Department of Primary Industries and Regional Development

Grapevine management guide 2024–25

NSW PRIMARY INDUSTRIES MANAGEMENT GUIDE

Compiling author: Penny Flannery

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Department of Primary Industries and Regional Development

Grapevine management guide 2024–25

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Image acknowledgements
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Vineyard at Piccolo Family Farms, Griffith, NSW. Taken 23 April 2024 by Penny Flannery, NSW DPIRD.

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Contents

Introduction

The *Grapevine management guide* is one of NSW Department of Primary Industries and Regional Development's flagship publications. Such publications are a crucial means of providing information to wine industry professionals.

It is with great pleasure that I welcome you to read and benefit from the information in the *Grapevine management guide* for 2024–25.

Vintage 2024 was very different from Vintage 2023, with spring being warmer than usual, harvest was much earlier than expected. The Hunter Valley and Orange regions harvested 5–6 weeks earlier than 'normal'. The favourable season meant reduced chemical inputs and the result was extremely good fruit quality. In Canberra, frost damaged large parts of crops in late spring, and in the Riverina, market saturation and higher-than-average summer rainfall created challenges. The season proved overwhelming for the Riverina region, and I am concerned for the mental well-being of many of our growers.

With Darren Fahey departing in September 2023 and Katie Dunne in January 2024, I would like to thank the following people for contributing to this edition of our guide.

Jessica Fearnley (Development Officer – Temperate Fruit) for taking on board our Rootlings' Network program and the conference, which was held in the Hunter Valley in May 2024 (page 6).

Dr Meena Thakur (Research Horticulturist – Entomology) started in February 2024 and has been working closely with growers in the Riverina region on scale and mealybug issues (page 58 and page 62).

Dr Bruno Holzapfel (Senior Research Scientist – Perennial Crop Physiology) is continuing his work on Gen 1 and Gen 2 powdery mildew and downy mildew-resistant selections (page 74).

Leonie Martin (Plant Biosecurity Officer) provided an update on one of our major biosecurity threats, the red blotch virus (page 76) and an article on Tocal's vineyard emergency response training (VERT) for the Hunter Valley and Griffith regions in March and April 2024, respectively (page 80).

Myles Parker (Leader – Southern Horticulture) established the under-vine trial site in Orange (page 22), assisted with the crown gall issue in NSW (page 84) and attended a study tour to New Zealand (page 52).

Finally, I wish to thank Dr Amanda Warren-Smith (Development Officer – Information Delivery); this guide would not have happened without her.

NSW DPIRD would like to take this opportunity to thank Darren Fahey and Katie Dunne for all their work delivering influential projects for the wine industry, including establishing the under-vine ground cover project (page 22 and page 16) and the resting vineyard work (page 44).

Feedback please

The NSW Department of Primary Industries and Regional Development (DPIRD) want to ensure that the information it provides is what you need to grow your business. I would like to receive any feedback that you care to offer – good, bad or indifferent. This will help me to improve future editions. Please contact me with your suggestions,

Penny,

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Rootlings' Network update

Jessica Fearnley, Development Officer – Temperate Fruits, NSW DPIRD

The Rootlings' Network is funded by the NSW Department of Primary Industries and Regional Development (DPIRD) through the Viticulture Skills Development Program and is delivered by NSW DPIRD in collaboration with NSW Wine.

Introduction

In 2022, a youth network pilot program was established in NSW to encourage, engage and empower Australia's future wine industry workforce. The Rootlings' Network was created to run educational webinars, hold regional and state-wide events, and engage with schools and universities to promote the industry to students. The aim of these activities was to attract and retain young people in all areas of the wine industry so the future generation is engaged and committed to their careers.

In 2024, the program continued under the NSW DPIRD Viticulture Skills Development Program and followed the groundwork laid in the pilot program. This article provides a summary of activities offered to the NSW Rootlings' Network during the 2023–2024 financial year.

Webinars

Feedback from the inaugural Rootlings' conference in 2023 indicated the online webinars removed access and time constraint barriers and allowed participants to gain new skills quickly and efficiently. The webinars were recorded and placed on the NSW Rootlings' Facebook page for anyone to revisit or watch if they missed the session. These webinars had a strong focus on personal development and building soft skills. Three 2-hour webinars focusing on navigating change, difficult conversations and managing burnout were attended by over 40 members of the network. Cynthia Mahoney from Cynthia Mahoney Professional Development facilitated these sessions on Zoom and provided tangible, practical skills for members to use in their workplace and through their careers. The image in Figure 1 was taken at our final webinar session, which was on managing burnout.

Figure 1. NSW Rootlings' members participating in a webinar facilitated by Cynthia Mahoney (top left).

Regional networking events

Towards the end of 2023 and early 2024, face-to-face events were held in the Hunter Valley and Griffith regions. These were championed by individuals in these areas and were based on a regional topic of interest. The Hunter Valley networking night was held at De Iuliis Wines Cellar Door and was used to identify the key topics affecting Hunter Valley grape growers this season. Low tourism numbers and wet growing conditions were identified as key priorities, and the group heard how others were coping with these challenges (Figure 2).

Figure 2. A group discussing the 2023–2024 Hunter Valley growing season.

In Griffith, NSW DPIRD ran an alternative variety workshop at Piccolo's Family Farms (Figure 3). This workshop was well received as current market saturation is creating a challenging environment for the vineyards and wineries in Griffith. Alternative varieties could create different markets, which might pay more than current traditional markets. The workshop included a tasting of the different varieties, a discussion on growing these varieties and a vineyard walk (Figure 4).

Figure 3. Luke Piccolo shares his experiences with alternative wine varieties.

Figure 4. A vineyard tour of the alternative varieties planted at Piccolo Family Farms in Griffith, NSW.

2024 Rootlings' Conference

The largest investment of this year's program was the 2024 NSW Rootlings' Conference, which was held in the Hunter Valley from 21 to 23 May 2024. The aim of the conference was to continue the work done in the previous year's conference and facilitate:

- networking between different viticulture industries and growing regions
- intergenerational knowledge sharing via industry leaders and experts
- skills development through visits to businesses
- technical skill sessions such as wine judging and winemaking activities.

The conference program was built on feedback from last year's conference, with a range of activities being offered (Figure 5). The program ensured that participants from different industry streams (e.g. viticulture, winery, and cellar door) could select the sessions applicable to them to gain the most out of the two days (Figure 6). Two dinners provided sit-down networking opportunities with industry leaders and mentors, which were well received by attendees.

Tuesday 21 May 2024

Time	Activity	Venue	Speaker
6–9 pm	Rootlings' Welcome BBQ	Saddler's Creek Wines 15 Marrowbone Rd, Pokolbin NSW 2320	Jessica Fearnley – Development Officer, NSW DPIRD

Wednesday 22 May 2024

Time	Activity	Venue	Speaker
7.30 am	Coach departs from Wine Country Motor Inn	Wine Country Motor Inn 5 Darwin St, Cessnock NSW 2325	NA
8.00 am	Scarborough Wines activation	Scarborough Wines Cellar Door 179 Gillards Rd, Pokolbin NSW 2320	Scarborough Wines Team
	Sustainable pest and disease controls		Liz Riley – Viticulturist, Vitbit and Scarborough Wines
	What is your story? Improving your cellar door marketing		Sally Scarborough – Scarborough Wines
10.30 am	Scarborough activation/Keith Tulloch Wine	Scarborough Wines 972 Heritage Road, Pokolbin NSW	Brent Hutton – Vineyard Manager, Keith Tulloch Wine
	Improving under-vine management		
	Winery discussion		Jerome Scarborough – Winemaker, Scarborough Wines
12.00 pm	Lunch		NA
1.30 pm	Wine show judging	Ben Ean Cellar Door 119 McDonalds Rd, Pokolbin NSW 2320	Stu Burgess and Emily Glover
3.00 pm	Mentoring session – get to know your industry leaders		Liz Riley, Angus Barnes, Aaron Mercer, Jennie Curran and Sandra Brown
5.00 pm	Travel to Cessnock/free time	Wine Country Motor Inn 5 Darwin St, Cessnock NSW 2325	NA
7.00 pm	NSW Rootlings' Industry Dinner	Cessnock Leagues Club 1 Darwin St, Cessnock NSW 2325	Hosted by NSW DPIRD

Thursday 23 May 2024

Time	Activity	Venue	Speaker
7.30 am	Coach departs from Wine Country Motor Inn	Wine Country Motor Inn 5 Darwin St, Cessnock NSW 2325	NA
8.00 am	Successful winemaking and dry grown viticulture	Tyrrell Wines Cellar Door 1838 Broke Rd, Pokolbin NSW 2320	Bruce Tyrrell – Owner, Tyrrell Wines
10.00 am	Developing emotional intelligence and overcoming perfectionism	Wine House Hunter Valley 426 McDonalds Rd, Pokolbin NSW 2320	Nerida Bint – emotional intelligence coach
12.00 pm	Effective wholesale relationships		Adam Winder and industry leaders
12.30 pm	Lunch		NA
1.00 pm	Money matters: developing your business skills and preparing to buy your own business		Craig Saywell – Saywell Accountants
2.00 pm	Closing remarks		Jessica Fearnley – Development Officer, NSW DPIRD

Figure 5. The conference program showing the range of activities.

Figure 6. Bruce Tyrrell from Tyrrell Family Wines explains dry viticulture to the group.

The industry dinner was a new addition to this year's program and included a 'next generation of viticulture panel' facilitated by Kurt Nilon from the Rootlings' conference committee (Figure 7). The dinner provided attendees with the opportunity to network in a casual environment, and there was a formal session where committee members and supporters could be acknowledged for their contributions. In future years, this dinner could provide an opportunity to present industry awards or scholarships as the program develops.

Figure 7. The industry dinner included a panel session facilitated by Kurt Nilon (far right).

The conference had 65 attendees from around NSW including the Hunter Valley, Orange, Canberra and Mudgee. Attendees ranged in age from 25 to 36 years, with the occupation breakdown of 14% grower, 26% winemaker, 45% sales, marketing and cellar door, 6% wholesale and 9% business owner. Of these attendees, 98% said their overall experience at the conference was excellent and 100% of the attendees said the conference met their expectations. Figure 8 shows the attendees' feedback on how valuable they found the conference.

Figure 8. Attendees' rating on how valuable they found the conference.

This year's conference would not have been successful without the support of the conference committee including Jenna Vaughan, Allanna Wigley, Kurt Nilon, Adam Winder, Hayley Crain, Emily Glover and Beatrice Checkley (Figure 9). The conference was also strongly supported by several Hunter Valley Cellar doors and wineries.

Figure 9. The conference committee including Jenna Vaughan, Kurt Nilon Allanna Wigley, Jessica Fearnley, Hayley Crain, Beatrice Checkley and Adam Winder. Missing is Emily Glover.

