

Case Study

Establishment of Ground cover species in Apple Orchard

Trial Conducted by: Aimee Lister, AgFirst

Overview

We wanted to better understand if low-growing, perennial plants can be established as a ground cover in pipfruit orchards, as an alternative to a traditional ‘weed spray strip’. The weed strip area often has low light, poor soil structure, and with long-term herbicide use can result in low organic matter levels, poor soil biology and unfavourable soil organisms.

This trial looked at the establishment and impact of seven under-row ‘cover crops’ over a 9 month period.

Objectives

- To establish low-growing perennial species as a ground cover as an alternative to a ‘weed spray strip’ and determine the practicability and efficacy of this management practice.
- Improve understanding of the effect the perennial cover species may have on tree health and crop quality.
- Understand the effect the perennial cover species may have on soil health and biology.

Proposed benefits of under-row ‘cover crops’

- Improved soil health
- Erosion control,
- Help retain soil moisture,
- Increase organic matter,
- Provide plant exudates to ‘feed’ soil biology,
- Sequester carbon into the soil.

Site Details

Location	Brightwater, Nelson
Tree details	Mature 2D Breeze (Royal Gala) To allow greater sunlight, future-focused design
Rootstock	M9
Planting density	Intensive 2.5m x 1.4m
Soil type	Oronoko-f - Deep, well-draining loam over sand.



Equipment

Tilled soil under the tree using a row hucker



This narrow strip is a difficult area to fit machinery into. We wanted to cultivate right up next to the tree trunks without damage, and far out enough into the interrow space that we could cover the entire ‘weed spray strip’ – without disturbing the permanent grass sward.

A row hucker rear-mounted on the tractor was used. This has hydraulic movement to get close to the trees. Three tined discs on an 80-degree angle, were tilled 8cm into the ground. This depth was enough to establish a seed bed, without damaging any tree roots that were close to the surface.



Establishment Summary

Seed was sown in Spring and Autumn, to see differences in establishment.

	Spring	Autumn																								
	 <p><i>Figure 1 Spring seed bed, soil dry and compacted.</i></p>	 <p><i>Figure 2 Autumn seed bed, soil moist making it more friable.</i></p>																								
Tillage	Row Hucker	Row Hucker																								
Till Timing	During flowering – no obvious impact on flowering/tree stress																									
Passes	2 x passes - soil was dry	1 x passes – soil moisture ideal																								
Sow Timing	End October 2022	26th April 2023																								
Sow mix	Individual species sown separately No mixes	Individual species sown separately Some mixes																								
Sow rates	Heavy to ensure good coverage. These are not ‘usual’ sowing rates for normal practice.																									
	<table border="1"> <thead> <tr> <th>Species</th> <th>Sow rate</th> <th>Seed weight</th> </tr> </thead> <tbody> <tr> <td>Plantain</td> <td>10g/m²</td> <td>4,000 seeds/ g</td> </tr> <tr> <td>Sheep’s Burnet</td> <td>16g/m²</td> <td>140 seeds/ g</td> </tr> <tr> <td>Birds foot trefoil</td> <td>14g/m²</td> <td>2000 seeds/ g</td> </tr> <tr> <td>Common yarrow</td> <td>14g/m²</td> <td>1,700 seeds/ g</td> </tr> <tr> <td>Chicory</td> <td>10g/m²</td> <td>700 seeds/ g</td> </tr> <tr> <td>Strawberry clover</td> <td>10g/m²</td> <td>330 seeds/ g</td> </tr> <tr> <td>Alyssum</td> <td>14g/m²</td> <td>1,000 seeds/ g</td> </tr> </tbody> </table> <p><i>Figure 1 Source: https://greenharvest.com.au/SeedOrganic/SeedsPerGram.html</i></p>		Species	Sow rate	Seed weight	Plantain	10g/m ²	4,000 seeds/ g	Sheep’s Burnet	16g/m ²	140 seeds/ g	Birds foot trefoil	14g/m ²	2000 seeds/ g	Common yarrow	14g/m ²	1,700 seeds/ g	Chicory	10g/m ²	700 seeds/ g	Strawberry clover	10g/m ²	330 seeds/ g	Alyssum	14g/m ²	1,000 seeds/ g
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Post sowing treatment	Once sown clods left were broken up and raked by hand to ensure the seed was lightly covered. In an ideal situation, we would use a piece of machinery that could till then broadcast or air drill seed, then lightly rake and/ or roll soil – again the area is narrow, and this piece of machinery does not yet exist.	Not ‘raked’ over – may have led to less seed-to-soil contact, and therefore poor germination. This reinforces the fact that sowing seed in these areas means we must have a decent seed bed to begin with, and the ability to cover the seed if needed.																								
Irrigation	Sprinklers used twice during germination Once species were established, no more water was used specifically for the trial. Irrigation was still provided through the usual plan for the trees.																									

