1. Ungrafted rootstocks being screened for soil stress.

Better tree performance through root system resilience – project update

In December 2016 Australian Nutgrower published an article which provided an introduction to a new project, based at CSIRO, which aimed to improve tree performance of almonds through better management of their root systems. The project is due to end in late 2020 and here the authors provide a progress report on the work to date.

Rootstock screening

The vast majority of almonds in Australia are grafted to Nemaguard rootstock. Whilst this is also the most commonly used rootstock in California, a wider range of rootstocks are used there, with soil type probably the largest factor behind rootstock choice. Currently, there is no breeding program used here for almond rootstocks in Australia, meaning that the Australian industry is reliant on imports for new genotypes.

In addition, the number of almond rootstock trials in Australia to date has been limited, such trials requiring many years and they cannot represent all soils and regions. Improving the availability of rootstock genotypes suitable for use with almonds and the information on their performance under Australian conditions for growers is likely to be a significant benefit to the industry.

To help address this situation, the first component of our project was to develop rapid, greenhouse based, rootstock screens against abiotic stresses (drought, high soil conductivity/salinity). These screens are intended to be a preliminary step, allowing many rootstock genotypes to be tested in a short time, prior to selection for traditional field trials or importation. The screens using ungrafted material (seedlings or cuttings), are completed in a few weeks and can be carried out by nurseries with little specialised equipment.

The principal is to use growth as the ultimate measure of production, but rather than use biomass per se, the screens use relative growth rate, the increase in biomass per unit biomass per day. This approach allows better comparison between trees of different sizes and between trees grown under non-identical greenhouse conditions. However, the approach can only be used for factors which affect the root system directly.

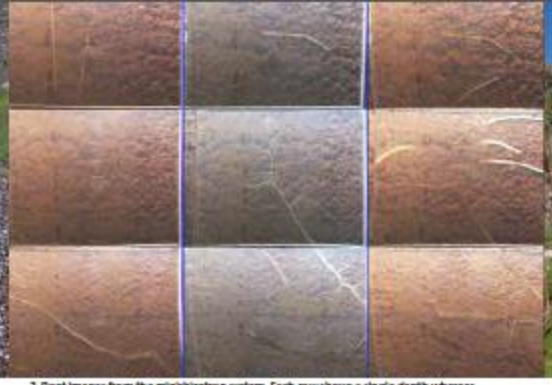
By comparing relative growth rate under control and stress conditions an index of stress tolerance is calculated. To date 17 rootstock genotypes have been screened against low soil water availability and against high soil conductivity (photo 1). We expect to publish these results in the coming months, following some additional validation work.

Root phenology - the impact of reduced irrigation and nitrogen

Both water and nutrients enter the tree primarily through the root system. Typically a fresh, white root is thought to have a much higher ability to absorb nutrients than a brown root and a woody root will absorb little water or nutrient. In almonds we have little idea how much difference there is between such roots, fine roots of different ages or between different classes (diameters) of fine root. We also have poor information on what proportion of fresh root is produced in spring relative to the rest of the season. We can use the term phenology for the root system, just as with the above-ground growth of the tree, and, by improving our understanding of fine root phenology in the orchard, we hope to improve the way that water and fertiliser is applied, resulting in an improvement in water and nutrient use efficiency.

To this end, the project has been collaborating with staff at the Department of Economic Development, Jobs, Transport and Resources (DEDJTR) Irymple and with CMV Farms. DEDJTR have been running a factorial trial with reduced water and nitrogen application in a CMV Farms orchard at Lindsay Point (photo 2).

2. Irrigation and nitrogen trials at CMV Farms Lindsay Point



3. Root images from the minirhizotron system. Each row shows a single depth whereas each column shows a different point in time.

4. The outdoor pot experiment at bloom.

5. Manufacture of soil amendments from waste at Select Harvests Carina West.

As part of that trial we have been monitoring fine root production and growth using a minirhizotron camera system (see previous article in Dec 2016 issue), which allows us to track roots over time in the soil without disturbance.

Whilst the minirhizotron system provides information on root growth and phenology, it doesn't give us a good assessment of the actual amount of root present.

To establish this, the minirhizotron work has been paired with soil coring during tree dormancy. Roots are extracted from these cores, allowing root length density and biomass to be estimated per unit volume of soil. In addition we are monitoring whole tree water use with a sap flow measurement system. This data is then tied to the spur productivity and orchard production data being collected by DEDJTR.