Sustainable Winegrowing Australia: 2023 update

Source: Sustainable Winegrowing Australia

The data presented in this report are aggregated from individual Sustainable Winegrowing Australia member data (Table 1 to Table 3). The accuracy of data generated by or obtained from the Sustainable Winegrowing Australia member portal depends on data entered by users. The AWRI makes no representation or warranty in relation to the accuracy or completeness of any data presented in this report. Data were accurate on 16 November 2023.

NSW membership statistics

Table 1. NSW membership statistics from Sustainable Winegrowing Australia.

	Total vineyard members	Certified vineyard members	Vineyard area (ha)	Total winery members	Certified winery members	Total members
2019–20	27	4	2,174	5	2	32
2020–21	57	8	5,730	20	4	77
2021–22	64	5	5,890	21	4	85
2022–23	83	25	8,044	28	8	111

NSW winery statistics

Table 2. NSW winery statistics from Sustainable Winegrowing Australia.

		2019–20	2020–21	2021–22	2022–23
Production	Total tonnes crushed	65,921	154,495	149,354	222,626
Water	Average water use (kL/t crushed)	1.9	3.3	3.6	3.4
	Average wastewater generated (kL/t crushed)	4.2	2.9	3.0	3.4
Waste	% of members sending organic waste to recycling	75	76	71	84
	% of members sending other waste to recycling	–	–	90	92
Energy	Average electricity (kWh/t grapes crushed)	565	444	449	525
Biodiversity	% members participating in on or offsite biodiversity projects	75	65	90	84

Growing and making wine sustainably is a holistic approach that considers the environmental, social and economic aspects of production. It looks at how we can better use energy and water to create efficiencies, support regions and communities, and maintain businesses that are resilient and thriving.

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sustainablewinegrowing.com.au

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NSW vineyard and winery statistics

Table 3. NSW vineyard and winery statistics from Sustainable Winegrowing Australia.

		NSW total				Canberra district			Hunter Valley	
		2019–20	2020–21	2021–22	2022–23	2020–21	2021–22	2022–23	2019–20	2020–21
Average yield (t/ha)	Excluding vineyards with no fruit harvested	9	8	10	10	5	6	5	3	4
	Including vineyards with no fruit harvested	7	7	9	12	4	5	5	2	4
Mid-row management (total ha)	Annual cover crop	207	1,452	339	875	0	0	0	48	58
	Permanent cover crop non-native	292	722	2,008	1,271	12	25	7	0	25
	Permanent cover crop volunteer sward	863	1,488	1,601	1,518	41	49	30	127	201
	Permanent cover crop native	650	341	455	1,231	17	168	168	0	0
Under-vine management (total ha)	Herbicide	1,610	4,991	5,164	6,907	25	200	191	236	344
	Cultivation	363	1,169	1,948	1,240	2	0	0	137	140
	Other	95	614	289	256	48	28	15	0	0
Total water use by source (ML)	River water	5,278	28,251	22,785	29,882	1	0	0	339	418
	Groundwater	548	592	340	681	34	6	29	12	6
	Surface water dam	110	127	185	277	18	8	2	9	11
	Recycled water from winery	0	0	3	1	0	0	0	0	0
	Recycled water from other source	0	0	1	0	0	0	0	0	0
	Mains water	1	2	0	440	0	0	0	1	1
	Other water	0	5	2	0	1	0	0	0	0
	Frost control	–	–	–	1	–	2	0	–	–
	Average water use (ML/ha)	3	2	2	3	1	0	1	1	1
Total irrigation delivery by type (total ha)	Dripper	1,890	5,628	5,777	7,517	70	227	197	200	312
	Under-vine sprinkler	5	0	0	248	0	0	0	0	0
	Overhead sprinkler	96	95	103	201	0	0	0	0	0
	Flood	0	47	47	9	0	0	0	0	0
	Non-irrigated	89	102	130	127	0	0	8	89	98
	Pressurised water	101	345	731	1,231	2	0	0	22	22
Total energy use	Electricity from the grid (MWh)	2,204	8,505	7,001	9,556	50	28	114	45	338
	Generated renewable electricity (MWh)	118	346	663	438	20	16	15	59	27
	Petrol (L)	43,281	58,448	89,938	70,940	5,652	3,676	4,079	3,949	2,197
	LPG (L)	980	5,676	489	3,224	1,077	40	1,820	0	573
	Diesel (L)	374,107	1,045,448	942,074	1,213,331	15,483	45,195	27,222	92,935	110,488
Biodiversity	Biodiversity area (ha)	313	4,339	4,274	5,069	202	262	70	38	41
	% of members participating in on or offsite biodiversity projects	56	65	55	58	80	55	67	80	67

Hunter Valley		Mudgee			Murray Darling			Orange				Tumbarumba		
2021–22	2022–23	2020–21	2021–22	2022–23	2020–21	2021–22	2022–23	2019–20	2020–21	2021–22	2022–23	2020–21	2021–22	2022–23
6	5	4	4	4	25	28	20	4	4	6	4	6	9	7
5	5	3	4	5	24	22	22	3	4	5	5	5	9	7
63	108	35	15	9	1,187	247	672	12	22	14	22	0	0	0
58	67	65	69	136	0	1,267	597	183	578	561	445	32	28	20
383	291	0	9	0	82	89	104	341	594	509	498	0	27	27
0	7	20	24	77	54	83	96	527	118	108	108	8	16	8
552	554	79	83	134	2,954	3,227	4,329	599	573	486	385	48	63	55
167	204	23	30	17	704	1,200	467	177	87	492	492	0	0	0
0	0	24	7	22	0	20	24	89	380	214	196	0	8	0
409	391	115	34	63	23,174	20,934	24,572	287	395	145	204	0	13	0
0	0	24	1	64	0	0	0	570	526	102	208	2	1	0
41	32	9	66	81	0	0	0	90	76	4	163	13	26	0
2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	0	0	0	0	439	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
0	0	–	0	0	–	0	1	–	–	0	0	–	0	0
1	1	1	1	1	7	8	6	1	1	0	0	1	1	0
482	504	114	112	198	2,927	3,141	4,160	996	1,177	1,175	1,067	59	63	47
0	0	0	0	0	0	0	248	0	0	0	0	0	0	0
0	0	1	0	12	82	83	125	0	0	0	0	12	20	20
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110	116	0	17	0	0	0	0	0	3	2	2	0	2	2
0	21	0	3	12	206	219	763	0	109	0	0	0	0	0
178	293	92	231	56	6,391	5,788	6,910	1,099	646	303	454	7	16	12
9	241	131	16	0	26	46	47	45	131	32	51	5	15	2
1,235	1,783	1,409	1,480	1,481	27,624	44,787	42,128	10,242	11,656	34,423	9,362	700	764	1,765
0	90	3,300	0	0	178	275	760	310	172	54	120	0	0	0
146,125	175,301	16,505	19,500	18,065	640,655	494,352	612,857	67,313	106,817	162,931	173,124	10,084	15,043	10,698
97	160	101	74	84	3,494	3,562	4,198	144	145	164	160	301	42	70
58	80	71	57	57	33	64	40	70	60	50	60	75	43	40

Under-vine ground cover update: year 3

Case study: Keshnee Mudaly, Lowe Family Wine Company, Mudgee

Keshnee (Kesh) Mudaly is a passionate viticulturist and organic and biodynamic specialist at Lowe Family Wine Company. She is in her second year of being the Assistant Vineyard Manager and is completing a diploma in viticulture at TAFE NSW Kurri Kurri campus.

Figure 10. A Zinfandel block at Lowe Family Wine Company with the cellar door in the background.

In December 2023, the Mudgee Wine Grape Growers Association visited the Mudgee vineyard (Figure 10 and Figure 11), where Kesh is trialling several regenerative agriculture practices and implementing organic and biodynamic techniques.

Kesh aims to improve wine quality and make the vineyard sustainable. David Lowe, the director and chief winemaker, transitioned the vineyard to being certified organic in 2005 and biodynamic in 2011. David advocates for sustainability practices such as planting drought-, heat- and disease-resistant varieties from Italy and the Mediterranean to ensure quality wine production.

Some of the regenerative agriculture techniques Kesh is using include establishing multi-species under-vine cover crops throughout the vineyard, crash grazing and making biodynamic compost to feed the soil.

Figure 11. Keshnee Mudaly speaking to members of the Mudgee Wine Grape Growers Association.

Kesh has implemented some trial areas with under-vine cover crops or pastures, and some weed matting to suppress weeds and improve soil moisture content.

The initial Shiraz block trial (dryland vineyard) of creeping saltbush (*Rhagodia spinescens*; Figure 12 and Figure 13), dichondra (*Dichondra repens*) and white clover (*Trifolium repens*) was planted in early September 2022. The seed was purchased locally from Nathan Lovett, owner of Naway Yila Buradja (Today Brings Tomorrow), to ensure successful germination and to adhere to the Lowe's environmental mission of locality and community.

The block was originally planted in 1995 using clone 1654 on its own rootstock. The vines were established on a bush vine trellis system, where they are allowed to grow naturally with a single iron post for support. As there is no irrigation, foliage is not excessive.

The under-vine area was cleared of weeds to prepare for planting, then seeds were hand-broadcast and worked in with a garden rake. Kesh timed the planting to happen before rain and was lucky enough to have rain once a week for a few weeks after planting.

Both the creeping saltbush and dichondra germinated, but the clover did not. Kesh believes this was due to the lack of irrigation in this part of the vineyard. Creeping saltbush was initially slow to germinate and establish, but has continued to spread and self-seed over the past 15 months. It now covers approximately 70% of the under-vine area it was sown into and is spreading into the mid-row area (Figure 14).

Figure 12. Keshnee in the Shiraz block with the creeping saltbush.

Figure 13. Creeping saltbush under the Shiraz in December 2023.

Figure 14. Creeping saltbush under the Shiraz in June 2024.

Dichondra was sparse (Figure 15) and patchy and has not progressed much further than the few clumps that initially established. This block does have some winter irrigation on a K-Line® system, however, the lack of irrigation in summer could explain why the dichondra struggled to establish.

Kesh said that once dichondra is established, it tolerates heat and water stress without dying off completely and tends to bounce back after some rainfall.

The results from the Shiraz dryland trial led Kesh to set up another trial row in the under-vine area in the Nero D'Avola block (which is part of the Latin Quarter planting) since irrigation is available (Figure 16).

This trial was planted at the end of February 2023 and has established very well over the past 10 months, covering close to 90% of the under-vine area (Figure 17).

Under-vine species were then established in the Nero D'Avola clone MAT 1. This block has irrigation, and the dichondra established successfully. Birds spread the creeping saltbush seed, which survived quite well and is likely to regenerate, as it did in the Shiraz block.

This autumn (2024), Kesh will plant a mix of sub clover (*Trifolium subterraneum*), black medic (*Medicago lupulina*), and dichondra under the new vines (the Latin Quarter), as these blocks have irrigation installed. This mix should suppress weeds and improve drought and frost tolerance.

