Cover crops for soil health and productivity

Funded by Hort Innovation's Almond Fund, two trial sites to investigate the real-world effects of cover crops in almond orchards were sown in May 2023:

- **Loxton (ACE, SA):** sandy soils, 266 mm annual rainfall
- **Darlington Point (NSW):** heavier soils, 400 mm annual rainfall

These trial sites are different in many ways; soil and climate being those most prominent. As a consequence the constraints growers are working with are different for each region. For example poor soil structure makes the mid-rows impossible to drive through after rain at Darlington Point, whereas moisture does not stay long in the soil at Loxton. Despite these differences, cover crops can be beneficial in both contexts.

At each site there are five treatments:

1. **Herbicide control**. Bare earth with no cover crop. Standard practice for most growers.

2. **Legume mix** (medic, clover, vetch). Pure nitrogen fixers. No grasses or other plants.

3. **Medic/rye/clover mix**. Annual rye has a deeper root system than the N-fixers but dies off (senesces) in early summer.

4. **Pollinator mix**. Lots of brassicas and a couple of legumes (clover/vetch).

5. **Barley/vetch/radish mix** (at the ACE orchard) and **'big blend'** mix at Darlington Point consisting of a chicory, vetch, plantain radish, brassica, rye, clover, quinoa and oat. Treatment five was altered because the Riverina site could handle more water demanding species.

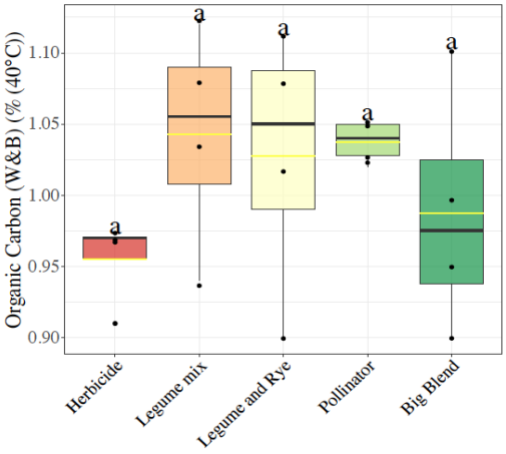

Figure 1: Darlington Point soil organic carbon from the mid-row in March 2025.

Data collection and results

Data is collected on nut production, soil nutrient content, water use, soil temperature, canopy temperature and tree stress. In the most recent sets of data collected, we haven't seen any meaningful differences among the treatments. Changes are slow to accumulate in soil.

Figure 1 shows the soil organic carbon (SOC) concentration at Darlington Point in the mid-row. You can see there are no significant differences and a lot of variation, but a trend where cover crops do build more carbon than the control may begin to be observed. As we continue to collect more data this should become more visible.

Figure 2 shows the daily rate of warming for the first two hours after sunrise. There are subtle but significant differences among treatments. As you might expect – as the sun rises, soil with a ground cover doesn't absorb as much heat as bare earth, keeping the canopies cooler for longer at the start of the day. The bare earth control has the highest rate of daily warming. It is possible that this might influence water usage, or phenology of the trees. The limitation here is the size of a research trial: we're missing the cumulative effect that could be seen on a larger scale. Whole orchards with cover crops throughout would likely see an even greater cooling effect of the canopy than we can detect at the ACE trial site.

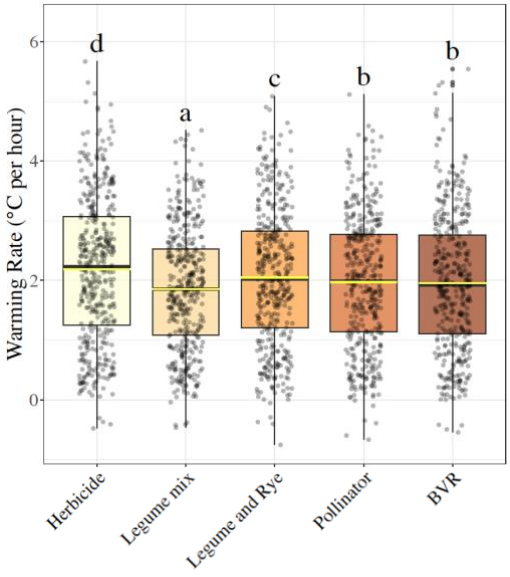

Figure 2: Daily warming rates (degrees per hour) from sunrise to two hours post-sunrise at Loxton, SA.

