

Case Study – Cover Cropping in the Avocado Inter Row, Meadowvale, Queensland, 2021-22

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Farm snapshot

Orchard planted: 23/9/18

Row spacing: 9 x 5

Variety: Haas

Total number of trees: 4,891, 22 Ha, 135 rows

Location: Meadowvale, Queensland

Soil type: red loam, grey loam

A bit more about the grower

Clinton Scott manages his orchard according to a number of key principles:

- Reducing and replacing chemicals.
- Soil health, with mulching and composting. Through time this work has moved to include the inter row, not just the trees.
- Integrated Pest and Disease Management, with monitoring, biocontrols and a focus on taking care of and increasing the presence of beneficial insects, including generalist predators and pollinators.
- Certification to clearly demonstrate to buyers his commitment to a sustainable farming system.
- Diverse vegetation in the inter row. Clinton seeded with a grass seed mix several years ago (signal grass, Rhodes grass, barley, couch). Signal grass established well but has become a dominant ground cover to the

exclusion of all other species (Image 1).



Image 1: Signal grass provides ground cover but is dominant in the avocado inter row. March 2021, prior to commencement of the trial.

This document has been prepared in consultation with Clinton Scott, for the purposes of sharing his experience with other avocado growers.

Goals for the trial

Increase plant species diversity

- Can additional plant species be incorporated into inter row vegetation, which is currently dominated by signal grass? Signal grass provides ground cover and some organic matter but otherwise minimal ecosystem services. It is also a very dominant species, to the exclusion of others. Improvement of the inter row with flowering species for beneficial insects is a high priority.

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Soil health

- Typical of many orchards in this region, the soil specifically in the inter row has a mix of features. Can cover crop species be selected for progressive overall improvement of soil health there?

Potential challenges associated with inter row cover cropping in the avocado orchard inter row

Cover crop establishment

- Establishment of ground cover in the inter row in this region and this soil type can be challenging.
- Species that can be selected from conventional “cover crop” species suited to the conditions are limited.
- Soil moisture in this region relies on irrigation for year-round consistency and the inter row is often dry. No additional irrigation is available for the trial.

Cover crop strategy

Improving vegetative diversity

This trial employed a general strategy of increasing ecological complexity and biodiversity in time and space on-farm in order to secure a range of ecosystem services for soil health, pest regulation and pollination.¹ Specifically, the trial sought to increase plant species diversity in the inter row throughout the orchard for an entire year with a series of seasonal cover crop seedings.

The limits of the inter row in terms of regional soil moisture and soil type being well understood, a decision was made to seed directly adjacent to tree-mounds. This was within sprinkler range and where

soil health has had sustained attention for the benefit of the crop.

A single strip was seeded for each row, leaving the alternate side of the tree unseeded.

The cover crop trial was to be achievable with seasonal rain, plus existing irrigation infrastructure and water allocations. This included sprinklers along the tree line, with a reach of around 2m into the inter row.

Opportunities for successive seasonal seeding were to be utilised to work consistently on improving plant species diversity.

Trialing different seed mixes across the year would also provide an opportunity to observe performance and pick winners, given the challenging conditions.

As per conventional orchard design, the centre has a v-drain. This area was not seeded with cover crops, instead being left unchanged with existing signal grass.

Soil health

A major challenge for this trial is in cultivating and sustaining diverse ground cover species in the inter row, given regional precipitation and soil types. Soil health in the inter row is a necessary precondition for success with cover crops there, rather than an inevitable consequence. The trial sought to identify a range of species that are suited to the conditions and can contribute to improving ecosystem services.

