South West NRM

Case Study

Using interrow cover crops for avocado pollinators

Interrow cover crops are typically used in fruit orchards to improve or protect soil. However, they can also be used to attract beneficial insects for crop pollination and pest management.

The main pollinator of fruit crops is the European honeybee. However, visitation by honeybees to avocado flowers tends to be poor due to its low nectar quality. For avocados, flies are considered to be the second most important pollinator behind honeybees.

To increase flower visitation by all pollinators, South West NRM engaged Seven Days Farm to trial the use of interrow cover crops at three Manjimup avocado orchards in 2022. The aim was to support a wide range of pollinators and other beneficial species with nectar and pollen at all times of year, not just during avocado flowering.

To achieve this, a multispecies cover crop that can provide flowers over extended time periods was trialled.

The effect of the cover crops on avocado pollination was investigated by conducting insect surveys and fruitlet counts (fruits did not mature before the project ended). An economic analysis of cover cropping was also conducted.

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Control row.

Trial sites

Three avocado orchardists were engaged near Manjimup, which has a Mediterranean climate. The rainfall is winter-dominant with an average of 870 mm per year (1991–2020). Mean minimum and maximum temperatures range from 7–15°C in July, to 14–28°C in February.

- **Site 1** – a north facing block at Crowea with 200 trees in 16 rows on dark sand and karri loam over kaolin clay soils. Interrows consist of kikuyu grass, milk thistles, winter grasses and white clover.
- **Site 2** – a north facing block at Jardee with 1288 trees in 28 rows on well-drained gravelly karri loam soils. Interrows consist of kikuyu grass, winter grasses and white clover.
- **Site 3** – a south-facing block at Deanmill with 250 trees in 15 rows on karri loam soils. Interrows consist of winter active lucerne (Sardi 7) and clover.

Figure 1. Site 3 from the air showing pairs of Treatment (cover crop) interrows and Control interrows, with the Treatment and Control avocado trees separating paired interrows. Taken October 2022.

Establishing the interrows

The pasture species chosen for the trials were based on a "Pollinator Mix" sold by local seed supplier Bells Pasture Seeds (Table 1). The mix was sown at 25 kg per hectare, equating to 2.5 kg per hectare for each species. At Site 3, an additional 3 kg per hectare of buckwheat was included in the mix.

The mix was sown on both sides of three rows of trees at each site (Treatment rows; e.g. Figure 1). These were separated by two control interrows where standard management was practiced. Insect surveys and fruitlet counts were taken from the row of avocado trees between two Treatment interrows and two Control interrows, so were conducted no more than 20 metres apart.

Seeds were sown with a double run of the seeder, up and back. However, at Site 2, a second treatment (Treatment 2) was included where only a single run of the seeder was used.

All sites used a double knockdown to control weeds except Site 2 which had a single knockdown due to windy conditions. Remnant kikuyu at Site 2 was mown as low as possible before sowing.

The sowing date of April/May was relatively early to give the pasture mix enough time to germinate and establish before colder winter days reduce growth rates. Also, early sowing ensured late-maturing varieties flowered during avocado flowering rather than after. All sites applied fertiliser before and/or after seeding based on soil testing.

Seeding machinery varied between sites. Site 3 could not fit large-seeded species through the seeder box, so these were broadcast and rolled in.

Pasture species	Seeds per kg	Growth observations	Aug	Sept	Oct	Nov	Dec
Black mustard	360,000	Dominant, fast growing to 2m					
Chicory	700,000	Grew in summer. Flowers after December					
Ryecorn	70,000	Low abundance					
Field peas	5,000	Low abundance					
Common vetch	18,000	Low abundance					
Crimson clover	265,000	Prolific flowering in spring					
Balansa clover	850,000	Prolific flowering in spring					
Persian clover	1,400,000	–					
Medic	350,000	–					
Messina	–	Did not appear					
Buckwheat	33,000	Did not germinate. Too cold					

Table 1. Pasture species sown with growth notes and observed flowering times. Higher seeds per kilogram indicates smaller seed size. Dark green cells indicate full flowering period with lighter green indicating partial flowering. Avocados were in full flower in October and November, and partial flower in September and December. No observations were made after December.