Leaf testing to monitor vine health has shown the vines are photosynthesising well and have a high sugar content. Kesh has indicated she would like to use soil probes to monitor changes in soil moisture. In this block, the inter-row is slashed and the mulch is used to protect the seedlings as they germinate.

A weed mat was trialled (Figure 18) in an early planting area. However, this was unsuccessful as weeds grew through the mat, and it made the soil temperature extremely high, reducing vine growth. There was also the challenge of environmentally disposing of the weed mat.

Figure 15. Creeping saltbush and sparse dichondra in December 2023.

Figure 16. Dichondra under the Nero D'Avola vines in December 2023.

Figure 17. Dichondra under the Nero D'Avola vines in June 2024.

Case study summary

The decision to eliminate tillage and limit tractor hours to reduce compaction in the vineyard influenced the reasons for establishing permanent ground cover in the under-vine area of both the dryland and irrigated blocks.

The main benefit of ground cover is to suppress weeds, especially fat hen (*Chenopodium album*) and farmers' friend (*Bidens pilosa*), as these grow into the vine canopy, restricting airflow and adding to disease pressure.


Figure 18. Weed matting used in the trial.

Kesh observed that ground cover plants help retain soil moisture, reduce evaporation, keep soil temperatures lower, provide habitat for beneficial insects, and help stabilise the soil, which results in reduced soil erosion. Also, by covering the soil in the under-vine area, downy mildew spores in the soil are less likely to be splashed onto the leaf surface during rain.

The native ground cover plants do not appear to compete with the vines for resources, and the earthworm population has increased under the creeping saltbush. They are drought and frost-tolerant once established, and both creeping saltbush and dichondra were established without much rainfall or irrigation. However, dichondra was very slow to do so in these conditions.

Establishing permanent ground cover also means no-till in the under-vine area. By leaving the soil undisturbed, a more complex and diverse microbial network below ground will be encouraged. Kesh believes these microbes support the vines in many ways, helping to make nutrients available to the plants, providing disease protection and weed suppression.

The under-vine trial of dichondra in the irrigated Nero D'Avola block showed that it would establish more quickly to produce a matting effect if it was irrigated during establishment.

Kesh believes that all these benefits contribute to improved overall fruit quality. She also feels that fruit quantity will increase as there is less weed competition for water and nutrients and less disease pressure, as well as providing a habitat for predators, which makes biological pest control more successful. By monitoring progress once the permanent ground cover is established throughout the block, the effects can be more fully assessed.

The negative effects (or challenges) are that it is hard to control weeds during the establishment phase as they cannot spot-spray any weeds nor cultivate the under-vine area without killing the ground cover plants.

The main benefits of ground cover are:

- weed suppression
- soil moisture retention
- reduced soil erosion
- reduced spore splash from the soil onto the vines
- increased earthworm populations
- no-till in the under-vine area

Acknowledgement

This case study was part of the Greater NSW–ACT Regional Program delivered by NSW DPIRD in partnership with NSW Wine. The Regional Program is supported by funding from Wine Australia. Wine Australia invest in and manages research, development and extension of behalf of Australia's grape growers and wine makers and the Australian Government.

Case study: Brent Hutton, Vineyard Manager, Keith Tulloch Wine

Introduction

An under-vine, mid-row project was established in Autumn 2021 in a block of Semillon vines at Keith Tulloch Vineyard in the Hunter Valley. Under-vine species included crimson clover (*Trifolium incarnatum*), dichondra (*Dichondra repens*), and desert fescue (*Vulpia microstachys*). For information on the establishment phase of this trial, refer to the *Grapevine management guide 2021–22*, and for the second year updates, refer to the *Grapevine management guide 2023–24*.

The aim of the initial trial was to reduce inputs such as synthetic herbicides, maintenance and labour when managing under-vine areas, increase soil carbon stocks, water holding capacity and biological activity and reduce weeds, all without affecting grapevine yield and quality. This trial site was handseeded, however an additional trial site at the same location was hydroseeded in May 2024 (refer to page 28).

Figure 19. Desert fescue in January (top) and May (bottom) 2024.

Trial site

Results showed that desert fescue was too robust and competitive (Figure 19), reducing vine vigour (Table 4). It is probably more suited to a vigorous vine variety, such as Shiraz, when grown on heavier soil.

The dichondra established well (Figure 20) but Brent indicated that without irrigation, it would be a difficult species to establish. The crimson clover died (Figure 21), and being an annual, it did not re-establish after seeding.

Based on the trial results, Brent established dichondra in a small Chardonnay block on sandy soil to help with weed suppression and improve the soil moisture. A combination of wine marc, mushroom, and chicken compost (Figure 22) was added to the soil.

While grape quality parameters differed between years, inconsistent results make it difficult to determine whether the ground covers are leading to meaningful changes.

Another significant aim for Keith Tulloch Wine's vineyard manager is to have the business become carbon neutral. Having under-vine crops reduces the number of tractor passes. Other benefits from under-vine crops and nearby biodiversity beds (Figure 23) are reduced light brown apple moth (LBAM) numbers. This is likely due to the introduction of beneficial pest species, such as brown lacewings, which feed on LBAM. Powdery and downy mildew disease incidence has also decreased.

Table 4. 2024 Block 3 Semillon cane weight results.

	Control	Dichondra	Fescue
Average number of shoots per vine	20	19	18
Maximum cane length (mm)	1,200	840	540
Average cane length (mm)	620	500	340
Minimum cane length (mm)	150	130	140
Total cane weight (g)	770	356	181
Average total cane weight per vine (g)	257	118	60

Figure 20. Dichondra in January (left) and May (right) 2024.

Figure 21. Bare earth after the crimson clover died.

Figure 22. Wine marc, mushroom, and chicken compost.

Figure 23. A biodiversity bed near the Chardonnay block.

Key points

- When selecting an under-vine ground cover, consider soil type and vine vigour to limit any competition to vines that might affect yield.
- The ground cover selected should improve soil biological, physical and chemical parameters, increase soil organic matter and carbon stocks, improve soil moisture retention, and reduce input costs and maintenance.
- Additional benefits include encouraging beneficial species to reduce the use of chemical pest and disease controls.

Acknowledgement

This case study was part of the Greater NSW–ACT Regional Program delivered by NSW DPIRD in partnership with NSW Wine. The Regional Program is supported by funding from Wine Australia.

Under-vine pasture demonstration

The Wine Australia supported Greater NSW–ACT Regional Program received ongoing funding to establish an under-vine cover crop trial in Orange and an upcoming planting (June 2024) in the upper Hunter Valley.

The Orange site (Figure 24) was established in October 2023 and the vines are transitioning from having bare earth or pasture in the under-vine area to having a planted full cover under-vine area.

Location: Nashdale Wines, 125 Nashdale Lane, Nashdale NSW.

Co-operator: Nick Segger (vineyard owner).

Variety: Pinot Gris (clone D1V7) planted in 2008 (Block 4A). This Pinot Gris has a moderate bunch size and yield and can produce highly aromatic and textural wines.

Figure 24. The Nashdale vineyard rows used for this trial.

Aims

1. To trial different pasture species for under-vine weed control and vineyard sustainability.
2. To trial different under-vine vineyard practices to improve soil biological, physical and chemical parameters, soil moisture retention (especially in upcoming periods of predicted drought), improve soil biodiversity, weed suppression and encourage beneficial insects.

This trial is a follow-up from one conducted in the Hunter Valley in Autumn 2021, refer to *Grapevine management guide 2023–24*. Under-vine species used in the Hunter Valley trial included crimson clover (*Trifolium incarnatum*), dichondra (*Dichondra repens*) and desert fescue (*Vulpia microstachys*).

Three changes were made for the trial in Orange:

1. Replacing the desert fescue with creeping fescue as the desert fescue grew into the fruiting zone of the vineyard.
2. Replacing the crimson clover with red clover due to the regional pasture selections for Orange.
3. Adding annual ryegrass to mix with the red clover. Studies have shown that using annual ryegrass in vineyards can control weeds, including kikuyu infestations, and improve soil aeration, soil structure and organic carbon levels. It can also reduce soil erosion, but if it is not managed effectively, it can compete with the vines and reduce yields.

Methods

The methods used were designed to establish the species; they were not necessarily a practical way of establishment. The seed rates were higher than necessary, and irrigation was used because the trial was planted in mid-spring. Ideally, these treatments would be sown in autumn with cooler temperatures and higher effective rainfall. Mulch was necessary because the seed was not buried, to conserve soil moisture and cool the soil. Sugar cane mulch was used because it was weed-free and easy to handle.

Treatments

Treatments were applied in October 2023 as follows:

- Rows 1, 2 and 11 – **control** (bare ground)
- Rows 3 and 4 – **dichondra** (*Dichondra repens*) at 460 g seed/row (20 m)
- Rows 5 and 6 – **creeping fescue** (*Festuca rubra*) at 460 g seed /row (20 m)
- Rows 7 and 8 – **annual ryegrass** (*Lolium multiflorum*) and 2 species of short season **sub clover** (*Trifolium subterraneum*) at 800 g seed/row (20 m)
- Rows 9 and 10 – **red clover** (*Trifolium pratense*) at 420 g seed/row (20 m).

The seed was broadcast on a 600 mm band under the vines. Sugar cane mulch was applied to each row to cover the seeds. Each row had 250 L of water applied (equivalent to 20 mm rainfall; Figure 25).

Vine spacing: there were 5 panels with 13–14 vines per row at a 1.5 m spacing.

Site preparation: one week before sowing, the rows were sprayed with Spray.Seed® (135 g/L paraquat + 115 g/L diquat), a broad-spectrum contact herbicide.

Each row was then cultivated by hand using a 3-prong tine to loosen the soil surface.

Fertiliser: every row had 570 g of Rustica Plus fertiliser applied (12.0% nitrogen, 5.0% phosphorus, 14.0% potassium, 9.7% sulfur, 3.1% calcium, 1.2% magnesium, 0.1% zinc and 0.02% boron) by hand in April 2023 (Figure 26 to Figure 30).

Germination: broadleaf species germinated on 1.11.2023.

De-suckering: 22.11.2023, 28.11.2023, and 24.1.2024.