The minirhizotron and soil coring work has been running at CMV farms for almost four seasons, with one season of data collected prior to the irrigation and nitrogen treatments being applied and the third consecutive season of treatments currently underway. This has resulted in tens of thousands of images, which the project team is currently working through to produce detailed information on root growth patterns and the effects of water and nutrient availability on those patterns (photo 3).

Root function – the link with phenology

Improving our knowledge of root phenology will tell us when the most active roots are present, the proportion of all fine roots which are active and to what extent active roots might appear post-harvest, but basing irrigation or fertigation decisions on that knowledge still relies on assumptions about which roots best take up water and nutrients. The third component of our project is linking more detailed investigation of root function, specifically how different roots vary in their ability to take up nitrogen, with phenology in the field to model whole system nutrient uptake.

This work is using short-term glasshouse experiments, where root systems can be dissected and their constituent parts examined, and whole season outdoor experiments using grafted trees in large pots (photo 4). At present all of these experiments are utilising a stable isotope of nitrogen (15N) to quantify nitrogen uptake in different parts of the root system and to trace the speed and transport of that nitrogen through the tree. 15N is a naturally occurring, harmless, non-radioactive isotope that makes up 0.4% of the nitrogen in the atmosphere and has the same chemical properties as the more common 14N, that makes up 99.6% of the nitrogen in the atmosphere. Nitrogen fertiliser with a high 15N content (10%) is fed to the trees, following which shoot and root samples are taken and analysed for their 15N content with a mass spectrometer.

At the time of writing, a large glasshouse experiment has been completed which utilised a range of rootstock:scion combinations and followed uptake of nitrogen over a period of ten days following a fertiliser application. The resulting tissue samples, including different root classes, are currently being processed and analysed. This experiment allows us to not only examine the rate and amount of N taken up by different roots, but also whether this differs by rootstock or is influenced by scion variety.

The outdoor pot experiment is also underway, with the second of three fertiliser applications high in 15N planned for the 2018/19 season having recently been completed. Again, root and leaf samples are currently being processed for analysis. The primary aim of this experiment is to examine how tree phenology alters root nitrogen uptake and the role that root age plays in this.

Ultimately, we will combine the knowledge gained on the potential nitrogen uptake of root classes at different times of the season with the knowledge of the proportion of the root system that falls into these classes from the minirhizotron work to produce predictions of whole tree potential nitrogen uptake at different times during the season, which can be used to further optimise current fertiliser regimes.

Field application of the research

The final component of the work is to apply all the knowledge gained as new management regimes in a commercially managed orchard. At present we are intending to centre this on nitrogen fertiliser use. To this end, the project is collaborating with Select Harvests at Robinvale who are trialling a soil amendment manufactured from orchard and processing plant waste (photo 5). The project team are monitoring any changes in the soil and their impact on the tree root systems.

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Hort Innovation new strategy

Hort Innovation is calling out to industry stakeholders to get involved and provide their input on the direction of its new corporate strategy.

Under the leadership of new CEO Matt Brand, a national roadshow of consultation workshops is now underway across Australia, visiting all states and territories, concluding in April.

Mr Brand said these workshops offer the opportunity to learn more about how Hort Innovation currently works to invest levy funds, and to freely discuss views and ideas on how it can be done better in the future to meet the needs and priorities of the sector.

"We are inviting our members, levy payers, industry bodies and horticultural growers nationwide to take part in consultation workshops that will help to determine our new strategic direction," he said.

"As the grower-owned Research and Development Corporation for the Australian horticulture industry, it is the task of Hort Innovation to invest levy funds into research, industry development and marketing projects that will grow the hort industry in both domestic and international markets.

"The new strategic plan will strengthen the way our organisation works from the top down – and we want to ensure that our growers are at the forefront of the new strategy."

The workshops are free to attend but registration is required. An online ideas portal has also been set up to allow anyone who cannot physically attend to provide insight and ideas into the strategy process.

The new corporate strategy will come into effect around mid-year, following the face to face workshops with growers, industry bodies, and incorporating online feedback.

All growers and industry stakeholders are encouraged to get involved and contribute.

Workshops began in early February and conclude on April 2 with one on the Sunshine Coast on April 2. You can participate by filling in the four question survey on the Hort Innovation website: www.horticulture.com.au

Hort Innovation