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Optimising nutrient management in apple orchard

Key Points

- **Spring N application** mainly contributes to **fruit and leaf**; **More N is diverted to buds and spurs** than when N is applied in summer
- **Summer N application contributes greatly to storage** in trunk, roots, and branches only; and has **lower nitrogen use efficiency** than spring N application
- Despite the lack of N in the previous season, the mechanism to provide sufficient N to new growth in apple trees is unknown
- **Mineral nutrients can interact with each other** to affect plant uptake and utilisation, how do N, P, K, and Ca interact?

Optimising nutrient management through fertigation to improve fertiliser use efficiency in the orchard has become the focus of the apple industry, due to the pressure from market price, high freight and labour costs, and adverse seasonal conditions.

Optimising nutrient management allows more efficient utilization of resources and improves returns per unit area for growers.

However, guidelines for the optimum supply of apple nutrients are limited, and the impact of the interaction between mineral nutrients on tree nutrient uptake remain minimally understood.

Project objectives

This project aims to determine how fertiliser application timing can be managed to meet apple tree nitrogen (N) requirements and improve apple fruit quality. We will also examine how mineral nutrients interact between each other. The data generated from this study can then be used to complete N budget for commercial apple production.

TIA is a joint venture of the University of Tasmania and the Tasmanian Government

Fate of nitrogen under different fertigation timings

Application of nitrogen (N) is crucial in apple production, the wrong application timing and rates can adversely impact the fruit yield and quality.

In this study I use a nitrogen tracing technique that uses a stable but heavier form of nitrogen (^{15}N) to understand how tree nitrogen demand varies over a growing season and how fertilizer timing can be used to optimise apple production and quality.

In this study, fertilizer tracer was applied to 28 mature apple trees at either spring (three weeks after full bloom) or summer (after harvest) at the rate of 50 kg/ha N in year 1. No nutrient was provided to the trees in year 2. Whole trees were excavated in the dormancy period of year 1 to measure the N uptake, while the remining trees were also excavated after harvest of year 2 to measure the remobilisation of storage N.

What the results show:

1) Apple trees use spring applied nitrogen twice as efficiently as nitrogen applied in summer. Nitrogen use efficiency in spring was 30% compared to 15% in summer.
2) Spring N fertigation contributes mainly to fruits and leaf growth. N partitioned into buds and spurs was also higher in spring fertigated trees.
3) The nitrogen status of trees N fertigated in spring or summer is equal, but summer fertigated trees stored higher levels of fertilizer N in the trunk, roots and branches of trees.

Figure 1: Excavating apple tree roots with the help of an excavator

Interactions between nitrogen, phosphorus, and potassium on fruit quality

Previous research showed that higher fertigation rate of a mineral nutrient can influence the uptake and distribution of another mineral nutrient. Although the impact on post-harvest physiology of apple nitrogen (N), phosphorus (P) and potassium (K) has been extensively studied, little is known about the interactions between the mineral nutrients.

To optimise the usage of fertiliser in apple production without compromising yield and quality, it is crucial to understand how mineral nutrients interact with each other to affect the tree nutrient uptake and utilisation. In particularly, we are interested in the interactions between of N, P, K, and Ca.

This new study will be divided into two parts:

1) We will examine the xylem and phloem flows, leaf and fruit nutrient status of trees fertigated with different rates of N and P, and K.

2) We will use synchrotron radiation technique to investigate the impact of high N and K rates on the fruit cell wall structure and how it relates to fruit firmness.

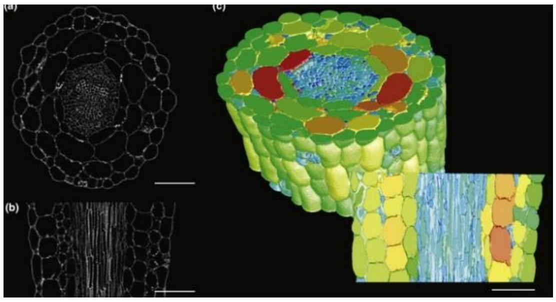

Figure 2. High resolution synchrotron X-ray computed tomography image of a hypocotyl at cellular level.

More information

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