There are numerous well understood benefits for soil health associated with cover crops.² As a bare minimum they will

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improve ground cover and prevent soil loss. They can greatly increase the production of bulk organic matter on-farm for incorporation into mulching and composting. Diverse living roots in the soil year-round can also add a number of soil health benefits including mitigation of compaction, stabilisation of aggregates, and more.³

Pest regulation

There is good evidence that cover crops will benefit generalist predators and parasitoids, which can help to suppress pests of the crop.⁴

Pollination

Incorporating cover crops into the inter row can improve pollination and provide pollination security.⁵

Screening the seed mix for risks, practicality & value

Species suitable for the seed mix were drawn from standard commercial options currently available as cover crops. They were also screened against:

- Pest reservoir - a number of commonly recommended cover crop species can host Green Vegetable Bug (GVB), which is a pest of many crops, though not currently an issue for this orchard. To avoid a build-up of GVB in the orchard it is recommended that large pod forming brassicas and legumes are kept to under 20% total of the seed mix.
- Weediness and/or dominance - brassicas are especially well adapted to making the most of difficult orchard inter row environments. Where there are excess nutrients from chemical fertilisers they will perform especially well, potentially working against the objective of diversity. They can also

set a lot of seed, with a potential future risk for weediness. For this reason, brassicas are recommended at a rate of not more than 5% total of the seed mix.

- Suitability and practicality for standard inter row management. For example, high-growing sunn hemp and sorghum were not included for this farm. These species can grow to well over 2m over many months. Height could obstruct access to the trees while bulky and woody residues would be challenging to manage with available machinery.
- Market availability.
- Value for money.

Seed mix #1 Autumn 2021 (recommended by a commercial supplier, not the project team).

- Vampire Ryecorn 15%
- Brunswick Oats 20%
- Woolly Vetch 10%
- Tillage Radish 5%
- Trit/pea 15%
- Clover 5%
- Mustard 5%

Seed mix #2 Spring 2021

- Wynn Cassia 5%
- Pensacola Bahia Grass 20%
- Commander Chicory 10%
- Captain Plantain 5%
- Teff Grass 10%
- Ryecorn 15%
- Shirohie Millet 20%
- Buff Cowpea 15%

Seed mix #3 Autumn 2022

Option 1

- Safflower 5%
- Smart Radish 5%
- Stylo Caribbean 15%
- Triticale 75%

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Option 2

- Chicory 5%
- Mustard 5%
- Field pea 15%
- Ryecorn (forage) 75%

Irrigation

Irrigation was an important consideration during the set-up of the trial. The previous summer had been hot and dry. Orchard inter row cover crop trials on other farms had struggled under these conditions.

No additional irrigation was made available in the inter row for the trial. The trial relied on existing sprinklers already in place along the tree-line.

