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Low-growing indigenous groundcover plants' weed suppression study

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June 2023

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Planting low-growing indigenous groundcover plants to control weeds may benefit vineyard ecology instead of compromising it, compared with current practice. However, a lack of knowledge prevents this idea from transforming into practice. In this study, we investigated the ability of mixed species of native groundcover to resist weed invasion after the groundcover canopy had fully covered the ground. The percentage composition of native groundcover and weeds species were also assessed along with their height at the end of the trial.

We found that native groundcover demonstrated an ability to protect 70% of the surface area from weed invasion after a 5 month period, from January to late May. Particularly noteworthy was the significant restraint and suppression of grass growth by the native groundcover. Dandelion was the main weed species (66%) causing decline to native groundcovers. Native species with woody stems were more effective at controlling broad leaf weed species without a true stem growth habit like dandelion.

To enhance resistance to weed invasion in the future it would be beneficial to grow groundcover plants with a woody structure in closer proximity to each other. Additionally, incorporating fast-growing plants with less woody structure among the woody plants would help reduce the vulnerability to weed invasion. This approach would also enable the fast-growing plants to quickly interlock any gaps among the woody plants, providing a more robust defence against weed invasion.

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1 Introduction

Horticulturists commonly control weeds through herbicide application or cultivation, but these practices have drawbacks. They result in bare soil surfaces, leading to degradation of soil organic matter, flora and fauna, and soil structure (Haynes 1981; Francis et al. 2001; Wardle et al. 2001). Concerns arise regarding the potential harm caused by herbicides entering the human body through direct contact or groundwater residues (Carretta et al. 2022). Cultivating or under-vine mowing of stony ground or terraces to control weeds is particularly challenging, making elimination of synthetic herbicides difficult in viticulture. An alternative approach could be the use of low-growing indigenous groundcover plants in the under-vine strip to control weeds, benefiting the vineyard ecosystem instead of compromising it. However, limited knowledge currently hinders commercial implementation of this idea.

Establishing indigenous groundcover under-vine can be costly. It is crucial to have established indigenous groundcover that can effectively suppress weeds in the long term. Current projects focused on this topic had only reported the weed suppression ability of establishing plants with the help of hand-weeding and mulch around the groundcovers (Foo 2012; Shields et al. 2016). These trials have used single species treatments instead of a combination of species. Therefore, it remains unknown whether the groundcover can suppress weeds and resist invasion from adjacent weedy strips independently once the targeted area is fully covered and the mulch applied at establishment stage has decomposed.

In this research project, we planted a combination of mixed species in close proximity to each other in the treatment plot. The woody mat-forming plants in this combination tend to have a slow growth rate with rounded edges, resulting in gaps where weeds can emerge. On the other hand, some faster-growing native ground cover species have a more flexible shape and can quickly fill in these gaps. By utilising different species combinations, we aimed to create a denser ground mat by interlocking and compensating for each other's growth form and speed. Once the native plants fully covered the trial plots, we conducted monitoring every 2 months to assess the percentage area occupied by weeds.

The research question addressed in this study is whether mixed species of native groundcover, once fully established and covering the ground, can effectively resist weed invasion.

2 Method

2.1 Trial design and layout

At the Nelson Marlborough Institute of Technology (NMIT) campus trial site, we selected four perennial indigenous plants (Figure 1) based on their growth density, height, establishment speed, and hardiness. The choice of these plants was informed by last year MRC funded native groundcover project results and literature sources (Foo et al. 2011; Metcalf et al. 2014; Shields et al. 2016) as well as information obtained from nurseries.

Veronica odora var. *prostrata* and *Coprosma propinqua* var. *martini* 'Taiko' were chosen for their ability to form a dense, non-thinning woody mat on the ground surface. They have a medium-fast growth rate. *Muehlenbeckia axillaris*, and *Acaena inermis* var. 'Purpurea' also form a dense ground mat, but they are less woody and robust compared with *Veronica odora* var. *prostrata* and *Coprosma propinqua* var. *martini* 'Taiko'. They have a faster growth rate and a less defined growth shape, allowing them to fill the gaps more effectively. The mature height of these plants is less than 0.3 m. Additionally, all selected species are frost tolerant and disease-free. In the native groundcover treatment, selected species were closely planted to each other to cover the majority of the plots surface area (Figure 2). The planting of these plants took place in September 2022.

