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PRODUCTIVITY IRRIGATION PESTS AND SOILS

Optimising nitrogen management in apple orchards

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Optimising nutrient management allows more efficient utilisation of resources and improves returns per unit area for growers. A mismatched nitrogen (N) supply to N demand can adversely impact fruit yield and quality by reducing N uptake and tree N status.

Guidelines for the optimum supply of apple nutrients are limited, and this requires a more comprehensive and accurate understanding of the N cycle within orchards.

Project objectives

This project aimed to determine

- how fertiliser application timing can be managed to meet apple tree nitrogen (N) requirements, and
- how much N is returned to the soil from the decomposition of plant litter/mulch.

KEY POINTS

- **Apple trees used nitrogen twice as efficiently** when it was applied in **late spring** (between petal fall & early fruit set, 32%) compared to post-harvest applied nitrogen (17%)
- **Late spring N** application (between petal fall & early fruit set) contributed more N to **fruit, leaf, buds and spurs** than post-harvest fertigation
- **Late spring and post-harvest nitrogen** application contributed the **same amount of N to storage organs** of roots, trunk and branches
- **Mature trees** demonstrated the capacity to **buffer seasonal variability** in N availability through the remobilisation of stored N and uptake of soil N.
- **Mulching** of fallen leaves and winter prunings contribute between **1 and 5% of annual tree N requirement**
- **Application of foliar urea** in autumn may improve decomposition of plant litter/mulch, assist the release of litter N and make more soil N available in the following spring

Nitrogen fertigation with ^{15}N

We used a stable isotope of nitrogen (^{15}N) in the form of calcium nitrate to track how N is taken up over a growing season and how it is allocated to different tree organs. In the first season, N treatment was applied either late spring (for four weeks starting at petal fall) or post-harvest (for four weeks starting one week after harvest) at the rate of 50 kg N per ha. Each treatment received 4 weekly applications of N via fertigation. No additional N fertiliser was applied in the second season to measure the remobilisation of fertiliser N.

- **Late spring:** N applied for four weeks starting at **petal fall**
- **Post Harvest:** N applied for four weeks starting **one week after harvest**

Nitrogen use efficiency at different times

Apple trees took up late spring applied N twice as efficiently as post-harvest applied N (32% uptake efficiency versus 17%).

Season one - distribution of fertiliser nitrogen in the tree

The **majority of N from fertiliser** applied in late spring was distributed to **fruit and new shoots** (leaves and spurs) Figure 1. Most of this N was distributed to the fruit (5.1 g/tree).

Despite this, late spring N application had no detrimental impact on fruit yield or quality and there was no difference in the fruit N content between pre and post-harvest treatments.

Similar levels of N were distributed to **storage organs** (roots, trunk and branches) irrespective of whether N was applied pre or post-harvest.

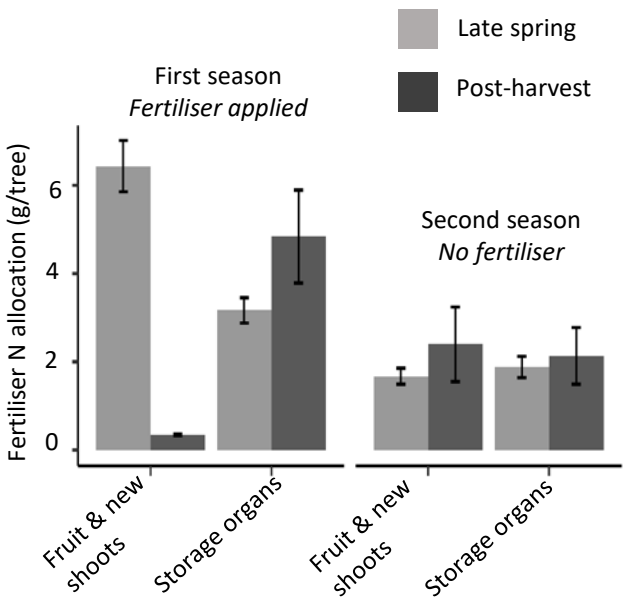

Figure 1: Distribution of pre and post harvest applied fertiliser N in apples

Season two - Nitrogen remobilisation from storage

No fertiliser N was applied in the second season so that we could see how the tree **remobilises N** from fertiliser applied in the first season (Figure 1).