Establishment Observations

Trial species	Spring/ Summer				Autumn/ Winter	
	Germination November 2022	Initial establishment Dec 2022 – Feb 2023	Establishment Feb 2023 – April 2023	Weed suppression	Continued growth April 2023 – June 2023	Weed suppression
Plantain <i>Plantago lanceolata</i>	Good, heavy sowing rate meant very good cover.	Clumpy, heavy rate means many plants growing.	Still very dense, haven't 'self-thinned' but maybe some competition as plants have not yet got to 'mature size'.	70%	Still very small plants, very good weed suppression. Plants have not matured/ competing with each other due to high sowing rate potentially.	95%
Sheep's Burnett <i>Sanguisorba minor</i> <i>subsp. Muricata</i>	Good, quick germination. True leaves in 1 week.	'Fine' leaf, light plant with small foliage, quick to establish. OK coverage.	Plants still giving good weed suppression, low growing.	65%	Very good coverage, continued growth into frosty winter days. Good weed suppression, good coverage, OK height – some aerial roots here as ground cover is close to trunks, and scion is close to the ground.	95%
Trefoil <i>Lotus corniculatus</i>	Good, easy establishment.	Good, also a bit patchy from hand sowing, OK coverage. Plants tend to grow upright to begin with, then fall to create mat.	Plants still giving good weed suppression, low growing once they grow up then have fallen.	60%	Ok coverage, very small leaved plant so where not as dense, weeds have come through, potentially better coverage would mean better ground cover as the mat it creates is dense.	75%
Strawberry clover <i>Trifolium fragiferum</i>	Good, easy establishment.	Good quick growth, great coverage when young, long stems create 'matted' carpet.	OK coverage. Tended to grow up, tall and lanky. When foliage fell it then created a mat with OK coverage.	50%	Ok, cover, however, it has been eaten partially by rabbits (the only species with this issue) cover is good and dense in well-sown areas.	60%
Common Yarrow <i>Achillea millefolium</i>	Good. Tiny, very light seed, difficult to sow well.	S lower to grow, clumpy from hand sowing the light seed.	Great coverage, feathery foliage creates dense low growing mat in areas were evenly sown.	65%	Cover is good and dense in well-sown patches; weeds have come through where there are gaps.	55%
Chicory <i>Cichorium intybus</i>	Good, very easy germination in Spring.	Great, quick establishment. Well suited to this area.	Great coverage, big leaves physically cover ground, and potentially strong competition with other species/ weeds around it.	70%	Very good cover, very few weeds coming through/ Ground cover is close to trunks and has the highest foliage so far – aerial roots here also. Height to be an issue?	95%
Alyssum <i>Lobularia maritima</i>	Good, first to show/ germinate, heavy cover.	Quick growing in this early stage.	Started to yellow off in summer, potentially too hot? This made the plants die back a bit, and weeds were able to re-establish.	20%	Poor growth.	10%

Trial Species Performance - Based on the ability to suppress weeds and growth when densely sown.