Veronica odora var. *prostrata*

Muehlenbeckia axillaris

Coprosma propinqua var. *martinii* 'Taiko'

Acaena inermis var. 'Purpurea'

Figure 1. Indigenous groundcover plants selected for the trial.

The trial setup included four replicate plots of initially cultivated bare soil (control group) where the grass and its roots were removed and four replicate plots of the mixed groundcover species treatment. Ten-centimetre bare soil gaps were maintained between trial plots by hand weeding. The arrangement of the plots followed a complete randomised block design.

Figure 2. Trial site preparation and layout.

2.2 Trial site information

The trial site was located at the NMIT, Blenheim campus. Trial plots were converted from grassland. The whole trial area was fully exposed to the sun. The soil is waimakariri deep loam over sand (Marlborough district council, soil map). The topsoil has loam texture and is stoneless and subsoil dominated by sandy texture. Generally soil is free drain with high water holding capacity.

2.3 Measurements

Visual assessments of percentage of weed coverage of the trial plot ground surface area were made every 2 months starting from January 2023. The dominant weed species in each trial plot were also documented. At the conclusion of the trial at the end of May 2023, visual assessment of the percentage ground surface coverage of native groundcover and each dominant weed species along with their average height were recorded.

3 Results

3.1 Percentage weed invasion

In the control group where plots were left as bare soil, 100% of the area was covered by weeds 2 months later and remained at 100% coverage until the end of the trial. However, in the native groundcover treatment group, an average of 5% weed emerged, primarily through small gaps between plants, 2 months after initial establishment. As the season progressed and reached late-May, the weed coverage had increased to 29% of the total surface area (Figure 3).

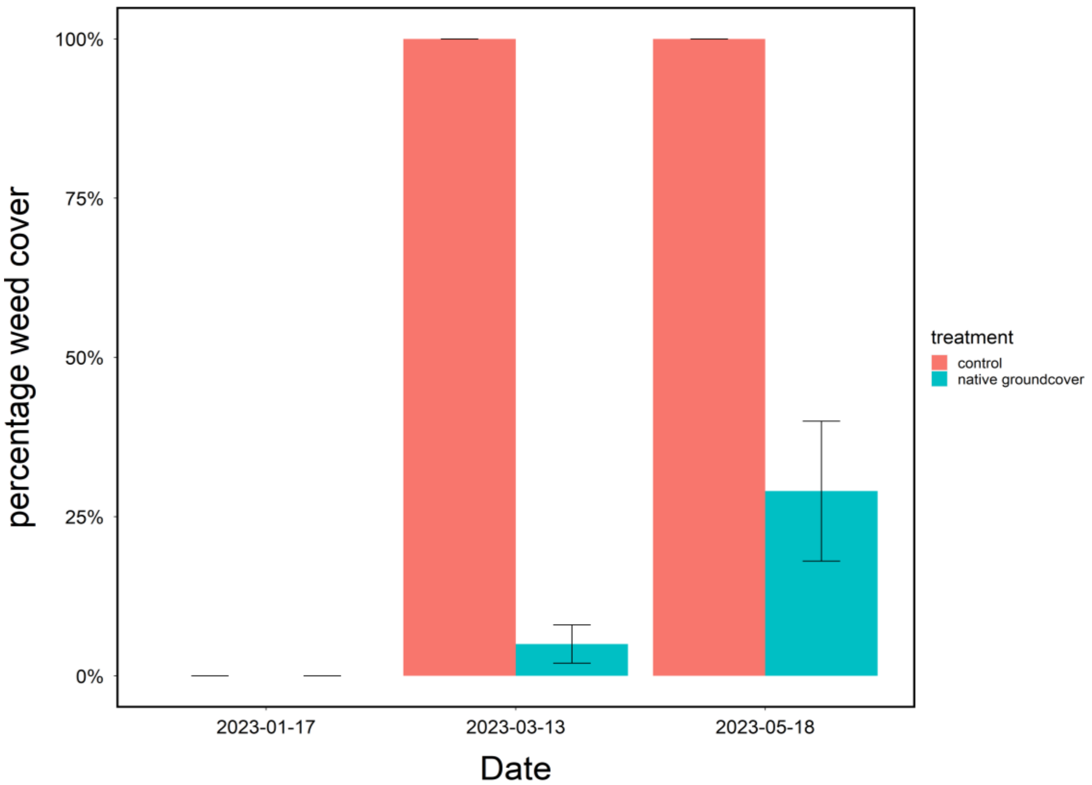

Figure 3. Percentage weed coverage of control and native groundcover treatment at three monitoring dates. Error bars indicate the standard deviation of the mean.