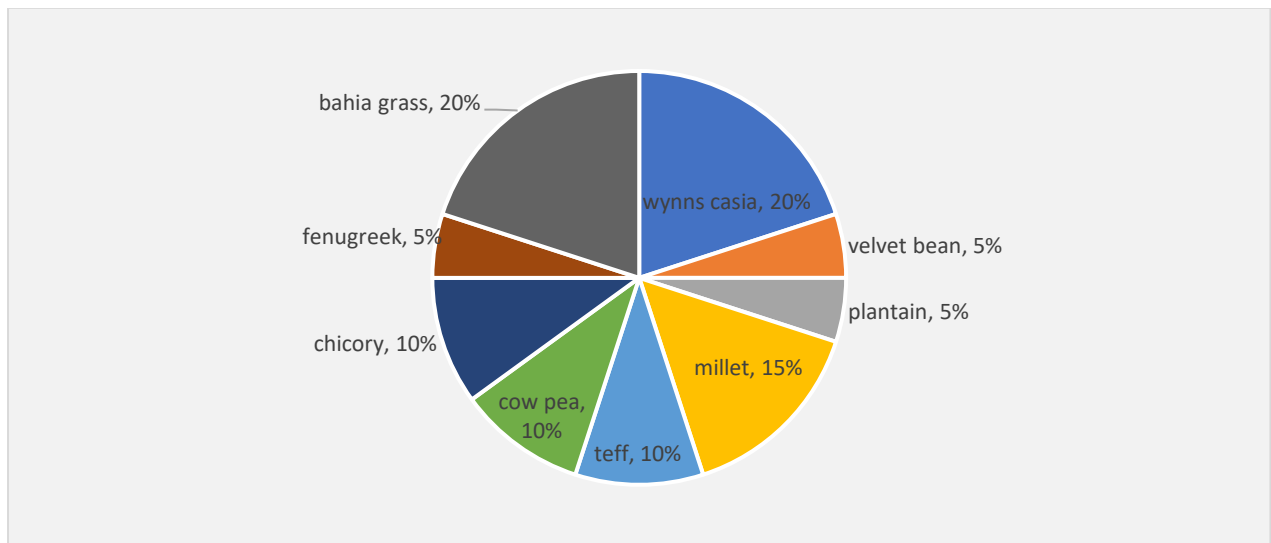


Image 2: Seed mix # 2, Spring 2021

Machinery and ground preparation

Seeding for this trial was done with a Network Seeder - linkage drawn, direct drill, double disc, open roller, single box, 1.4m wide (Image 3).



Image 3: The Network Seeder is 1.4m wide.

Network Seeders were made available free of charge by BioResEd for trials for growers located in the NSW northern rivers, Gympie and Bundaberg regions.

The trial was designed to be achievable with existing machinery and the growers' preferred inter row management practices in place for the life of the trial.

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Ground preparation for this trial as follows:

1. Signal grass mulched to 100mm.
2. Direct drill seeding in strips into mulched signal grass.
3. Signal grass mulched a second time, to the ground and covering the seeded area.

This took place over several days.

Timeline

March 2021 (Images 4 & 5, below)

Prior to commencement of the trial, there is conventional orchard floor management in place. Signal grass is dominant, with some weeds also present. It is slashed regularly directly adjacent to the trees.

Predator & parasitoids were present, although in low numbers.



Image 4: March 2021

Fruit spotting bug nymphs were found in some parts of the orchard with visible damage. Some of the weeds hosted parasitoid wasps and assassin bugs.



Image 5: March 2021, prior to seeding, beneficial insects including wasps are observed visiting inter row weeds.

May 2021 (Image 6, below)

Seed mix #1 has been seeded. Instead of slashing adjacent to the trees, as is typical with conventional management, this area is now being utilised for cover cropping, because soil health is good and existing sprinklers reach this area.

The centre strip sustains existing signal grass, which is on a reduced-slash program.

Early emergence of the seed mix is evident.

This seeding coincided with a general increase in rainfall, after several dry years.



Image 6: May 2021, early emergence of the seed mix.

July 2021 (Image 7, right)

There is good establishment and growth for:

- Tillage radish
- Trit/pea
- Woolly vetch.

The trial is beginning to achieve an increase in plant species diversity. In terms of functional ecology, the success of just these three species brings new benefits to the orchard for:

- *Soil health* – the root structures of tillage radish and vetch are recognized for working on compaction, especially when growing in tandem.⁶ Furthermore, with two legumes (vetch and pea) active, there will be nodulation and N fixing.
- *Resources for beneficial insects* – By introducing additional species into the inter row, a range of new resources are now available for pollinators, parasitoids and generalist predators –

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Shelter, Nectar, Alternate prey and Pollen (SNAP).⁷

Signal grass is maintained in the centre strip where irrigation does not reach.