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There have been no changes to soil nutrient and carbon content driven by cover crops at this stage, though as the trial matures, we may be able to draw a clearer picture around what is happening.

In Figure 3 you can see the mineral nitrogen species, nitrate and ammonium, from the soil in the mid-row of the Darlington point trial. As with Figure 1, no strong pattern has emerged, but the herbicide does have the lowest average of all treatments, which is what we would expect with cover crops. Higher organic soil carbon allows for better retention of soluble nutrients such as these.

Challenges and Next steps

In the coming months, we will install microtensiometers at ACE that measure water stress 24/7. Combining this with canopy temperature and humidity, as well as soil moisture and temperature, we're hoping to capture the right data to answer whether cover crops are influencing tree water use efficiency.

Cover crops have a hard time in almond orchards – they're slashed, sprayed and graded. They only cover half the surface area, and they're shaded by the almond trees. As a consequence, our expectations for how these plants will change the soil and its properties needs to be realistic. For maximum effect, cover crops need enough water to establish and reach maturity. Ideally, they should be allowed to set seed for next years' cover crop. For the legumes such as the medic species, lignification of the stems at seed set will also slow the breakdown of the residual plant matter, allowing it to act as a mulch for longer (most advice encourages early termination prior to seed set, thus leading to more rapid breakdown and nitrogen release). With a clear understanding about what can be gained from a cover crop, growers can more effectively manipulate their management practice to maximise its outcomes.

All of these considerations will go into the economic modelling phase of the project next year, where we will compare each treatment's long term economic outcome against the others.

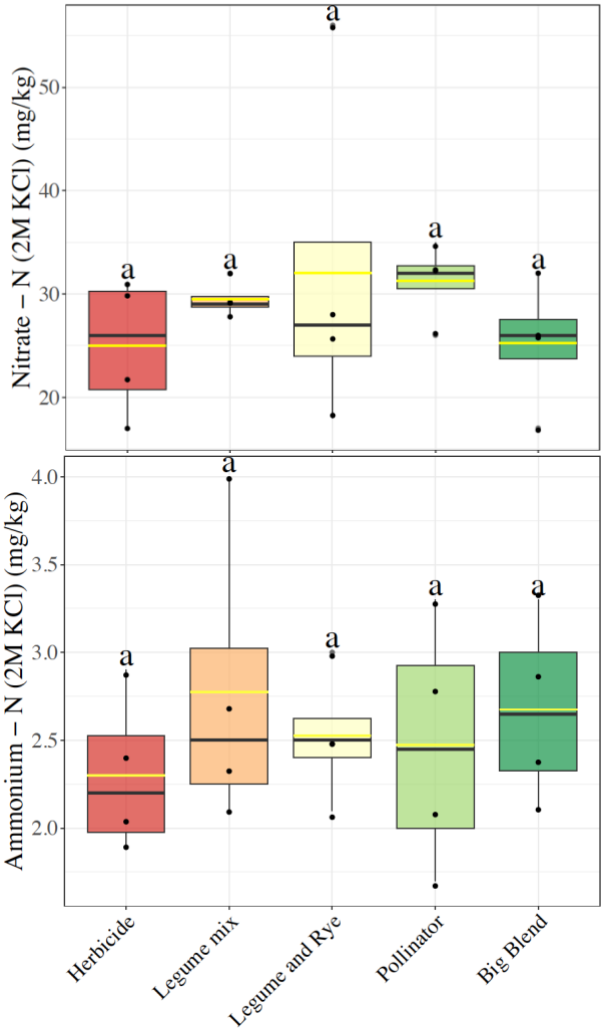

Figure 3: Mineral nitrogen in mid-row, Darlington Point soil, March 2025.

Acknowlegements

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