Distribution of N was similar irrespective of when it was applied in the previous season. The tree effectively buffers the seasonal difference in N availability using 'native N' by remobilising stored N and accessing soil N reserves. This native N makes up the bulk of N (85%) in the older tree, (Figure 2).

Applying N in late spring is the most efficient way to maintain sufficient N reserves in mature apple trees. The tree can then buffer seasonal variations in available N to maintain yield and fruit quality.

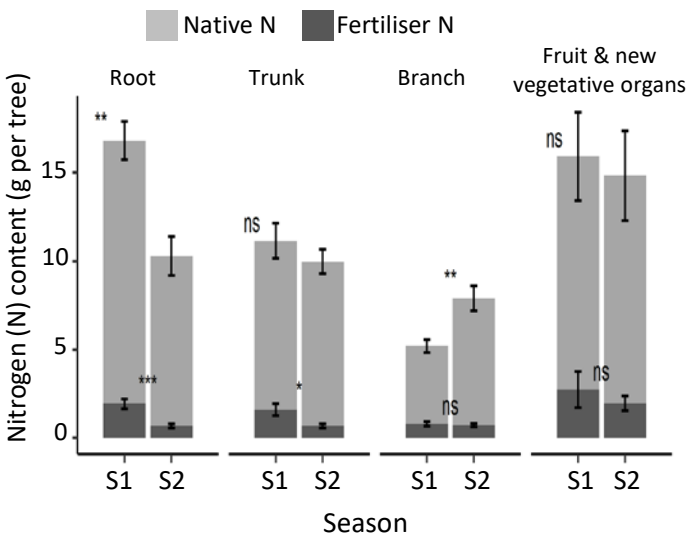

Figure 2: Remobilisation of N in the apple tree and the relative contribution of fertiliser and native N in Season 1(2017-18) and Season 2 (2018-19)

Nitrogen from plant litter

We collected prunings and fallen leaves from apple trees to work out how much N they contribute to the orchard system and how much of this is utilised by the tree each season. The litter bags were left to decompose in an orchard to simulate what happens naturally (Figure 3).

Each year, fallen leaves and pruned branches can return approximately 10 kg of N per hectare to the orchard. Over 2 seasons, trees took up approximately 1 kg N per hectare derived from leaves and prunings. The remaining N is most likely stored in the soil system as more complex forms of N and in soil microbiota.

In this trial, leaf mulch decomposed and released more N than branch mulch, whilst more N from the branches was taken up by the trees.

Although the tree is less efficient at using N applied by fertigation in autumn compared to spring, foliar application of urea is known to increase litter decomposition and inhibit pathogenic fungal (Alternaria leaf blotch and fruit spot) growth.

This practice is likely to increase the availability of litter N and urea-N in the following season when the temperatures are favourable for plant and microbial activity.

Figure 3: Litter bags used to measure changes in N content of mulch after leaf fall

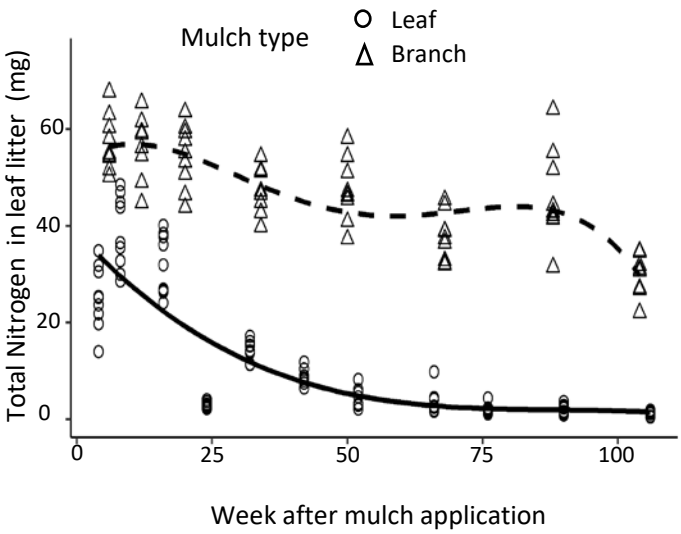

Figure 4: Nitrogen content of mulched leaves and branches

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