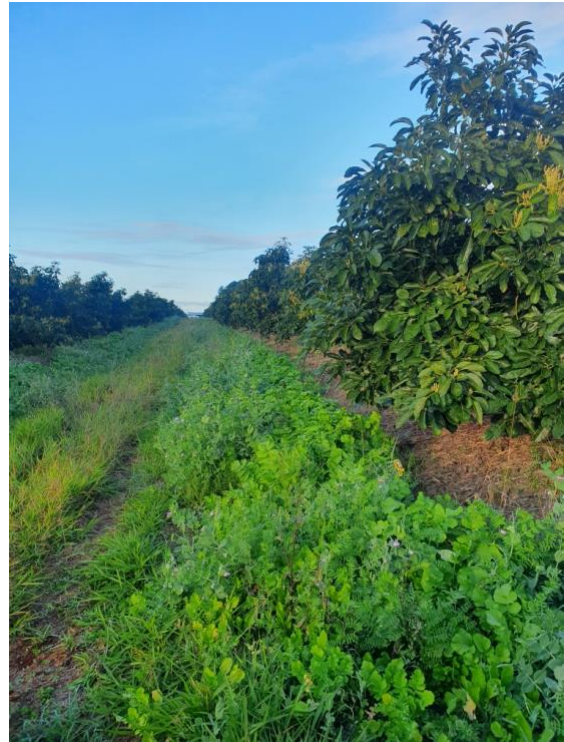


Image 7: July 2021, Tillage radish, Trit/pea and Woolly vetch are especially vigorous.

August 2021 (Image 8, below)

From July through to August there has been ongoing and increasing flowering in the inter row. By August, tillage radish is flowering very heavily. This is observed to be highly attractive to bees, which are visiting the orchard in good numbers. This coincides with flowering in the avocado trees. Good fruit set reported.



Image 8: August 2021, tillage radish in heavy flower and attracting bees into the inter row.

October 2021 (Image 9 right)

Seed mix #2.

Tillage radish in seed mix #1 has done very well in this inter row, growing vigorously and flowering prolifically. There have been benefits both below and above the ground, as discussed above. The tillage radish has started to set seed, and before this reaches high volumes, it is decided to slash and reseed with summer active species.

Brassicacae, including tillage radish, often do very well in the early years of cover cropping. For this reason, it is recommended that their incorporation in a mix does not exceed 5% - there is a risk for weediness. Likewise, it can be prudent to slash prior to maturity to limit the amount of seed that will transition into the seed bank. With slashing, the living root will remain in the ground and the plant can become biennial.

In October a seed bed is prepared, once again in alternate rows adjacent to the trees, with a slash chop and drop.



Image 9: October 2021, ground preparation for spring seeding.

November 2021 (Image 10 below)

For seed mix #2 there is good establishment for chicory within a month of seeding.

Like tillage radish, chicory is characterised by a powerful tap-root, which can bring physical and chemical actions into the soil of the inter row. These are in turn favorable for beneficial soil biology.

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Image 10: November 2021, chicory is quick to establish.

April 2022 (Image 11 below)

The seed strips have been slashed several times to slow down the chicory and provide an opportunity for better establishment of other species in the mix.



Image 11: April 2022, chicory continues to thrive.

Despite this intervention, other species in the mix have not established strongly. Meanwhile tap-rooted and biennial chicory continues to thrive. Its success sustains improved diversity of living roots in the ground. But like tillage radish, and signal grass, it has become very dominant in the mix.

May 2022 (Image 12 below)

A number of different seed mix options are considered for autumn planting. With harvest preparation approaching and a number of issues to be reviewed for “next steps” for inter row vegetation, it is decided to wait for spring 2022.

Existing vegetation in the inter row is slashed, chopped and dropped, to prepare a bed for compost.



Image 12: May 2022, slash, chop and drop.

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Results and discussion

This trial commenced just as a prolonged dry period of several years concluded. It was well understood that establishment of a cover crop would be difficult under these conditions.

For each seed mix, establishment and subsequent growth through to maturity in the season included strong successes and also failures for specific species. Seed mixes were reviewed on this basis and for the forthcoming season.

Seed mix #3 did not go ahead: the reasoning being that a number of biennial species were doing very well and did not require reseeding (tillage radish, chicory), while others had failed and were not suitable for the site at this time.