Pasture establishment and growth

The mix contained a high number of the smaller seeded pastures (Table 1), which meant that the larger seeded pastures, with fewer seeds per hectare, were less common. The dominant species at germination across all sites was black mustard. Peas and vetch were sparse but evident. Clovers were less evident but present at Sites 2 and 3.

At Site 1, clovers were only seen where the sowing depth was shallower. Ryecorn was detected but not abundant at germination. Chicory and messina were not detected at germination and seedling-stage at all. Buckwheat was not detected, most likely due to being too cold for it to germinate.

Some pest damage was evident at all sites on emerging seedlings. Pests included slugs, redlegged earth mites and beetles. Pesticides were not applied at Site 1 or 2, but were at site 3 to control African black bettle.

By July, the main difference between Controls and Treatments at Site 1 and 2 was the presence of black mustard, which likely impeded the establishment of other species in the mix. Site 3 was relatively similar between treatment and control, with clover and lucerne common to both. Lucerne was not sown in the cover crop mix but was previously established in interrows by the grower and came back despite weed management.

Pasture	Site 1		Site 2		Site 3	
	T (%)	C (%)	T (%)	C (%)	T (%)	C (%)
Black mustard	23		23		9	
Clover				4	25	25
Ryecorn					9	
Lucerne					20	17
Kikuyu				37		2
Annual ryegrass		11		4		5
Winter grass		12		4		5
Other	28	19	28	1	36	20

Table 2. Percent pasture composition. T=Treatment, C=Control

Cover crop dominated by black mustard to two metres in height.

By September, the Treatments tended to have 1–2 tonnes of dry matter per hectare more than the Controls. At Site 2, where an additional treatment was seeded with a single run compared to a double, there was an extra 0.8 tonnes of dry matter per hectare compared to the Control, whereas the double run had an extra 2.3 tonnes.

Flowering of cover crop species was staggered (Table 1) and there was a significant cross–over with avocado flowering which was concentrated in October and November. Field peas were the earliest flowering but were declining in numbers as avocado flowering increased. Black mustard and vetch commenced flowering before avocados but with significant crossover in October. Crimson and Balansa clover flowered prolifically at the same time as avocados, while Persian clover was later flowering. As avocado flowering declined, lucerne went into flower at Site 3.

There was very little pest damage or presence during the trial other than black beetle and snails. With consecutive years of interrow plantings, snails may become an ongoing problem as they breed where there is abundant groundcover. Strategic mowing during spring and autumn may help to reduce numbers if they build up.

Surveys

Insect surveys suggest that the cover crop increased both the number of insect species and the total number of insects. Table 3 shows insects identified from the main flower-visiting orders, Diptera and Hymenoptera. The main difference was small flies, which could not be identified lower than the order (Diptera). Known avocado flower feeders such as Calliphora species and hoverflies were trapped in Treatment but not in control rows, but only in relatively low numbers.

This result is supported by observations that, upon entering the Treatment rows, the noise from insect activity was clearly audible. By comparison, the control rows were almost silent.

Common name	Scientific name	Site 1		Site 2		Site 3	
		T (%)	C (%)	T (%)	C (%)	T (%)	C (%)
Fly	Anthomyiidae					1	
Fly	Bombyliidae					1	
Fly	Calliphora albifrontalis			1			
Fly	Calliphora augur					1	
Fly	Chrysomya rufifacies			1			
Fly	Musca sp.	1	2	13	3	53	
Fly	Muscidae	1				3	
Hoverfly	Melangyna viridiceps					2	
Hoverfly	Simosyrphus grandicornis					1	
Hoverfly	Melangyna sp.			3		4	
Fly	Scaptia sp.	1				1	
Fly	Tachinidae	4	1	1			
Fly	Ceratitis capitata			1			
Robber Fly	Anabarhynchus sp.					1	
Fly	Tipuloidea	3					
Flies small	Diptera			129	11	575	45