Rain and irrigation

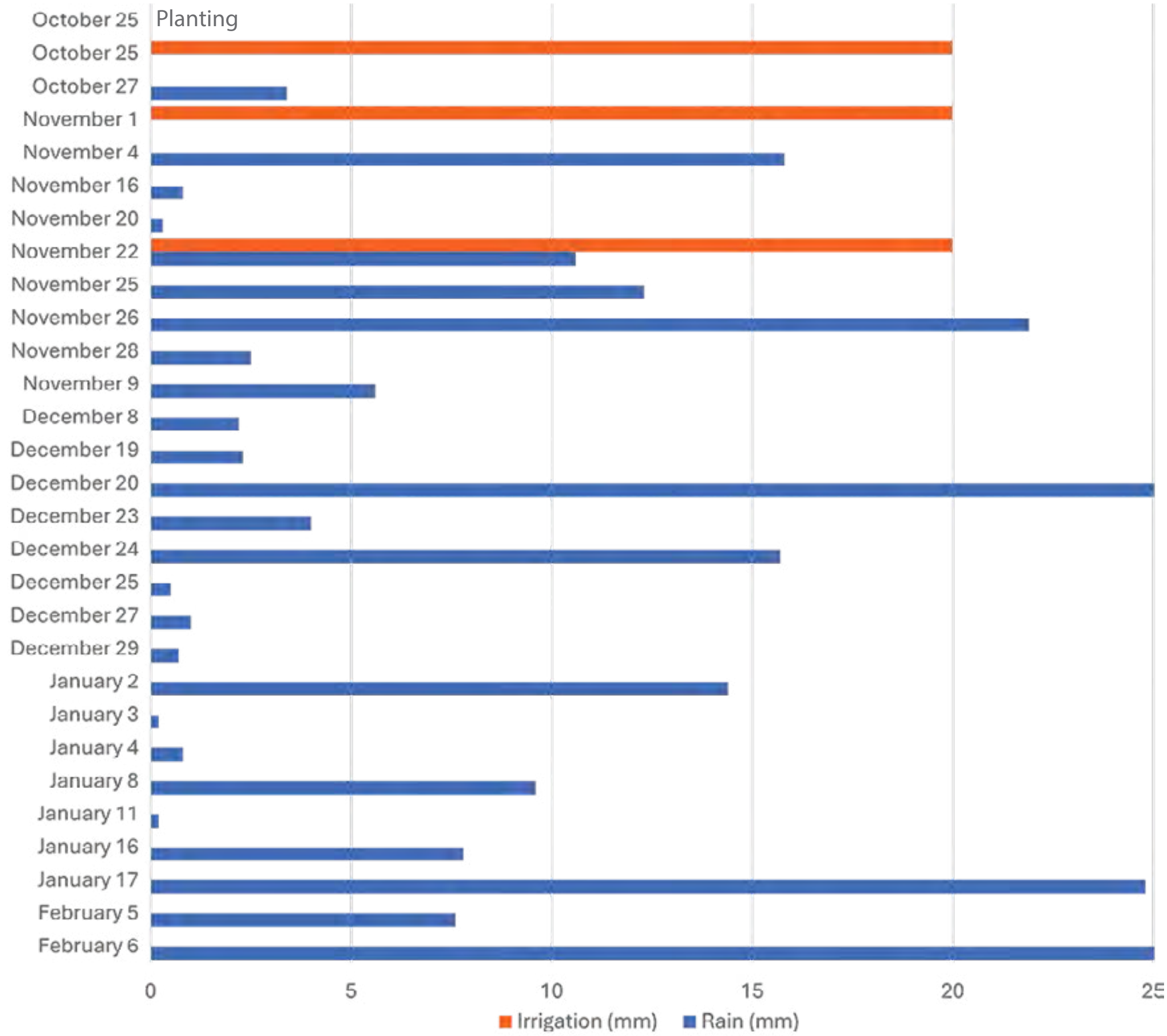


Figure 25. Rain (in blue bars) and irrigation (in orange bars) at the trial site in Orange. Note, irrigation was only applied during establishment.

Figure 26. The control rows in November 2023 (left) and after fertilising in April 2024 (right).

Figure 27. The dichondra rows in November 2023 (left) and after fertilising in April 2024 (right).

Figure 28. The creeping fescue rows in November 2023 (left) and after fertilising in April 2024 (right).

Figure 29. The annual ryegrass and sub clover rows in November 2023 (left) and after fertilising in April 2024 (right).

Figure 30. The red clover rows in November 2023 (left) and after fertilising in April 2024 (right).

Progress

As this trial was started in September 2023, there are no results yet. These and other results from the new trial site in the Hunter Valley will be available in the 2025 edition of the *Grapevine management guide*.

So far all under-vine species seem to be flourishing, especially the annual ryegrass and dichondra. The clover grows better in wet, cool conditions and tends to die back in hotter conditions.

During the next few years, we hope to determine which species are suitable for weed suppression, soil moisture retention, and reduced herbicide and chemical use in vineyards.

For subsequent under-vine plantings, we would aim to sow in autumn to early winter as this suits the pasture species and should avoid any problems with heat. We would also consider including a treatment for red-legged earth mite, especially for the dichondra, as the seedlings were eaten.

Save on labour with great results – no strings attached

GroGuard® Vineguards are saving growers thousands of dollars on training labour during the establishment phase of vineyards throughout Australia. Savings put growers well ahead in the first year with GroGuard® Vineguards, much more is saved in labour than they cost.

By re-using GroGuard® Vineguards, growers are spreading the cost of the guards over second and even third plantings, repeating the labour savings achieved in the first planting at no extra cost.

"Re-use brings bigger savings" John Pargeter, Angas Vineyards

No string or stake is used and the vine is trained continuously, without interruption, until it reaches the cordon wire.

"We just plant the vines, put the guard on and don't do anything at all until they pop out the top" Ashley Ratcliff, Ricca Terra

GroGuard® Vineguards train the vine straight up inside the guard. No people. No strings. No stakes.

"We didn't run a crew through the first year at all' James Sullivan, Katnook Estate.

In addition, GroGuard® VineGuard's ZipSafe seal saves labour costs on weed control. Controlling weeds with herbicide can be done effectively when the young vine is protected inside a fully sealed vineguard. Boom spray weed control is quicker and easier; the ZipSafe seal keeps out the finest herbicide droplets.

"A tall and sealed guard permits complete herbicide coverage without any chance of damage to the vine" John Pargeter, Angas Vineyards

Establishing a vineyard has proven to be more economical using GroGuard® Vineguards with substantial labour savings, and excellent results.

EcoVineyards: demonstrating the benefits of under-vine ground cover

Dr Mary Retallack, Retallack Viticulture Pty Ltd

EcoGrowers (those using ecological practices) are planting a diverse mix of low-growing ground cover to improve the functional capacity, resilience and profitability of their vineyards.

Wine grape growers throughout Australia are being supported in their actions to enhance soil health, establish ground cover and increase biodiversity in vineyards through the National EcoVineyards program.

The program aims to accelerate the adoption and practice change outcomes specified in Wine Australia's Strategic Plan 2020–2025, specifically to increase the:

- land area dedicated to enhancing functional biodiversity by 10%
- use of vineyard cover crops and soil remediation practices by 10%.

In addition to our annual events and activities, the EcoVineyards team is working closely with wine grape growers to establish demonstration sites in 8 participating wine regions throughout Australia, including the Hunter Valley, Orange, Margaret River, Yarra Valley, Mornington Peninsula, Clare, Adelaide Hills, and Langhorne Creek.

We encourage wine grape growers to achieve 100% functional plant cover (and active root growth) 100% of the time (where possible).

Why is this important?

With bare soil, nature will fill the void with weed species (also known as pioneer plants or early colonisers), which are often indicators of soil health. Early coloniser species include moss and lichen (also called cryptogams, or plants that reproduce by spores without flowers or seeds). They help to protect the soil surface when it is sterile due to prolonged herbicide application. Using herbicides in a vineyard is often problematic, with many weed species quickly becoming resistant to the herbicides.

What might be considered competition from weeds could be due to other factors including allelopathy, which is the adverse effect one plant has on another, caused by the exudation of chemicals into the soil that suppress the growth of nearby plants. For example, wireweed (*Polygonum aviculare*) and ryegrass (*Lolium* spp.), which produce suppressive chemicals, and weed species are commonly found in association with compacted and bacteria-dominant soil.

The aim is to replace these voids and weeds with diverse ground cover plants, which might include grasses, forbs (flowering plants) and low growing, prostrate woody plants. This should convert compacted and bacteria-dominant (Figure 31) soil to:

- be more friable with greater water-holding capacity
- have more soil carbon and microbial activity with fungi-dominated soil, which is preferred by perennial species such as grapevines
- transform nutrients into plant-available forms
- create pathogen-suppressive soil
- have greater resilience in the system.

Liquid carbon pathway

It is important to maximise the benefits gained from using nature's solar panels (i.e. the leaves of optimally photosynthesising plants) and the many benefits from the liquid carbon pathway (Figure 32) when it is working well in healthy systems.

The liquid carbon pathway is a symbiotic relationship between mycorrhizal fungi and 90% of all plants, including grapevines. Plants produce extra carbohydrates (simple plant sugars) and then exude that surplus into the soil to feed fungi. Arbuscular mycorrhizal fungi (AMF), in turn, use the exudates to create a sticky carbon exudate called glomalin.

Glomalin is critical when soil aggregates are forming to create soil structures with adequate pores for air and water storage. With the increased water-holding capacity that comes with increased soil carbon, a plant's photosynthetic capacity increases. This leads to more carbon being pumped into the soil, which is an important feedback loop, all fuelled by the sun. Photosynthesis and the liquid carbon pathway are essential for building soil.

In return for these exudates, soil microbes, particularly fungi, provide moisture and nutrients to plants. When the cycle is functioning well, soil biology will source, cycle and transport many nutrients that plants require for growth. Without this interaction, many minerals and trace elements are not plant-available, and the system does not work optimally.

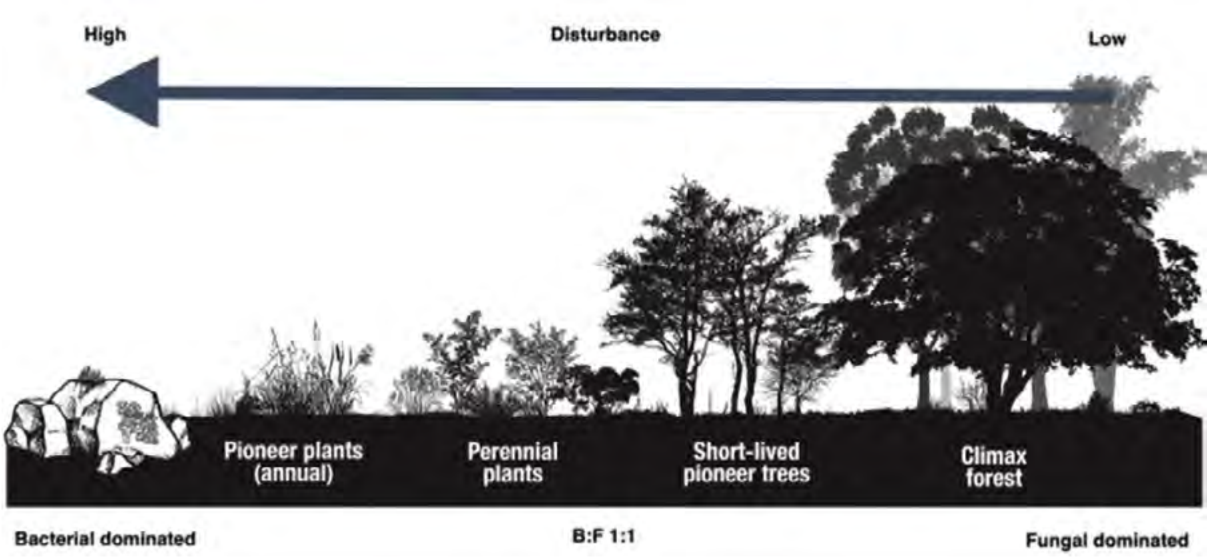


Figure 31. An example of the types of Australian plants involved in ecological succession.