3.2 Species composition of surface area

As shown in Figure 4, in the control plots, which began as bare soil at the start of the monitoring period, had 100% of the surface area covered by weeds at the end of the season. Specifically, 73% of the coverage consisted of grass, 26% was dandelion, 1% was clover, and less than 1% was crimping mallow.

In the native groundcover treatment plots (Figure 4), a comparison of two assessments showed that the gaps of bare soil had completely disappeared. On average, 29% of the surface area was occupied by weeds, including 19% dandelion, 4% grass, 5% clover, less than 1% broad dock, and mallow. The surface area occupied by *A. inermis* decreased by an average of 50%, a significant reduction ($p < 0.05$) compared with the initial monitoring. The reduction in *M. axillaris* was 33% ($p < 0.05$). While *C. propinqua* increased by 15% ($p < 0.05$). The percentage of surface area covered by *V. odora* did not show a significant change.

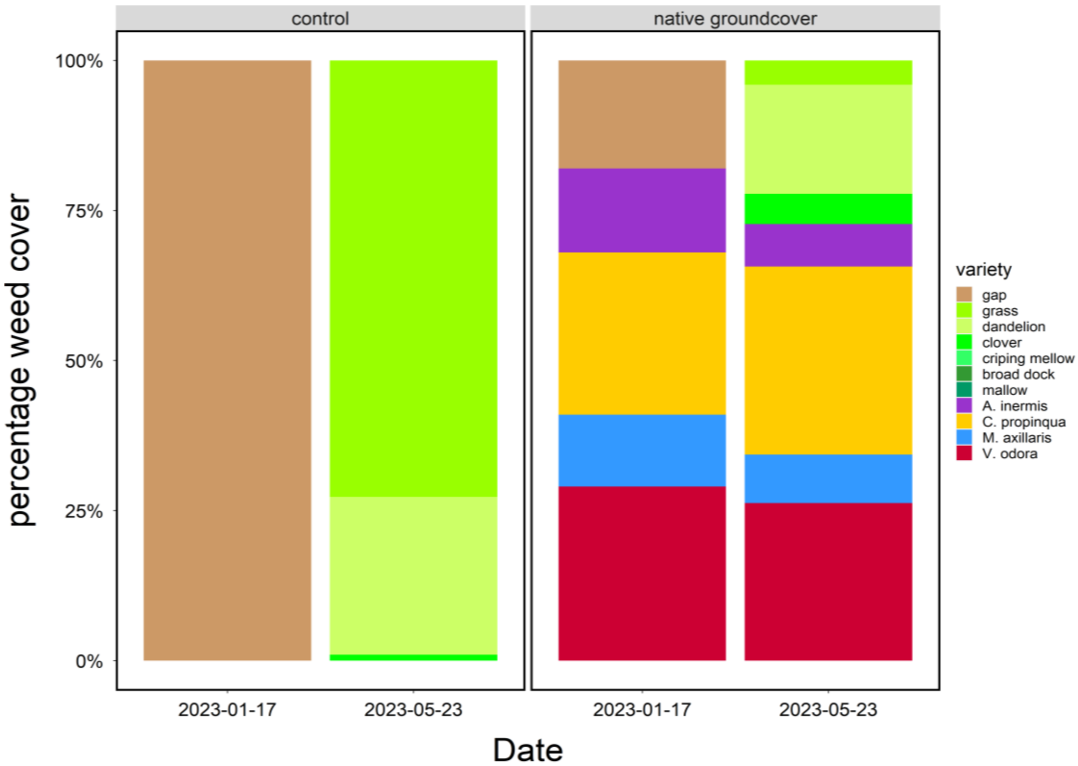

Figure 4. Groundcover surface area species composition of control and native groundcover treatments.