Common name	Scientific name	Site 1		Site 2		Site 3	
		T (%)	C (%)	T (%)	C (%)	T (%)	C (%)
Mosquito	Diptera	17	13	6	3	17	2
Flying ant	Hymenoptera			1			
Honey bees	Apis mellifera	1	15	6	18	18	13
Native bee	Callomelitta antipodes						1
Native bee	Euryglossa jucunda	8	7	1	1	22	
Native bee	Hylaeus sp.	3					
Native bee	Hylaeus alcyoneus	2					
Native bee	Leioproctus sp.					1	
Native bee	Trichocolletes leucogenys	1					
Native bee	Lasioglossum sp.	1		3	2		1
Ichneumon wasp (tiny)	Ichneumonoidea			1		3	
Wasp	Tiphiidae	2				1	
Native bee (tiny)	Hymenoptera					4	
Total species richness		13	5	13	6	18	5
Total insects		45	38	167	38	709	62

Table 3. Insect species from the main flower-visiting orders, Diptera (shaded) and Hymenoptera, caught in pan traps at each site. T=Treatment, C=Control. Scientific name shows the lowest taxonomic classification that specimens were identified to.


Cover crop mix

Fruitlets counts showed no significant difference in fruitlet numbers between the Treatments and Controls (Figure 2). This may partially be explained by the small sample size, with counts only taken from a single branch on 6–7 trees per row. Also, given the proximity of the Treatment and Control rows, it is possible that any benefit from the cover crop may have spilled over into control rows. Bees can move for hundreds of metres, and flies likely further. Finally, it is possible that cover crops attract pollinators away from avocado flowers. However, pollinator surveys by Curtin University suggest avocado pollinators require flowers from a diverse array of species (both native and introduced) to enable them to persist in avocado orchards.

Given the above result, the economic analysis was not able to show whether there is an economic benefit from cover cropping. However, it does show that costs are minor compared to other costs such as packing, transport, labour and water.

The direct costs associated with cover crops ranged from 0.9% to 3.1% of income compared to 54.1% to 54.6% for packing, transport, water and labour. Also, co-benefits such as soil health and pest management were not considered.

Costs can be reduced by restricting sowing to a single run, as demonstrated by results for Treatment 2. Also, if any increase in pollinators does occur beyond the sown interrow as discussed above, it may be enough to sow a smaller number of rows in an orchard, or only sow on adjacent cleared areas.

An alternative to using cover crops on these adjacent areas is to use native flowering trees and shrubs. Or a combination of the two methods could be used to better provide flowers all year round to continually support pollinator communities.

Bees can move for hundreds of metres, and flies likely further...

