Shoot/Flower management

The management of mango tree shoot and flower growth can positively influence fruit yield. It is important to understand the natural processes that support flower development to develop appropriate management practices. Practices must also suit the unique conditions of different production regions and mango varieties.

The process of mango flowering relies on all the components of canopy growth such as bud initiation, leaf maturation and stem growth. Driving these components are abiotic or environmental factors such as water, nutrient availability, and temperature (Figure 1) along with endogenous hormonal regulation that occurs within the plant. The key component of canopy growth that controls the emergence of flowers includes what are described as initiation and induction events.

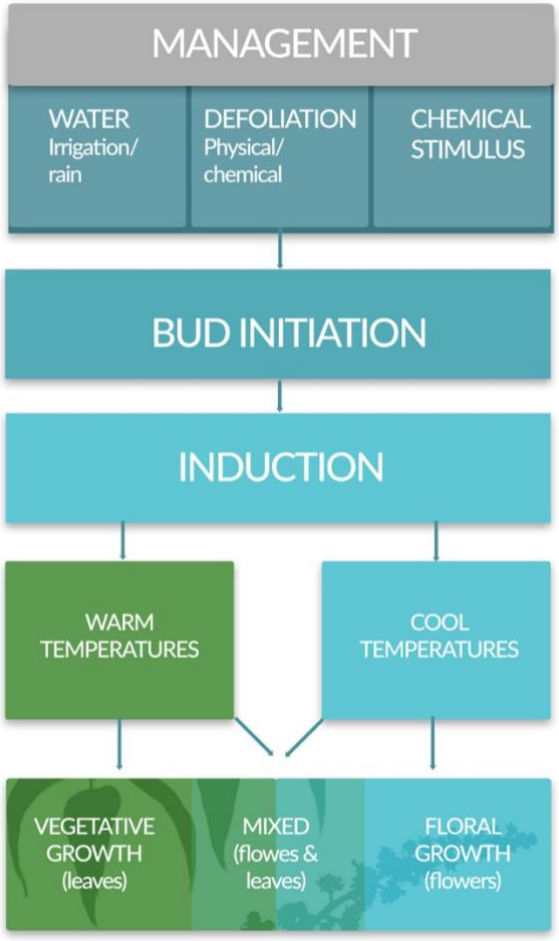
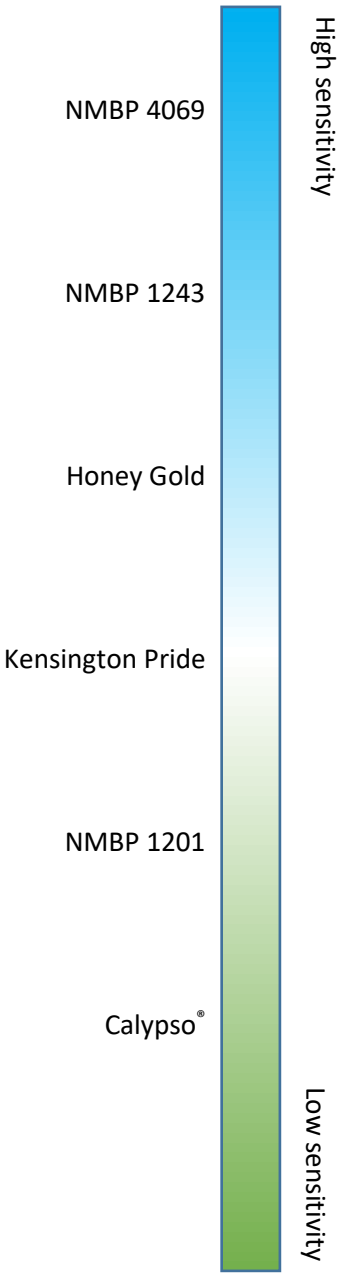


Figure 1. Mango flowering flowchart with management opportunities.

What is flower induction?

Flower induction is the process of initiating floral shoot growth as opposed to vegetative shoot growth. This process begins with shoot initiation which can be observed as the transition of a dormant bud into active growth by swelling and can be stimulated by pruning, defoliation, changing from dry to wet conditions, fertiliser application, and change in temperature as well as other factors. This process is regulated by phytohormones thought to be auxins from leaves and cytokinins from roots which appear to govern the initiation cycle. Auxins are known to stimulate growth in roots which in turn produce cytokinins which are major factors in stimulating shoot initiation. When leaves age the amount of auxin produced diminishes resulting in higher ratios of cytokinin hormones compared to auxins. This promotes shoot initiation and proliferation whilst higher levels of auxins will inhibit shoot initiation.



