MORE PROFIT FROM

NITROGEN

Optimising nutrient management for improved productivity and fruit quality in mangoes — *An economic case study*

About the research

The More Profit from Nitrogen Program (MPfN Program) was a cross-sector partnership between four of Australia's significant agricultural users of nitrogen (N) fertilisers: horticultural tree crops, cotton, dairy, and sugar. The program aimed to improve N use efficiency (NUE) in these industries to achieve improved profitability and environmental sustainability.

The Northern Territory Department of Industry, Tourism and Trade (NT DITT) conducted research trials on mangoes at multiple sites in the Northern Territory, supported by the Queensland University of Technology (QUT), and Hort Innovation using the mango research and development levy. The mango research team aimed to better understand how N could be managed to maximise productivity and fruit quality, minimise losses to the environment and provide economic benefits to producers. This case study details the economic implications of the MPfN Program research findings.

How much N is needed?

N removed at harvest - Yield is variable from year to year, and the starting point for calculating N requirements is an estimate of how much N left the property in the last crop. The research found that despite seasonal variation in yields the N content was relatively similar on a fresh weight basis, ranging between 0.84-1.11 kg N/t of fruit harvested regardless of the rate of N applied. For a yield of 15 t/ha, this equates to approximately 15 kg N/ha needed to replenish N removed at harvest.

Other sources of N: mineralised N - Most available N is lost from soils annually between the break of season rains to the end of the wet season. Decomposition of litter in response to rain events was found to release 11 kg N/ha of available N in the Darwin region and 17 kg N/ha in the Katherine region. What wasn't used was lost each year.

Application efficiency - If applied N was less than tree requirements, uptake efficiency was as high as 75 %. Higher rates of N led to reduced uptake efficiency of 20–35 %. For foliar fertiliser (potassium nitrate), leaves took-up around 35 % of applied N over 48 hours, which was transported around the tree rapidly.

KEY MESSAGES

- Applying more than optimum N does not give higher yields.
- The research found N removed at harvest was approximately 1 kg N/tonne (t) fresh fruit, or 15 kg N/ha for a 15 t/ha crop.
- Leaf litter and prunings can recycle 11-17 kg N/ha back into the soil-plant system over a season. The N not used is lost each year.
- N uptake efficiency can be as high as 75 % but reduces with excess N applied.
- For a crop of 15 t/ha with 11 kg of recycled biomass N, fertiliser application of 13 kg N/ha would meet the orchard requirements. Compared to a current practice of 50 kg N/ha, this has the potential to save $140/ha in N inputs, as well as reducing N losses to the environment.
- Applied N above 25 kg N/ha increases the risk of "stay green" skin, which could lead to a 10–20 % decrease in price received.

How much is too much?

The research identified a link between N application and mango quality, with application rates of N above the plant requirements increasing the risk of post-harvest defects relating to skin colour. In an orchard with 250 trees/ha yielding 15 t/ha commercial fruit, rates above 25 kg N/ha were associated with ripe fruit skin that was more likely to be "green ripe". Fruit from trees receiving 12.5 kg N/ha ripened normally. Green ripe fruit is a major quality problem that reduces the saleability of mangoes.

Consistently higher levels of green-ripe fruit could result in price downgrades of 10–20 %, particularly once there is a large volume of fruit at the market for wholesalers and retailers to choose from.

Analysis of farm level economic benefits

For an orchard density of 250 trees/ha with a two-year average 15 t/ha commercial crop, and full recycling of litter, prunings, and non-commercial fruit, the MPfN findings recommend the application of 13 kg N/ha (Table 1). Compared to a current typical practice of 50 kg N/ha, with N applied as sulphate of ammonia (SOA) through fertigation[1], the recommendations have the potential to save $140/ha in N input costs and reduce N losses to the environment. More significantly, the decreased rates of N have the potential to generate increased revenue of $2,949/ha because of avoided green skin-ripe fruit quality problems[2].

Table 1 *— Comparison of MPfN findings with an example current practice.*

	Unit	Current practice	MPfN findings
Commercial yield	t/ha	15	15
Fruit N concentration	kg/t	1	1
Average annual removed	kg/ha	15	15
Recycled biomass N application*	kg/ha	11	11
Supplementary N requirement	kg/ha	4	4
Fertilizer uptake efficiency	%	<20	30
Fertilizer N application	kg/ha	50	13
SOA equivalent application	kg/ha	238	63
Fertilizer cost savings[1]	$/ha		**140**
Crop income			
Farmgate price received[2]	$/tray	13.6	15.0
Farmgate price received	$/t	1944	2140
Total income	$/ha	29,156	32,104
Crop income increase	$/ha		**2,949**
TOTAL POTENTIAL BENEFIT	$/ha		**3,088**

*Includes recycled N from 2 x 2 % foliar potassium nitrate applications in both scenarios. Assumes 11 kg/ha mineralised N from litter is taken up by trees. Monitor N annually and re-evaluate considering last season's yield.

Monitoring key to nitrogen management

Monitoring N content is key to managing N efficiently and economically, particularly from season to season due to variations in crop load and climatic conditions. Considering N outputs in fruit, the N content of litter, and pruned material cycling in orchards, along with soil N availability and N mineralisation will help calculate annual N requirements.

[1] *With N content of 21 %, priced at $800/tonne (Nutrien Ag Solutions Darwin, 2021). As N is applied through fertigation, changes in rates of N have minimal impact on application costs.*

[2] *Assumes high levels of N with associated green-ripe results in 80 % of fruit downgraded from 1st grade to composite based on CSIRO, 2017, Northern Australia Water Resource Assessment—Mango GM, and AusMarket Consultants pers comm 2021. Remaining 20 % is 2nd grade. Prices per tray of $15.7 1st Grade, $14.0 Composite, $12.2 2nd Grade. Prices include cartage to Bne, levies and wholesaler commission of 14 % drawn from CSIRO op cit.*

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Gaseous emissions from soil, decomposing litter and fertiliser were sampled in mango orchards using automated, lidded chambers attached to a mass spectrometer. Dr Tony Asis of NT DITT checks the connections to the chambers

The dry matter content and skin colour of mangoes were measured by Dallas Anson and Dr Jo Tilbrook of NT DITT. Fruit was harvested from trees receiving a range of treatments to assess what level of nitrogen fertiliser resulted in ripe fruit with "stay green" skin.

Collecting data and setting up soil cores under trees in a Kensington Pride orchard, ready for excavation over the next year. Dr Tony Asis wields the sledge hammer while Raj Pandeya positions the casings and Dr Jo Tilbrook documents the layout.

MPfN

FURTHER INFORMATION

FOR FURTHER INFORMATION ON THE MPfN PROGRAM:

***Optimising nutrient management for improved productivity and fruit quality in mangoes* project, contact the project leader:**

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Visit www.crdc.com.au/more-profit-nitrogen

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