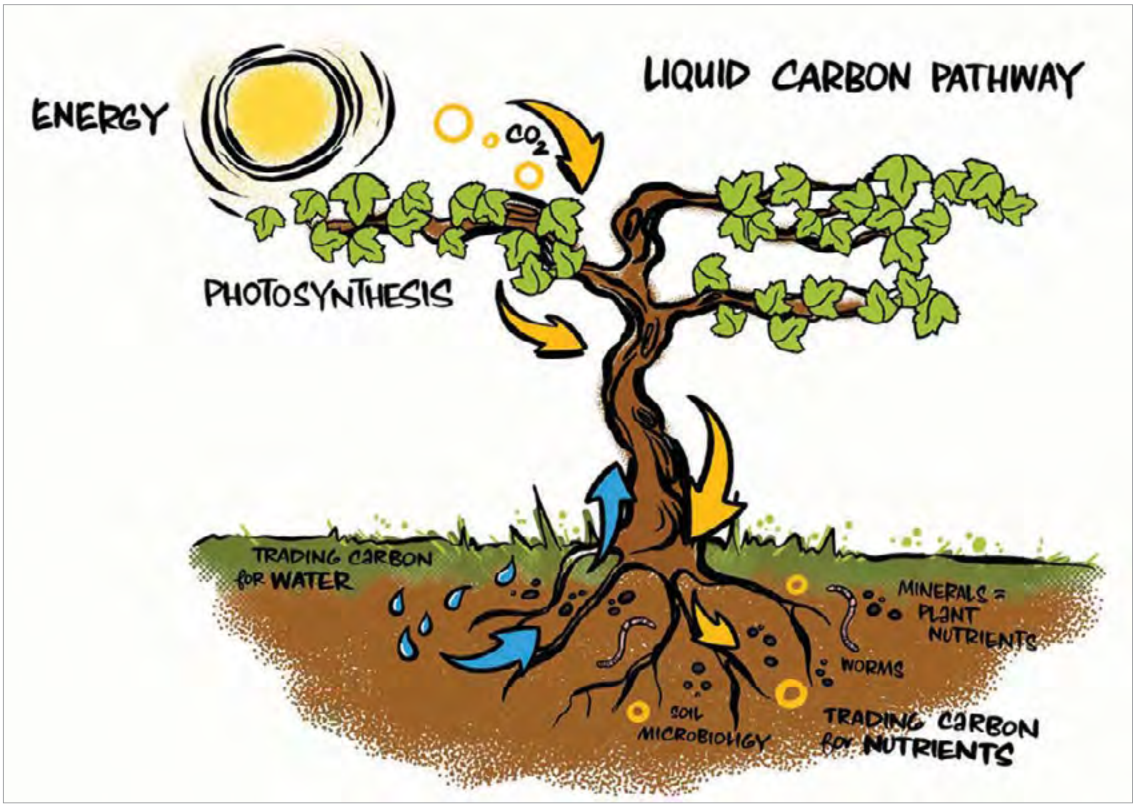


Figure 32. Soluble or liquid carbon pathway.

Low-growing ground cover

The EcoVineyards events held in May 2024 focused on a range of cover crops and perennial ground cover species (commercial and native) that can provide long-lasting benefits in vineyards.

PGG Wrightson's Seeds and Vortec Global demonstrated a purpose-built hydroviner for use in vineyards, and local contractors applied a slurry mix of wood fibre, water and seed.

We also explored a range of low-growing species (reported to grow <300 mm) that might be suitable in the under-vine area by hand-sowing individual species in each panel. Wood fibre was then hydroseeded over the top of half the row to assess germination rates with and without wood fibre, and the overall success and growth characteristics of each species. Commercially, a single blend of seed would normally be incorporated in the hydroseeding mix in a single pass.

NSW demonstration sites

The EcoVineyards team established demonstration sites at Keith Tulloch Wines (Figure 33 and Figure 34) in the Hunter Valley and See Saw Wine in Orange with the following 19 ground cover species in either location.

Native species:

- creeping saltbush (*Atriplex semibaccata*)
- cut leaf goodenia (*Goodenia pinnatifida*)
- dichondra (*Dichondra repens*)
- fuzzy New Holland daisy (*Vittadinia cuneata*)
- inland pigface (*Carpobrotus modestus*)
- kneed wallaby grass (*Rytidosperma geniculatum*)
- lemon beauty heads (*Calocephalus citreus*)
- native flax (*Linum marginale*)
- pussy tails (*Ptilotus spathulatus*)
- round-leaved pigface (*Disphyma crassifolium*)
- running postman (*Kennedia prostrata*) Orange only
- scaly buttons (*Leptorhynchos squamatus)* Orange only
- Swan River daisy (*Brachyscome iberidifolia*) Orange only
- weeping grass (*Microlaena stipoides*)
- woolly New Holland daisy (*Vittadinia gracilis*)

Introduced species:

- creeping thyme (*Thymus serpyllum*)
- Persian clover (*Trifolium resupinatum)* can grow up to 500 mm tall
- subterranean clover (*Trifolium subterraneum*)
- sweet alyssum (*Lobularia maritima*)

These demonstration sites will help identify which species are likely to grow well so regionally specific mixes can be developed. The findings from each region will be presented in a series of case studies in 2025.

Wine grape growers are invited to access a range of regionally specific resources on soil health, ground cover (including cover crops) and functional biodiversity on the EcoVineyards website (https://ecovineyards.com.au/).

Figure 33. Lorrae St Vincent (Brokenwood), Dr Mary Retallack (EcoVineyards) and Brent Hutton (EcoVineyards) at Keith Tulloch Wines (left). Ground cover species were sown in each panel and the hydroseed slurry applied to half the row and sown with kneed wallaby grass (*Rytidosperma geniculatum*) (right).

Figure 34. The hydroviner unit was used to apply a slurry of wood fibre and water at Keith Tulloch Wines in the Hunter Valley (top left) and Orange EcoVineyards event participants (top right and below).

Funding

The National EcoVineyards Program is funded by Wine Australia with levies from Australia's grape growers and winemakers and matching funds from the Australian Government. The program is delivered by Retallack Viticulture Pty Ltd with significant support from regional communities.

For more information, please visit the National EcoVineyards Program website (www.ecovineyards.com.au).

Ground cover seminar and hydroseeding demonstration

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

On 9 May 2024, I attended a ground cover seminar and hydroseeding demonstration by EcoVineyards and EcoScape Solutions of Orange at See Saw Wine in Orange.

Dr Mary Retallack (Figure 35) discussed work she is doing in South Australia and the Hunter Valley and Orange regions with multi-species ground cover blends. Some of the local vineyards involved include See Saw Wine, Renzaglia Wines and Tamburlaine Organic Wines.

Figure 35. Dr Mary Retallack of EcoVineyards presenting at a ground cover seminar at See Saw Wine.

Dr Retallack also indicated that EcoVineyards are conducting a 3-year development program starting with soil health (2023), cover crops (2024) and functional biodiversity (2025).

Jade Killoran of Healthy Farming Systems continued the discussion on multi-species cover crops, indicating there was a mix of annuals, perennials, insectary native grasses, native woody and native forbs or flowering species used. All species selected are low-growing.

Jade discussed a trial site on the NSW South Western Slopes with a mustard growing trial and a test site in Mudgee, where ryegrass and other native perennials were chosen to out-grow wireweed.

Tim Berryman of Cumberland Plain Seeds Pty Ltd spoke about restoring the land and assisting with regeneration by using species that suit the area. He also said that growers should understand the land they are working on to help with this.

Mark Stidwill of DuraVeg – PGG Wrightson Turf talked about his hydromulch and hydroseeding materials, which were originally used in the mining industry for erosion control. He discussed the creation of the slurry mixture based on the operation, which include factors such as slope, rain-resistant seed types, and fertiliser requirements. All affect the composition of the hydroseeding mixture. Mulch fibre is used and is usually from recycled wood.

The hydroseeding demonstration by EcoScape Solutions (Figure 36) from Orange NSW included several different species including:

- alyssum (*Lobularia maritima*)
- creeping saltbush (*Atriplex emibaccata*)
- cut leaf goodenia (*Goodenia pinnatifid*a)
- dichondra (*Dichondra repens*)

- inland pigface (*Carpobrotus modestus*)
- kneed wallaby grass (*Rytidosperma geniculatum*)
- lemon beauty heads (*Calocephalus citreus*)
- native flax (*Linum marginale*)
- pussy tails (*Ptilotus spathulatus*)
- round-leafed pigface (*Disphyma crassifolium*)
- running postman (*Kennedia prostrata*)
- scaly buttons (*Leptorhynchos squamatus*)
- subterranean clover (*Trifolium subterraneum*)
- Swan River daisy (*Brachyscome Iberidifolia*)
- weeping grass (*Microlaena stipoides*).

Figure 36. The hydroseeder seeding under the vines.

Species selection is determined by the needs of individual vineyards, which can include:

- increasing biomass, nitrogen-fixing, insect populations, nutrient cycling nitrogen to carbon cycling, and forage crops if stock are grazing the vineyards
- reducing compaction, waterlogging, salinity, and weeds
- requiring drought hardy species or salinity tolerant species
- using them as a nematicide (e.g. brassicas or mustard species).

Highlights include:

- Using a hydroseeder made establishing an under-vine planting easy, especially compared to hand-seeding, which is labour-intensive and time-consuming.
- The cost of hydroseeding is around $1,500/ha (Michael Curran, EcoScape Solutions, personal communication), depending on the material added to the mix, seed type, and fertiliser, but once established, it is 'set and forget'.

Rotational sheep grazing at Lowe Family Wine Company

Keshnee Mudaly, Assistant Vineyard Manager, Lowe Family Wine Company

Lowe Family Wine Company (LFWC) is a family-owned and operated wine and food business based in Mudgee, NSW. The 400-ha property (Tinja Farm) is certified organic and biodynamic, with 17 ha of grapevines, a no-till market garden, various orchards, and pastoral land for grazing livestock. On-site is a winery, cellar door, function centre, and hatted restaurant (The Zin House).