Induction is the temporary commitment of buds to evoke a particular shoot type upon initiation. It is regulated by the interaction of a putative temperature-regulated florigenic promoter (FP) and an age-dependent vegetative promoter (VP) (Davenport and Núñez-Eliséa, 1997; Davenport, 2000, 2003, 2008). The FP appears to respond during exposure of leaves to cool temperatures and is down-regulated to a constant basal level when temperatures are warm (Davenport, 2000). In contrast, the VP is thought to gradually decrease within leaves or buds as stems age, impacting the fate of initiating buds up to about four months after the young flush development. The ratio of FP to VP in buds, is thought to induce formation of the distinct shoot types; i.e. high FP to VP ratio induce generative floral shoots, low FP to VP ratios induce formation of vegetative shoots, and intermediate FP to VP ratios may be responsible for formation of mixed shoots.

Mango varieties differ significantly in their floral behaviour. Characteristics like timing, flower sex ratio, panicle size, duration of flowering, number of flowers and other traits vary with different genotypes. As a result, varieties will perform differently under particular environmental conditions and management practices. Some varieties are better suited to hotter environmental conditions, whereas some varieties are better suited to cooler conditions. Sensitivity to high temperatures during the flowering of new and common varieties is displayed in Figure 2. These types of considerations will be important to future-proof the industry to prepare for expected changing climates.

Figure 2. Cultivar sensitivity to high temperatures during flower induction in the Northern Territory (Clonan, M. et al. 2020).

Triggers for floral induction

Environmental conditions that create floral stimuli are believed to be cooler temperatures. The exact temperature conditions required for floral induction vary across cultivars. The reported temperature regimes for achieving flowering of most mango cultivars grown in Australia is when minimum temperatures between ~12 to 20°C and maximum temperatures between ~18 to 32°C coincide. However, although flowering may occur at the lower range of temperatures (~10 / 18°C), some key areas of floral development are negatively affected by colder temperatures. Two examples of this include shoot initiation, which is slower and, in some cultivars suppressed entirely, in day/night temperature regimes below 15 / 20°C, and flower sex ratio which is less favourable in temperatures below 15°C for most cultivars.

The arrival of whether that supports the occurrence of the temperature regimes described above, dictates to onset of flowering in production regions around Australia. Flowering is usually staggered between May and October, starting in the North and ending in Southern regions (Figure 3).

Figure 3. The occurrence of mango flowering around Australia starting in May in the Northern Territory (1) and finishing in southern Western Australia (4) in October (the highlighted regions are indicative only).

The arrival of inductive conditions

In the Northern Territory and northern Western Australia, the onset of cool inductive whether occurs when a high-pressure system in southern Australia draws cool air up to the north. This can be anticipated by viewing the wind and sea level pressure forecast on the Bureau of Meteorology website. During this time, night time temperatures are below 20 but day time temperatures are routinely ~30°C. This usually occurs between May and August (Figure 4).

In Queensland, New South Wales and southern Western Australia winter conditions can be too cold for mango flowering. During these periods, mango trees growth becomes dormant. If conditions temporarily become warm enough to flower in this time, flowers that do develop can be abnormal and often don't set fruit. As conditions warm in late winter to spring in these regions, flowering is more successful. Typically, mango flowering in Queensland occurs in August and September, followed by New South Wales and southern Western Australia continuing into October.

