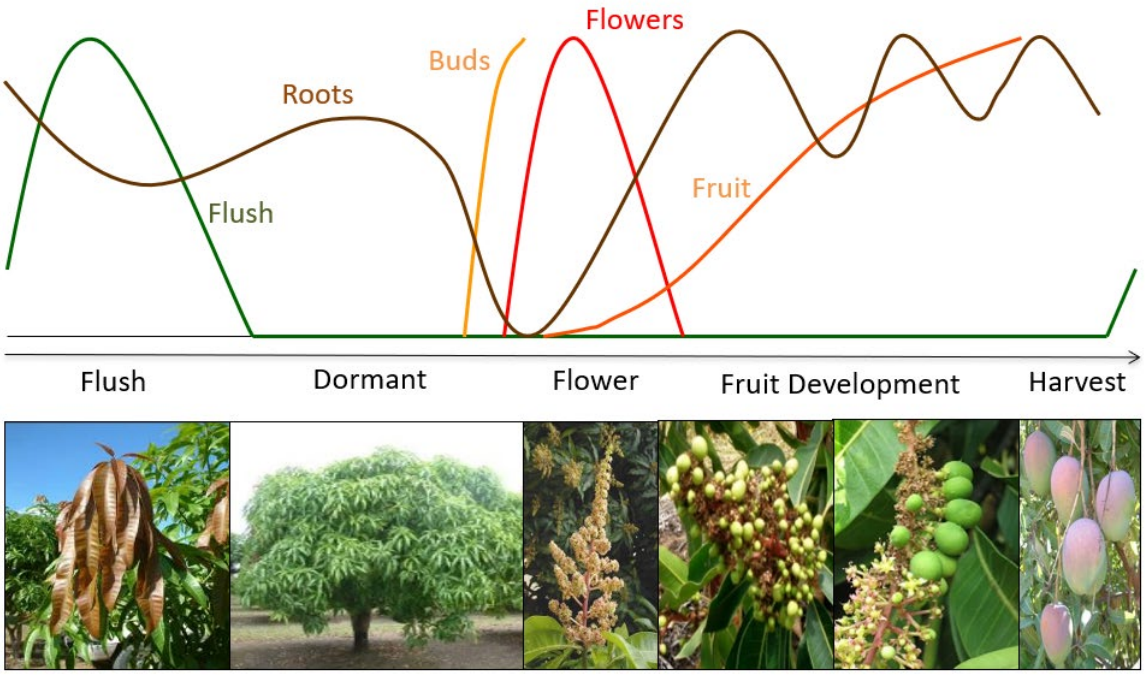
Timing fertiliser application to growth phases

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

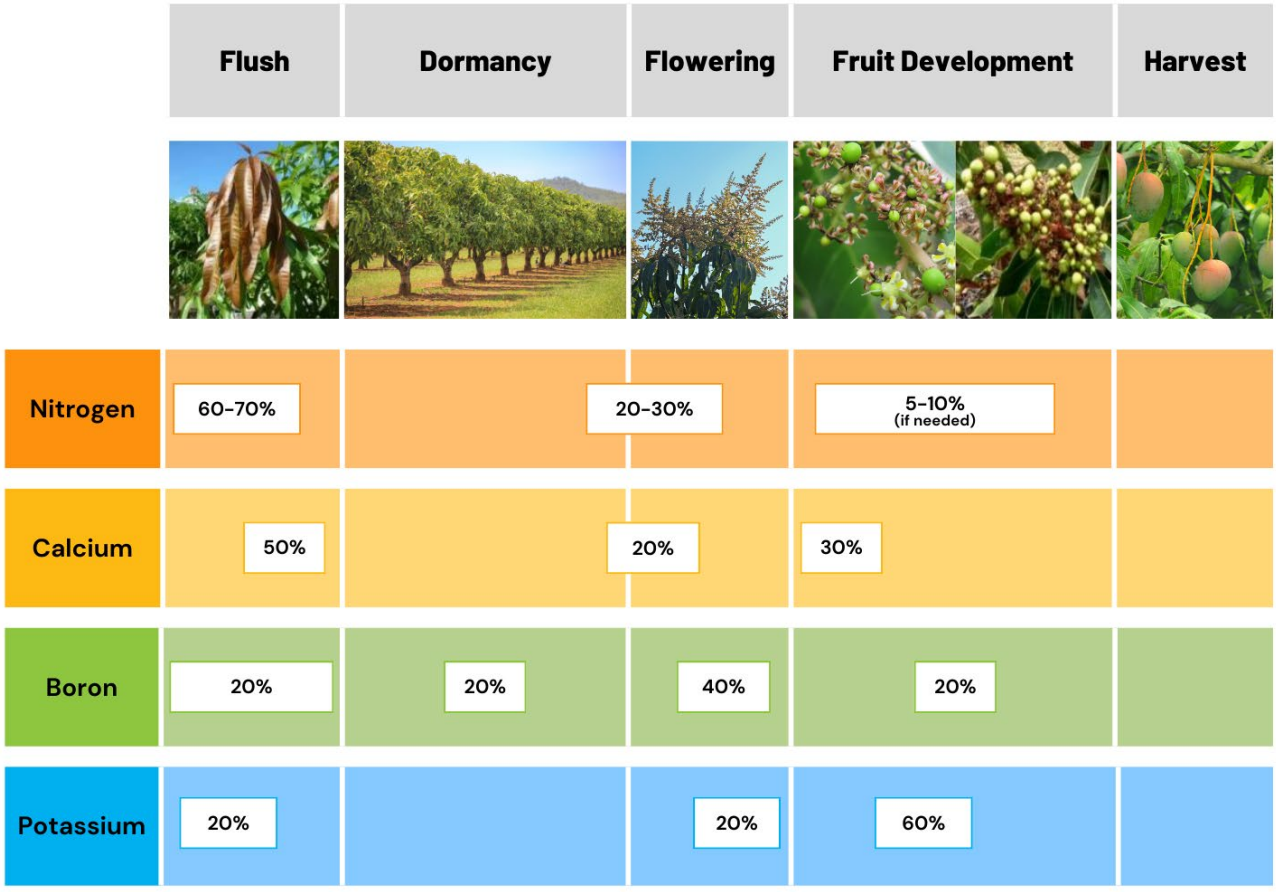
Figure 3. Mango tree growth phases



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). The greatest demand for nitrogen is during growth. The majority of the nitrogen budget should be applied after harvest to encourage the post-harvest flush (60-70% of the total yearly application).

Additional nitrogen may be needed at budding/early flowering (20-30% of the total yearly application) if the tree is visibly yellow, or leaf analysis results indicate a requirement. The remaining 0-10% of the total yearly application can be applied during fruit development, if needed. However, it is important not to apply nitrogen too close to harvest, as it will reduce fruit quality.

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



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