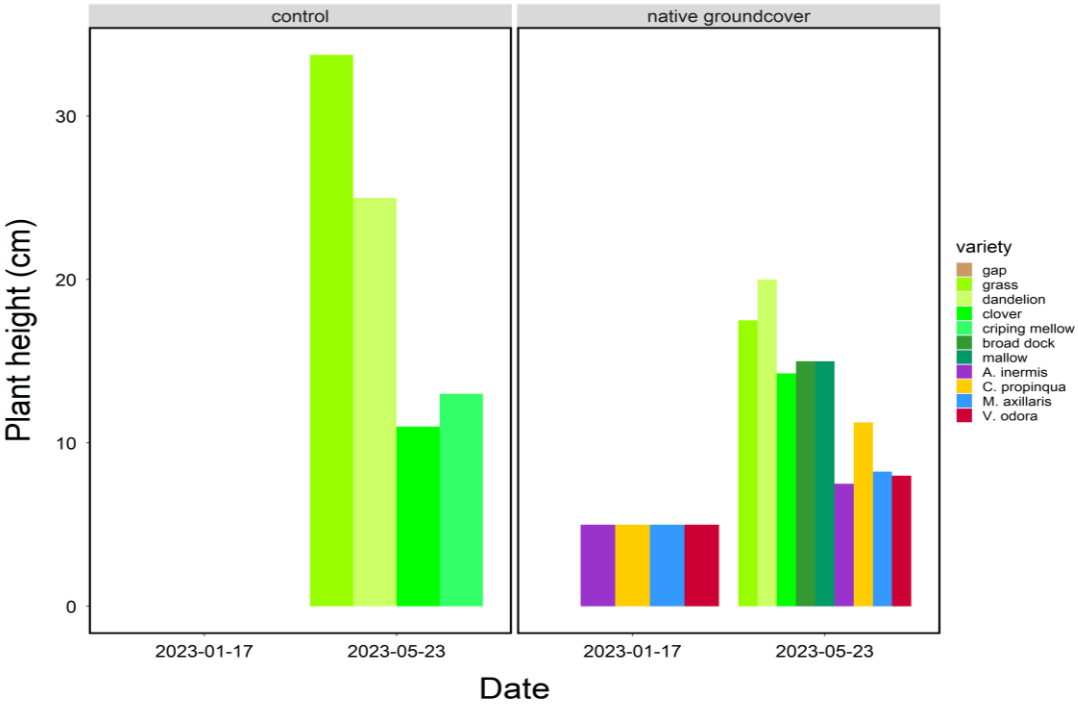

Figure 5. Species height of control and native groundcover treatments.

Comparing the two treatments at the end of the season (Figures 4 and 5), the native groundcover treatment significantly ($p < 0.001$) restrained grass coverage by 94%. Additionally, it significantly reduced ($p < 0.01$) the height of grass growth from an average of 35 cm in the control group to 15cm. The growth area and height of dandelion were 8% smaller and 5 cm lower, in the native groundcover treatment compared to the control group, but this difference was not statistically significant. The growth area and height of clover were 4% bigger and 3.25cm higher, respectively, in the native groundcover treatment compared to the control group, but this difference was also not statistically significant.

4 Cloudy Bay vineyard commercial trial establishment

With the experience we learned through the native groundcover projects at NMIT site, in the autumn of 2023, in collaboration with Cloudy Bay Vineyards Limited, we established a trial on a commercial vineyard, using a mix of indigenous plant species under the grapevines.

Veronica odora var. *prostrata*, *Coprosma propinqua* var. *martini 'Taiko'*, *Coprosma propinqua* var. *martini ' Hawera'*, *Leptospermum scoparium* var. *huia*, *Leptospermum scoparium* var. *kea*, *Leptospermum scoparium* var. *redfall* were chosen for their known ability to form a dense, non-thinning woody stem mat on the ground surface. *Muehlenbeckia axillaris*, *Fuchsia procumbens*, *Pimelea prostrata*, *Leptinella squalida*, *Geranium sessiliflorum* and *Acaena inermis* var. *'purpurea'* were also chosen as they form a dense ground mat, but they are less woody and robust compared with species with woody stems. However, they have a faster growth rate and a less defined growth shape, allowing them to fill the gaps more effectively. The mature height of all these plants is less than 0.3 m. Additionally, all selected species are frost tolerant and disease-free. In the native groundcover treatment, selected species were closely planted to each other to cover the majority of the plot surface area (Figure 6).