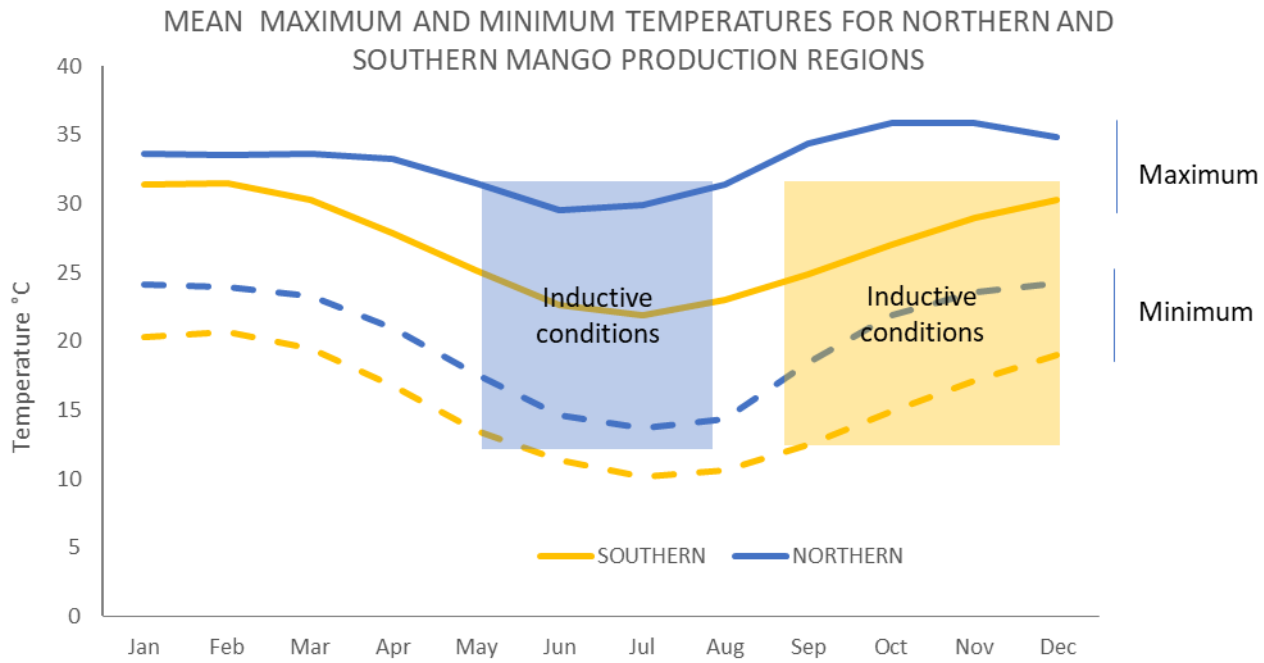


Figure 4. Difference in monthly minimum and maximum temperatures for southern and northern mango production regions.

Management practices that promote flower induction

There are a range of management practices that can enhance or promote floral induction in mango orchards. It is important to note that these practices cannot replace natural inductive conditions, rather they should be simultaneously used in targeted ways. The conditions which promote flower induction are those that prevent new vegetative growth and mature existing leaves. Examples of these conditions include water stress, flooding, cool temperatures, high evaporative demand and girdling. The following management practices imitate these conditions and can therefore be used to promote flower induction.

Water stress

Inducing water stress can supress vegetative growth but it does not trigger shoot initiation. This process can be valuable under highly productive conditions before the onset of inductive temperatures, as it will help to age the existing and restrict new vegetative growth to prepare for flower induction. The onset of irrigation after a period of water stress initiates shoot growth which may result in flower induction if favourable environmental conditions occur. Excessive water stress during periods of no growth can cause desiccation of buds and water stress after shoot initiation can limit shoot, flower and fruit growth.

Pruning

Pruning or removal of vegetative or floral shoots early in the inductive stage, can reset the canopy to promote new growth. If timed correctly with inductive conditions, the new growth can result in the production of flowers on mature terminals. This process can be utilised to either delay or synchronise flowering.

Chemical application

Chemicals used to promote flowering can be categorised as either plant growth regulators or floral promotors. Plant growth regulators limit or remove the inhibitory effect on flowering of young vegetative leaves. Floral promoters stimulate floral initiation by promoting shoot initiation during inductive conditions. If timed correctly, these applications can improve flower production during inductive conditions.

Paclobutrazol is a plant growth regulator registered with the Australian Pesticides and Veterinary Medicines Authority (APVMA). The postharvest application of paclobutrazol to the soil can have a significant effect on flowering and fruiting in the following year. It acts by reducing tree vigour, preventing excessive vegetative flushing in the lead up to flowering. Applications can be made after harvest and up until mid-February. A study has found that it is most effective to apply paclobutrozol 120 days before bud break for flowering (Bhagwan, A., et al. 2013).

Potassium nitrate is a floral promoter that acts by promoting the development of buds. When timed with cool weather, the initiation of bud growth can result in increased floral induction. Studies suggest that potassium nitrate is most effective as a foliar spray applied at night.

Boron and potassium nitrate are important nutrients in the promotion and development of flowers. These should be applied according to regular leaf nutrient analysis results.

Table 1. Chemicals for use in the management of mango flowering.

Chemical	Action	Application*	Timing*	Considerations
Paclobutrazol (APVMA regulated)	Growth regulator	Collar soil drench. 8 – 20 ml per tree (dependent on tree size)	Apply 4 weeks after harvest, no later than mid-February	Do not treat trees with canopies less than 3 m in diameter
Potassium nitrate	Floral promoter	3% KNO_3 foliar spray at night	Apply in the days leading up to cool inductive temperatures	If temperatures are not cool enough for floral induction, vegetative growth will occur
Ethephon (APVMA regulated)	Growth regulator	Application rate depends upon product type. Refer to permit	Apply initial foliar spray at early vegetative to first floral bud development and repeat approximately 28 days later	Do not apply more than two spray applications per season
Boron	Floral development	Foliar spray and soil application based on leaf analysis	Apply foliar at bud break, but maintain levels with soil applications at other times.	Boron can be toxic to mangoes at high levels

*Seek expert advice and adhere to label rates.

Girdling

Trunk or branch girdling (cincturing) limits vegetative flushing, therefore, causes the last flush of leaves to age. When carried out in late summer-early autumn, this has been found to occasionally increase flowering. However, girdling causes significant stress for a tree and in extreme cases is known to cause tree death.

Resources

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