Image 13: During the life of the trial Clinton purchased a roller to lay down vegetation strips and allow for re-seeding and tree access while leaving living vegetation in place.

It was decided that further consideration of options for composting in the inter row, ground preparation, management of signal grass, dressing seed, and cover crop species selection would be reviewed before future seeding would occur.

Success with establishment was contingent on trialling and reviewing a number of different approaches to ground preparation. The recurring challenge for this orchard was the very dominant growth of signal grass, which would eventually out-compete with most of the cover crop species.

Utilising existing irrigation and capitalising on hard work already done on soil health along the tree line paid off for this trial.

Overall, the trial achieved its objective of improved plant species diversity, with good results for tillage radish and chicory, in particular, which can be built upon. With each of these species being biennial and providing high value in terms of functional ecology, this represents a good return on effort and investment by the farmer.

Consistent results for sustained and increasing species diversity were more difficult to achieve. Seeding for diversity was characterised by cycles of boom for a few strong performers in the mixes and bust for many others.

Farm-by-farm and season-by-season, it is difficult to anticipate which species will thrive, and by contrast, which may fail. Indeed, this is one of several reasons for “mixes” generally and the blend of species selected specifically.

Sustained roll-out of a number of complimentary practices on this farm is

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paying off for biodiversity overall. This can contribute to farm productivity and sustainability. Observations collected during the life of the trial provide evidence for spider and bird populations in the orchard, both of which can contribute to an IPM program (Images 14a & 14b).^{8,9}



Image 14a: There were good indicators for biodiversity in the orchard during the life of the trial, with birds nesting in the orchard.

Conservation biological control

An initial survey found a range of beneficial insects including spiders, dragonflies and parasitoid wasps in the avocado trees. There was not much insect diversity in the signal grass. Certain weeds however were host to several wasps, assassin bugs and various fly species.



Image 14b: Spiders are completing their entire life-cycle in this orchard (spiderlings, above).

By August 2021 the cover crops grew well and had an abundance of nectar, prey and resources to build up the beneficial insect population. The alignment of cover crop flowering alongside avocado flowering will have increased the overall fitness of parasitoids and pollinators such as hoverflies. The impact of this warrants further investigation.

In a crop with limited vegetative diversity, it is easier for pests to proliferate. The additional cover-crop mix with small white flowers is ideal for hoverflies and parasitoid wasps.

One of the major predators of fruit spotting bug (FSB) are spiders. With good flowering diversity in the cover-crop during flowering, a much larger population of spiders will be sustained through the season, which will act in synergy with the release of *Anastatus*

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wasps (egg parasitoids) to control FSB during fruiting. (Images 14b & 15).

Over time the insect diversity will build up especially with having more compost from slashing, which will increase predators like beetles, that were in very low numbers at the start of the trial. Fly larvae and various other soil dwelling arthropods will provide an ongoing food source to spiders through-out the season so they can prey switch to pests of avocado. With more predators and parasitoids in the crop, there are less places for pests to hide and the combined effect of predators and parasitoids are more than the individual impacts alone.¹⁰

Conservation biological control is a slow process, but in combination with *Anastatus* releases we are likely to see this increase each season with the continuation of cover crops in the inter-row.



Image 15: March 2021, spider eggs in the avocado trees.

Next steps

Machinery

- Ongoing trialling of machinery for inter row management.
- Aiming for less traffic and weight overall in the inter row.
- A speedling operation may be a good option for better establishment success for some perennial species.

Seed mix selections

- Most conventionally recommended cover crop species are not well adapted to sub-tropical environments. More suitable species are available but have not been trialled as orchard cover crops – eg., safflower, stylo, *Desmanthus*, Kalonji, black sesame and so on.
- Investigating options that represent value for money and are commercially available.

Rats

- Ongoing integration of rat management program with inter row management decisions.

Soil health

- The cover cropping program will be more strongly tied to soil moisture and soil temperature regulation. This will relate to species selection and their management through time.

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