<p>1st equal</p> <p>Sheep's Burnett</p>		<p>These species had the least amount of weed species present at the end of the trial. They also covered the ground the best, creating a low-growing ground floor 'canopy'. Both species are still low to the ground and have not yet encroached into the pip fruit canopy. However, Sheep's Burnett has a better habit, it is lower to the ground and branches rather than growing straight up, whereas Plantain will continue to grow higher, and its flowers will likely be in the pipfruit canopy.</p>
<p>1st equal</p> <p>Plantain</p>		
<p>2nd</p> <p>Chicory</p>		<p>Chicory covered the ground very well, with little weed incursion at the end of the trial period and a well-covered orchard floor. The issue we may have with Chicory over time is that it will grow taller and grow up into the pipfruit canopy.</p>
<p>3rd</p> <p>Trefoil</p>		<p>Trefoil had decent ground covering ability, but its small leaves and wiry stems meant that more light could come through its 'canopy' even though it was well sown and was well spread over the trial plot. This species may 'come away' again next Spring, if it can persist it could cover the ground better next season.</p>

4th

Clover



Clover was the only species to have rabbit damage, first as the seedlings were young, and now, in June many of the tops (and perhaps the flowers) have been chewed off. The species is still persisting well, and where it is a dense mat, it covers the ground well and can suppress some weeds. As the foliage is eaten more light is able to reach the ground.

5th

Yarrow



Yarrow was difficult to sow, a very light seed. In heavily sown areas where seed germinated well the yarrow covered the ground exceptionally. Its tendency to fall flat means it covers the ground, excluding most weeds; the small leaflets create a 'mat' which blocks out a lot of light from the floor. Where the seed was not as well spread, weeds persisted and grew up through the trial species.

6th

Alyssum



Although it had quick germination and established fine, once the days got hotter and drier, the Alyssum seedlings yellowed, and at the end of the trial period, the species is insignificant in its plot. As a species, it could have merit in a mix, with its quick flowering useful for pollen/ beneficial insects, but as a stand-alone trial species, it was poor.

Species' ability to cover the ground

We worked with Plant and Food Research to understand if there would be a difference between each species' ability to cover the ground and reduce the level of light to the soil. We used a light meter on the orchard floor. The control was devoid of weeds until mid-summer.

The results showed under the trial species, when seedlings are still small, and the tree canopy has less leaf, there was more light reaching the orchard floor for the trial area compared to the control, and when as the plants grew, this swapped and less light reached the orchard floor of trial areas compared to the control area.



Impact of sowing on soil, tree and fruit

Soil nutrients

Soil samples were collected to measure nutrient status for planted vs control rows. As was expected, due to the short six-month timeframe between sowing and testing, there was no noticeable difference in nutrient levels. Soil samples will continue over the coming year. For full analysis of soil refer to full report.

Soil Food Web – soil organism biomass

Samples were taken ‘Pre sowing’ Nov 2022, and ‘6 months post Spring sowing’ May 2023, to measure changes to the fungi and bacterial biomass.

‘Total’ fungi and bacteria, refers to the entire fungal or bacterial biomass found within the sample, ‘Active’ refers to the living fungi or bacteria found. The control sample (pre sowing) shows a baseline. We can see both fungi and bacterial levels are low, likely meaning low food resources available. There are clear changes in fungi and bacterial amounts after 6 months, some that stand out are Trefoil, with a huge decrease in Active fungi after 6 months. Another is Burnett, which has

Fruit quality and size at harvest

Because crop load was not determined, any subsequent findings around fruit quality and fruit size cannot be directly linked as an ‘effect’ of the trial species this year.

	Active fungi (µg/g)	Total fungi (µg/g)	Active bacteria (µg/g)	Total bacteria (µg/g)
Ideal range	>375	>1,500	>75	>300
Pre sowing	16	280	11	231
6 Months post Spring sowing				
Plantain	10	286	8	230
Trefoil	1	196	2	308
Alyssum	11	383	13	251
Yarrow	11	192	2	281
Sheep’s Burnet	30	154	7	354
Chicory	24	242	7	316
Clover	22	306	18	249

Figure 2 Soil Food Web NZ - Soil detail report

Terminated shoot length.

To determine if there are any differences in tree vigour, as the trial species were establishing. Below table shows the average length (mm) of x20 terminated annual shoots in each trial plot. There were no major differences between the average length of shoots in each plot, and the deviation of each plots measurements also doesn’t show any particular trend for the trial species.

Trial species	Average terminated shoot length (cm)
Plantain	17
Trefoil	19
Alyssum	20
Yarrow	19
Sheep’s Burnet	19
Chicory	17
Clover	20
Mixed Bay	17
Control	19