Sheep and cattle are raised on-farm for the restaurant as part of the farm-to-table dining concept. Since 2022, LFWC has started using their sheep in the vineyard by implementing a winter rotational sheep grazing program (Figure 37).

Figure 37. Sheep grazing in the vineyard at Lowe Family Wine Company.

Sheep breed and management

Dorper sheep were chosen because:

- they are low-maintenance and adapted to various conditions
- they are very hardy, make good mothers, and generally have an easy-going nature
- the meat is excellent quality, which makes them a great option for the on-farm restaurant
- they do not require shearing, crutching, mulesing or tail docking, so maintenance requirements are low, making them the perfect sheep for an organic farm
- in Mudgee's dry climate, they do not require drenching
- Australian Dorpers have a natural skin pigment that protects them from skin cancer.

Benefits of rotational sheep grazing

1. **Weed and pest control**: sheep are efficient weed and pest controllers. Their grazing habits help manage cover crops and remove unwanted vegetation (pest host plants and competitive weeds) from the under-vine area and between vine rows. This promotes a healthier vineyard ecosystem and reduces overall environmental impact.
2. **Fertilisation**: as the sheep graze, they deposit organic matter (manure), which enriches the soil with essential nutrients. They also trample the cover crop into the soil, which helps the plant

material break down and feed the soil. This natural fertilisation improves soil structure, increases microbial activity, and enhances nutrient availability for the vines.

3. **Soil health**: rotational grazing promotes soil aeration, which is crucial for maintaining soil health and water infiltration. The sheep hooves help to break up compacted soil, allowing roots to penetrate deeper and access nutrients more effectively. Healthy soil contributes to vine resilience and long-term productivity.
4. **Carbon sequestration**: by incorporating organic matter into the soil through manure deposition, and reducing the need for tillage in the vineyard, sheep grazing contributes to carbon sequestration. This helps mitigate the effects of climate change by reducing the vineyard's overall carbon footprint.

Operational details

Before introducing the sheep into the vineyard, a cover crop (annual rye grass, white and sub clover) is sown in early autumn. This provides sufficient feed for the sheep and offers additional benefits such as soil protection, erosion prevention, weed suppression, and natural nutrient cycling to enhance soil and vine health.

The sheep grazing program reduces the need for at least 3 tractor passes between leaf-fall and budburst, reducing diesel use, emissions, and soil compaction in the mid-rows.

Flock management: the flock averages around 30 ewes and 10 lambs. Numbers are controlled to ensure consistent meat supply for the restaurant without overgrazing the farm. Maintaining a small flock eliminates the need for dividing the mob, making management easier.

Grazing schedule: sheep are introduced to the vineyard after 90% leaf fall and removed again before budburst (Figure 38). They cannot be used in the vineyard during the growing season because they will eat the vine leaves and grapes. The timing and duration of grazing are strategically planned based on the vineyard's needs, weather conditions, and the growth cycle of the cover crops. This ensures that each section of the vineyard receives adequate grazing without overgrazing.

Figure 38. Before grazing (left) and after grazing (right).

Fencing and water supply: portable electric fencing and water troughs are used to manage grazing areas (Figure 39). Initially, 3 electric lines were used, but this was reduced to 2 in the second year as the sheep quickly became wary of them.

Figure 39. The portable fence (left) and water trough (right).

Movement and monitoring: moving the sheep requires 2–3 people and a quad bike to guide the flock. Moving them regularly in a crash-grazing system ensures that parasites from manure do not build up and grasses are not grazed past the point of regeneration. Regularly monitoring vineyard health, soil conditions, and feed levels allows for adjustments to grazing schedules and ensures optimal grazing pressure is achieved with minimal negative effects.

After budburst, the sheep are rotationally grazed on other paddocks.

Outcomes

Using rotational sheep grazing has yielded significant positive outcomes, including.

- **Improved soil quality**: soil tests reveal increased organic matter, microbial activity, and nutrient levels in vineyard soil, indicating improved soil fertility and health.
- **Reduced input costs**: eliminating the need for off-farm inputs such as organic fertilisers and reducing tractor hours and diesel use have resulted in cost savings while maintaining high-quality grape production.
- **Fewer weeds with reduced vigour**: there are fewer weeds in the vineyard, and those that do come up, are less competitive with the vines and are easier to remove from the under-vine area.
- **Profitability**: livestock profits come from maintaining retail pricing when supplying meat to the restaurant, function centre, and bakery.
- **Enhanced wine quality**: the symbiotic relationship between healthy soil, diverse ecosystems, and grapevines has translated into wines with greater complexity, depth, and expression of terroir. Yield has increased by 25% without a compromise in quality.

Conclusions

Rotational sheep grazing is a fundamental component of the LFWC regenerative agriculture toolkit. Combined with cover crops, biodynamic soil sprays, and applying biodynamic compost annually, this practice has helped improve the soil's carbon levels, water-holding capacity, and reduced weed competition, resulting in sustainable and high-quality wine production.

Vine removal case study

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

In the early 1990s, 5 mature-age students decided to form a partnership to develop a substantial vineyard and winery. After a lengthy search, a large property at Cudal with ideal soil and climate was identified. The property, Monument Vineyard, was planted with just under 100 ha of vines in 1998 and 1999. Ten years later, in 2009, brothers Andrew, Phillip, and Stephen Jones acquired the business (Figure 40), which also included a poultry farm and a cattle enterprise.

Figure 40. The entrance to Monument Vineyard. Note the vine removal piles in the background.

In 2024, Stephen decided to reduce the size of the vineyard and employed Tom Stevens of Vine Sight, Canowindra, to remove approximately 65 ha of the existing 25-year-old vineyard as well as a non-viable 6 ha plot of rootlings. Varieties such as Shiraz and Cabernet Sauvignon were removed.

Stephen selected Vine Sight because he considered its method of removing vineyards as environmentally friendly.

Vine Sight follows a 5 step process:

1. unhooking the irrigation tubing from the wire
2. winding or rolling up the tubing (Figure 41)
3. winding or rolling up the wire (Figure 42)
4. removing the vines
5. removing the posts (Figure 43 and Figure 44)

The blocks are then converted to pasture or left fallow.

Irrigation tubing was bundled and recycled as plastic or resold depending on condition. If there is too much sediment inside the irrigation piping or if there is wire wrapping or fasteners, it cannot be recycled and it goes into landfill. At Monument Vineyard, the option to recycle was hampered by the irrigation being used for frost flippers or overhead sprinklers, which were attached using wire.

Wire and tubing can be recycled separately, but when they are inseparable, they must be disposed of in landfill.

Figure 41. Bundled irrigation tubing after rolling.

Figure 42. A bobcat was used to roll the irrigation tubing, and a tractor was used for post and wire collection.

Steel posts are bound together (Figure 43) and sold. Broken or bent steel posts were recycled.

Figure 43. Steel posts bound for resale.

Wooden posts were bound together and sold (Figure 44). The advantage of the wooden posts used at Monument Vineyard was that most were not copper chrome arsenic (CCA) treated. This meant that any broken posts could be placed with the vines and burnt in the winter (Figure 45). Any CCA-treated posts should not be burnt as the ash from them can contain up to 10% (by weight) arsenic, chromium, and copper.

Figure 44. Wooden posts bound for resale.

Figure 45. Vines, broken wooden posts and broken wire vine guards pushed together for burning in winter.

When dry, the limestone soil needed to be ripped near the vines and posts so they could be removed (Figure 46).

Figure 46. Rip lines in the soil to assist with removing vines and posts.

The cost of removing this vineyard, which had 3 m rows and 2 m vine spacing, was $2,750/ha. In Griffith, vineyard removal cost approximately $2,000/ha. These vineyards had irrigation drippers in the ground, single posts, cordon wires, and wider vine spacing.

Some of the costs can be recouped by reselling suitable steel and wood posts and irrigation lines in good condition. Much of the infrastructure is either recycled or reused.

An abandoned vineyard would usually incur a higher cost, especially if livestock had been grazing in the area and had damaged wires, posts, irrigation infrastructure and vines.

The enterprise remains economically sustainable due to being a mixed operation, and it retains 32 ha of vineyards (Figure 47) for continued sales.

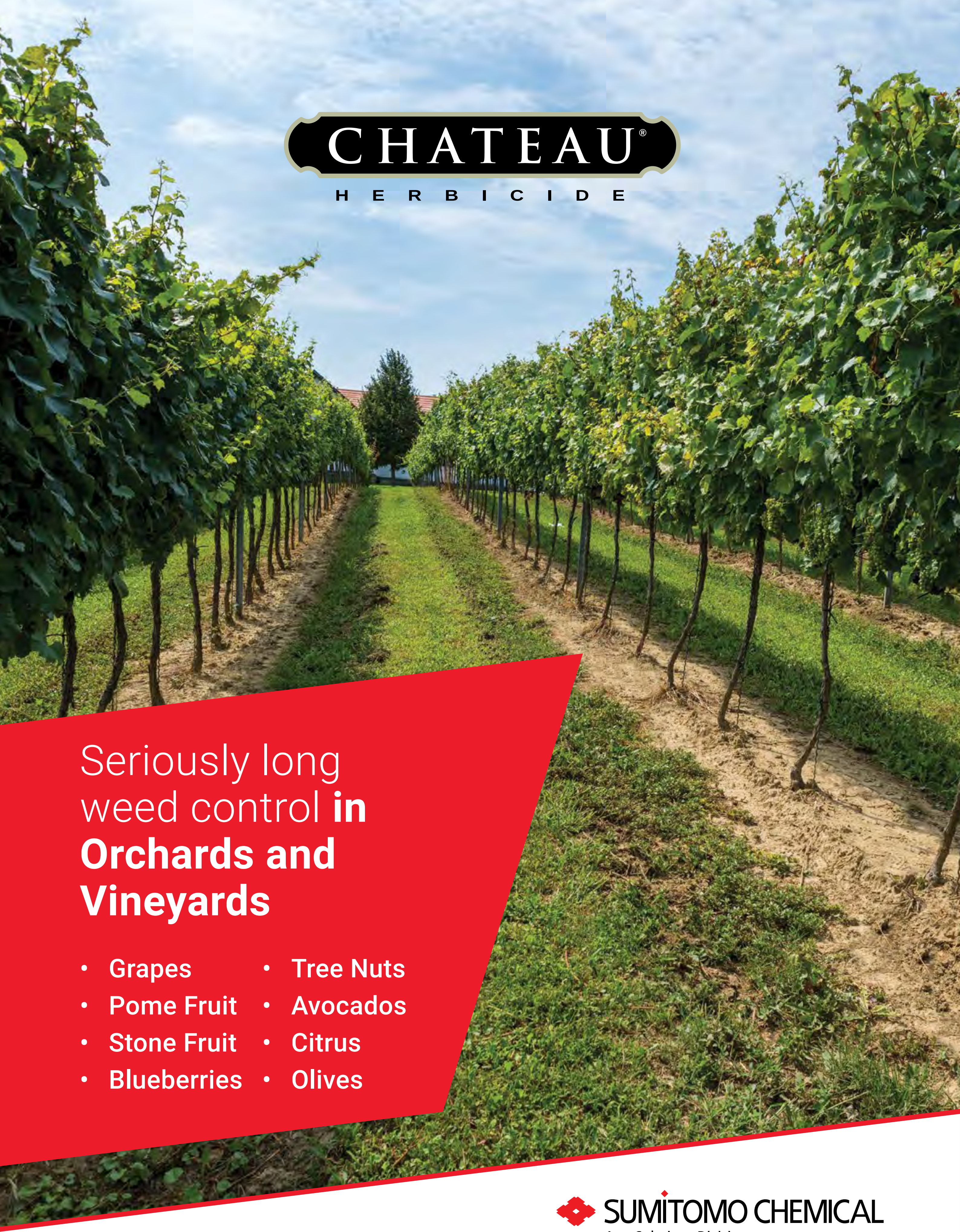
Figure 47. A vineyard beside the entrance to Monument Vineyard.