Figure 6. Native groundcover trial in Cloudy Bay vineyard.

Figure 7 shows the distribution of plant species between two vines. The groundcover planting beneath the grapevine strip comprises three rows. The two outer rows predominantly consist of woody species, whereas the middle row comprises faster-growing species specifically chosen to fill gaps.

The experimental design comprised of four replicate plots of cultivated bays (control group) and four replicate plots of treatment bays with a mixture of groundcover species. Each bay contained four vines, and the plot arrangement followed a complete randomised block design.

	Cop		Ver	Cop	Ger	Cop	Lepto	Cop		Cop	
Aca	vine	Aca	Mue	Lepti	Aca	Mue	Fusa	Mue	Aca	vine	Aca
	Cop		Cop	Cop	Ver	Pim	Cop	Ver		Cop	

Aca: *Acaena inermis* var. *'purpurea'*
Cop: *Coprosma propinqua* var. *martini 'Taiko'* / *Coprosma propinqua* var. *martini ' Hawera'*
Fusa: *Fuchsia procumbens*
Ger: *Geranium sessiliflorum*
Lepti: *Leptinella squalida*
Lepto: *Leptospermum scoparium* var. *huia* / *Leptospermum scoparium* var. *kea* / *Leptospermum scoparium* var. *redfall*
Mue: *Muehlenbeckia axillaris*
Pim: *Pimelea prostrata*
Ver: *Veronica odora* var. *prostrata.*

Figure 7. Plant species layout between two vines.

All plants were 10-15 cm in diameter and were hand planted. Wood mulch was applied at planting to suppress weed growth prior to the native groundcover developing further to fully cover the ground. The establishment cost in this manner is very high and not commercially viable on a large scale. However, technology such as native seed production, establishment through cuttings and more effective mulching material need to be developed to enable more affordable establishment. The technology development is expensive, thus the companies and research institutes need to evaluate first whether mixed species of native groundcover, once fully covering the ground, can effectively reduce weed invasion in the long term. The aim of this study is to determine if an established under vine groundcover of mixed native species can effectively supress weed invasion in a commercial vineyard.

5 Discussion

Native groundcover demonstrated an ability to protect 70% of the surface area from weed invasion after 5 months period from January to late May. Particularly noteworthy was the significant restraint and suppression of grass growth by the native groundcover. Since grass can spread through underground rhizomes, it is more difficult for grass roots to invade an area already occupied by native groundcover plants.

Among the weed group, dandelions comprised 66% of the total weed-covered area in the native groundcover treatment group. The growth of dandelions was not significantly suppressed by the native groundcover. These dandelions primarily emerged in the small gaps between plants and the growth areas of *A. inermis* and *M. axillaris*. However, *C. propinqua* and *V. odor*a exhibited better resistance to dandelion invasion. Dandelions, lacking a true stem, have soft leaves that grow from the uppermost area of their roots. Consequently, once dandelion seeds germinate, their leaves can penetrate through plants like *A. inermis* and *M. axillaris*, which have small or soft leaves but lack a sturdy stem. As the dandelion leaves grow above the native groundcover layer, they form a dense mat that shades the light from the native groundcover, eventually causing its decline. In contrast, under plants like *C. propinqua* and *V. odora*, it becomes difficult for the soft leaves of dandelions to penetrate through the woody stems. Furthermore, invading a more mature *M. axillaris*, which forms a dense and thick branch mat on the ground over time, would pose a greater challenge for dandelions in the following year. This observation could apply to other broad leaf weed species without a true stem growth habit. The areas with the fewest weeds were observed in the vicinity of *C. propinqua*, where *A. inermis* and *M. axillaris* had grown into *C. propinqua*, interlocking any gaps between the woody branches.

6 Conclusion

In the future, to enhance resistance to weed invasion, it would be beneficial to grow groundcover plants with a woody structure in closer proximity to each other. Additionally, incorporating fast-growing plants with less woody structures among the woody plants would help reduce vulnerable areas. This approach would also enable the fast-growing plants to quickly interlock any gaps among the woody plants, providing a more robust defence against weed invasion.

Extending monitoring of the current trial plots for additional years would provide valuable insights into how native species and weeds interact and develop over time.

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