Average fruitlets per branch

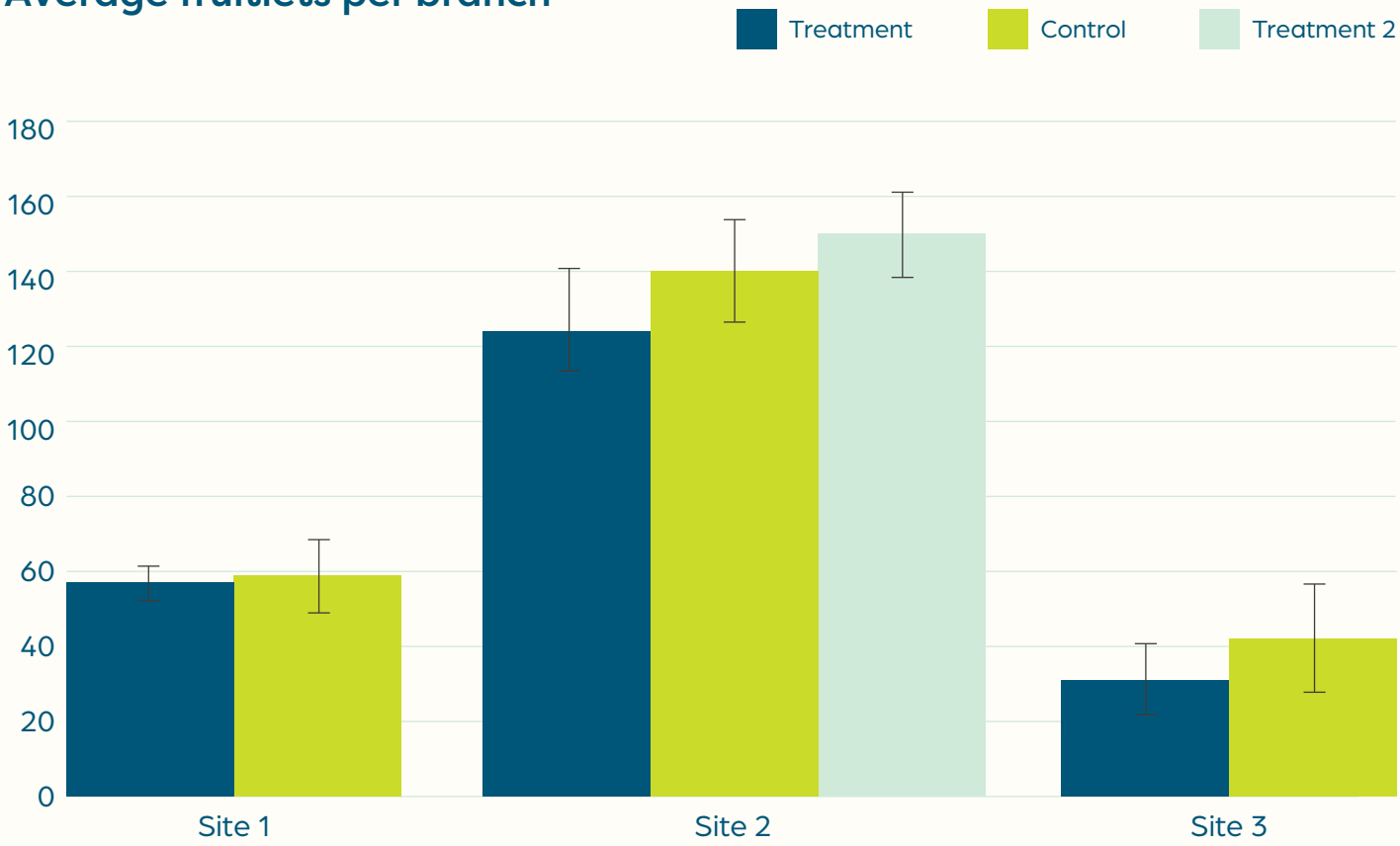

Figure 2. Average fruitlets per branch with standard error bars.

Summary

The size of seeds and competitiveness of species (size and growth rate) should be considered when designing a pasture mix, with more kilograms per hectare for larger seeded and/or less competitive pastures. The dominance of species such as black mustard will create unnecessary height and bulk to the sward, which may have adverse outcomes for orchard and pest management.

Direct costs associated with cover cropping were minor, within a range of 1–3% of income. Costs could be reduced by using a lower sowing rate (15kg/ha) or sowing in single runs instead of doubles.

It is not known if interrow cover crops distract pollinators away from avocado flowers. However, research from the same project by Curtin University indicates that pollinators use flowers from a diverse array of species (both native and introduced). As such, nearby flowers would appear to be more beneficial than detrimental.

Cover crop species can vary in the amount of nectar and pollen that they provide. While it is tempting to concentrate on nectar (energy) sources in a cover crop, pollen (e.g., from grasses) is a source of protein that is important to insects such as hoverflies. So, a mix of nectar and pollen is important.

Ensure seeds are sown at the correct depth to maximise germination and select species to suit your growing conditions and soil type so that they will persist for several years. Also, ensure best practice agronomy with soil testing to identify nutrient deficiencies, and weed and pest management.

Finally, consider the co-benefits from a cover crop. If you have other issues to address such as insect pests, soil erosion, soil structure, root disease, nutrient loss or water contamination, the overall cost-benefit of a cover crop will improve.

Photo credits: Stephanie Carstairs

Honeybee on mustard flower.

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This project is delivered by **South West NRM**, through funding from the **Australian Government's National Landcare Program.**