Vineyard removal tips

- Avoid using wire with dripper tube because it might affect future recycling opportunities.
- It is better to pull up a vineyard straight after harvest as those that are abandoned or stock-damaged are difficult to recycle and cost more to remove.

Acknowledgement

This case study was part of the Greater NSW–ACT Regional Program delivered by NSW DPIRD in partnership with NSW Wine. The Regional Program is supported by funding from Wine Australia. Wine Australia invest in and manages research, development and extension of behalf of Australia's grape growers and wine makers and the Australian Government.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Resting vineyard trial update

Alison Fattore, Robert Hoogers, Penny Flannery, Myles Parker and Bruno Holzapfel (NSW DPIRD)

We acknowledge Katie Dunne, who established the trial, Robert Hoogers, who assisted, and Paul Petrie (South Australian Research and Development Institute), who was consulted on the trial design.

Introduction

As part of the Wine Australia supported Greater NSW–ACT Regional Program, NSW DPIRD trialled resting vineyard methods on a block of Chardonnay grapevines over 2 growing seasons, similar to a trial by researchers at SARDI on Shiraz grapevines. The aim was to determine the most effective and economic vineyard resting options. This was done by assessing the yield of different crop removal/ reduction options in the season of treatment and the season after vineyard resting. A cost analysis of the different treatment options is also provided (Table 5).

Objective

To provide industry with low-cost options to maintain vineyards when growing and harvesting fruit is uneconomical.

Methods

Eight vineyard resting options, including a 'do nothing' approach (fruit unharvested), and 3 irrigation treatments were applied on a 2.7 ha block of Chardonnay at the Griffith Institute for Irrigated Agriculture in the Riverina. The Chardonnay was planted in 2001 on sandy loam and grafted onto the Ruggeri 140 rootstock, with 3.0 m row spacing and 2.5 m vine spacing (1,333 vines/ha).

Additionally a control with fruit harvested as per a normal season was applied. This allowed yields of different chemical or mechanical resting options with different irrigation levels to be compared with a control in a growing season when the vineyard was being rested. It also allowed the effect on yield when returning to production after resting to be measured.

Treatments

1. Control: fruit picked at harvest (as per a normal season)
2. Fruit unharvested (left on vines until pruning)
3. 100% fruit removal (simulating fruit removal with a harvester early in the season)
4. 50% fruit removal (half the bunches were removed from the vines)
5. Double pruning (manually pruned with a hedger to mimic commercial hedging by machine)
6. 2.5 kg/ha calcium nitrate (sprayed with a hand wand to mimic a blast spray)
7. 100 mL single ethephon (900 g/L) + 100 mL wetting agent (600 g/L nonyl phenol ethylene)
8. 2.5 kg/ha calcium nitrate + 100 mL ethephon (900 g/L) + 100 mL wetting agent (600 g/L nonyl phenol ethylene)
9. 100 mL double ethephon (900 g/L) + 100 mL wetting agent (600 g/L nonyl phenol ethylene).

Irrigation

Full (100%), reduced (50%), and low (25%) irrigation treatments were applied via a drip system. The full irrigation was managed by a weather-based schedule and soil moisture probes to supply 100% of evapotranspiration requirements. Reduced irrigation was 50% of full irrigation on the same valve and the same timing. Low irrigation was 25% of full irrigation at different time intervals. This allowed for more targeted irrigation applications around rainfall. Soil moisture was monitored with Green Brain, WiField, a NSW DPIRD logger, and a large array of sensors, including capacitance, watermark, trunk dendrometers and sap flow.

Over 500 mm of rain fell in the 2022–2023 growing season, which is almost double the average. This made it difficult to implement water stress. It also caused severe downy mildew and later season powdery mildew, which affected leaf and bunch integrity, leading to considerably lower yields compared with a 'normal' growing season.


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Results

Treatments with crop maintenance irrigation (25%)

The yields in the first growing season were relatively low (Figure 48). However, the relative treatment yields were similar in both growing seasons (Figure 49).

As expected, 100% fruit removal resulted in the least yield. The double pruning and 2 × ethephon treatments were the most effective at reducing yields compared with the other treatments. The 2022-23 growing season was very wet and the influence of irrigation treatments was probably negated.

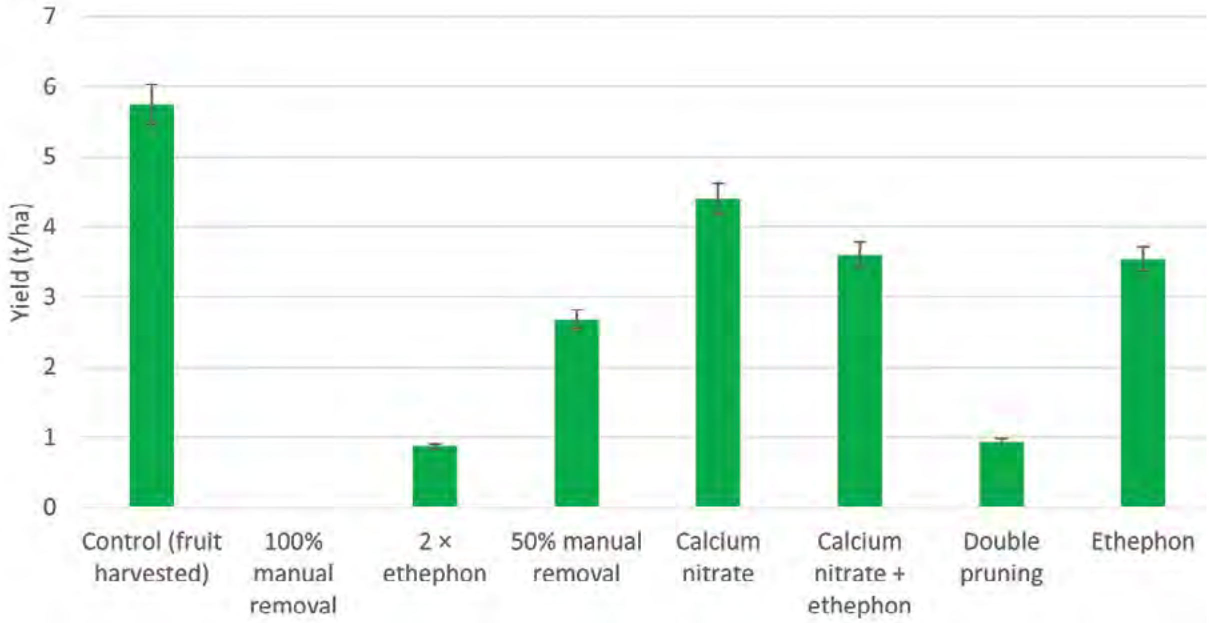

Figure 48. Treatment yields (t/ha) in the first growing season (2022–23) of the resting vineyard trial in Chardonnay grown in the Riverina.

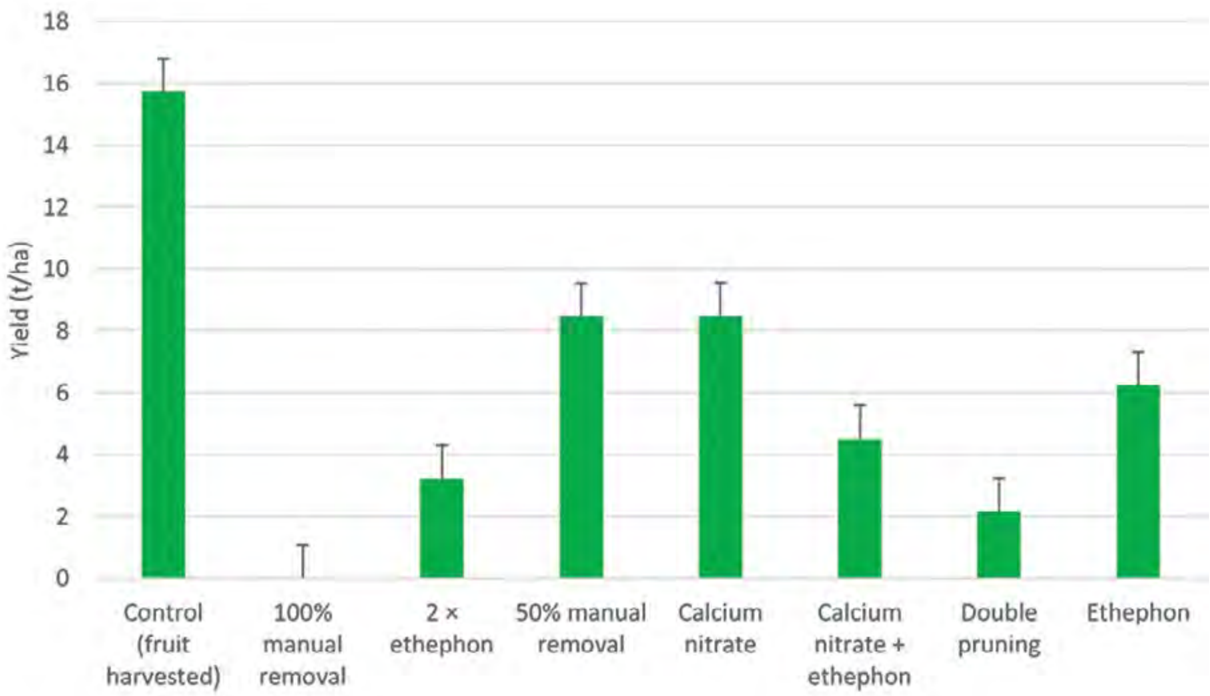

Figure 49. Treatment yields (t/ha) in the second growing season (2023–24) of the resting vineyard trial in Chardonnay grown in the Riverina.

Treatments with full, reduced (50%) and low (25%) irrigation

When yield was reduced by fruit removal, the effect of reduced irrigation (50%) was minimal. Low irrigation (25%) reduced yield in all treatments (Figure 50 and Figure 51). The 2023 growing season results were affected by the wet seasonal conditions and disease was the greatest contributor to yield loss.

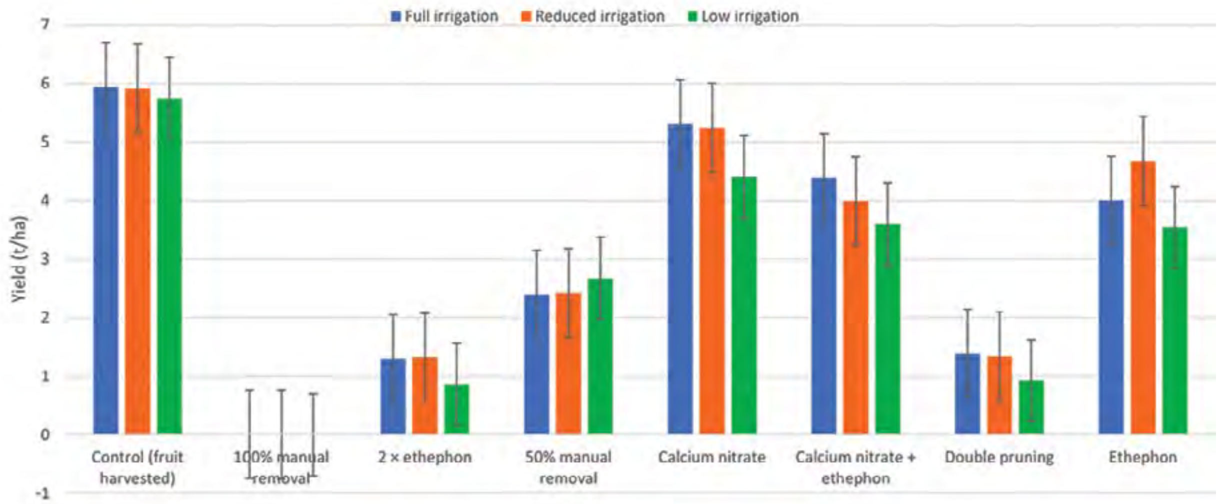

Figure 50. Treatment yield (t/ha) in the first growing season (2022–23) of the resting vineyard trial in Chardonnay grown in the Riverina with full (100%), reduced (50%) and low (25%) irrigation.

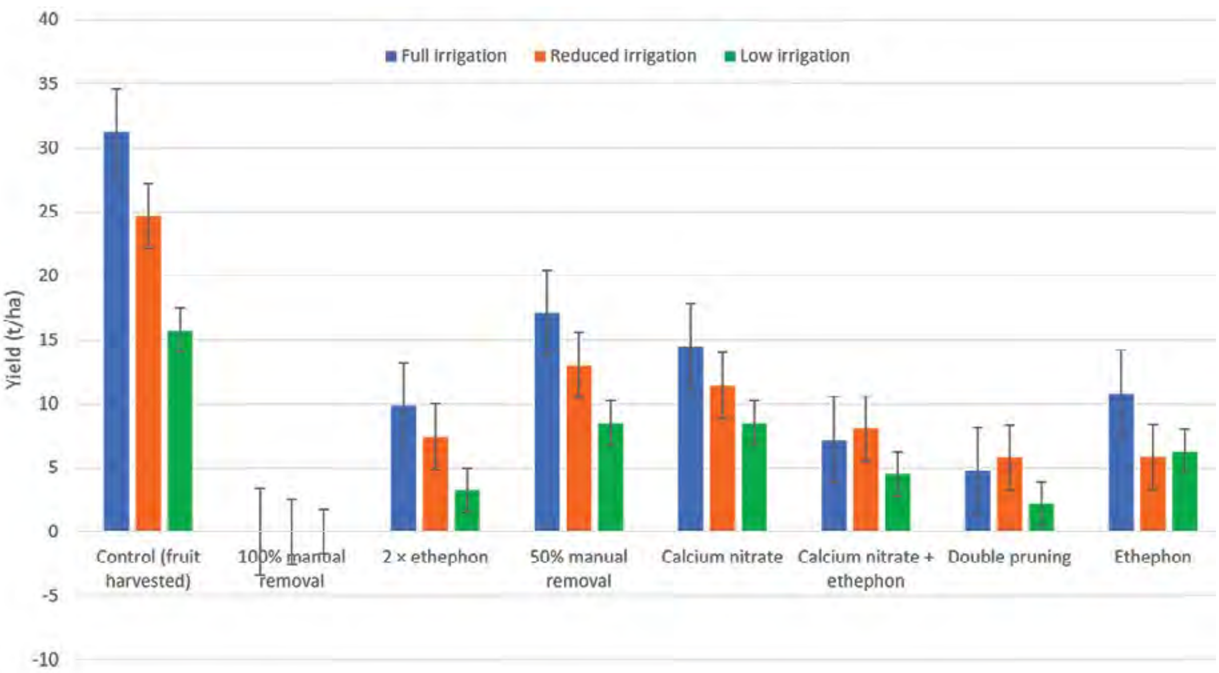

Figure 51. Treatment yield (t/ha) in the second growing season (2023–24) of the resting vineyard trial in Chardonnay grown in the Riverina with full (100%), reduced (50%) and low (25%) irrigation.

Resting vineyard cost analysis

Table 5. The treatments and costs ($/ha) used in the resting vineyard trial.

Treatment	Treatment cost ex GST ($/ha)
1. Control (fruit picked at harvest)	680
2. Fruit unharvested	0
3. 100% fruit removal	680
4. 50% fruit removal	680
5. Double pruning	190
6. 2.5 kg/ha calcium nitrate	142^
7. 100 mL single ethephon# (900 g/L) + 100 mL wetting agent*	142^
8. 2.5 kg/ha calcium nitrate + 100 mL ethephon# (900 g/L) + 100 mL wetting agent*	284^
9. 100 mL double ethephon# (900 g/L) + 100 mL wetting agent*	284^

Notes: #Ethephon (900 g/L; Promote® Plus 900). *Wetting agent (600 g/L nonyl phenol ethylene; Agral®). **Commercial spraying charge @ $140/ha. ^Costs include product plus labour. All other operations/running costs are assumed to be equal for all treatments. Prices are an average retail (ex GST) guide only, correct as of May 2024, but will vary according to location, availability and quantity purchased.

Returning the vineyard to production

To understand the effects of returning a vineyard to production after resting for one year, yields were measured in the following season. The double pruning and double ethephon treatments significantly reduced yield compared with the other treatments (Figure 52). From one year's results, it appears these treatments also reduced yield the following year. This will be followed up in the 2025 vintage.

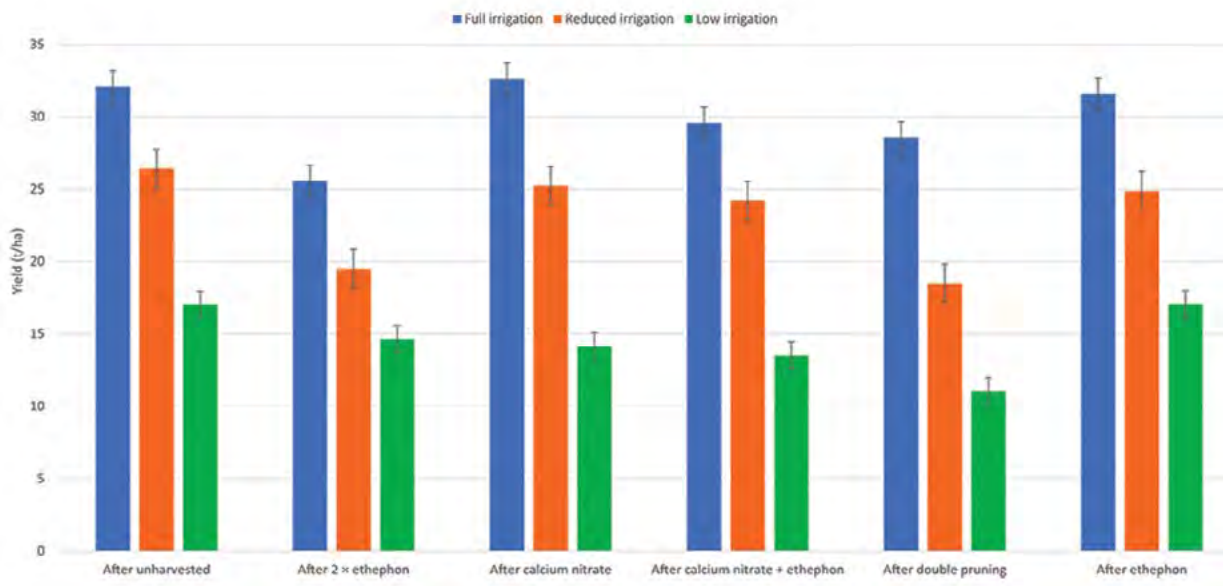

Figure 52. Treatment yields (t/ha) in the second growing season (2023–24) from the resting vineyard trial in Chardonnay grown in the Riverina with full (100%), reduced (50%) and low (25%) irrigation when returning to production.

Conclusions

When contemplating reducing fruit yield, first decide how much and for how long this reduction will be required. Most treatments can more than halve yield quite easily for one season. Double pruning and double ethephon will have some residual effect on yields when returning to production. To reduce yield below 30%, irrigating at 25% will achieve this with little or no effect on the following season. Reducing crop load will reduce irrigation requirements and their associated costs.

Climate vulnerability assessment of primary industries

NSW DPIRD has undertaken a comprehensive assessment of the vulnerability of key commodities to climate change in NSW. The project assessed the climate change risks and opportunities for 38 commodities and biosecurity risks in NSW. By filling gaps in our knowledge about the effects of climate change on the state's primary industries, we are assisting these industries to be more robust and resilient to the changing climate.

For horticulture and viticulture, this project has assessed the effects of climate change on the growing conditions for citrus (Navel oranges), cherry (Lapin), almond (Nonpareil), walnut (Chandler), blueberry (Southern Highbush), macadamia and wine grapes (Chardonnay). Currently, the project team is working on detailed results for each of the above commodities and to integrate the findings on related pests and diseases, such as Queensland fruit fly, with the relevant commodities. These results will help identify opportunities, adaptation needs, and research and development priorities that the industry and government can use to guide future investment and enhance the resilience of the sectors.

The finalised assessments for wine grapes, the summary report and wine grapes fact sheet (Figure 53) can be downloaded from the NSW DPIRD website (https://www.dpi.nsw.gov.au/dpi/climate/climate-vulnerability-assessment/horticulture-and-viticulture). In the coming months, you will also find our results reports on our website. We would welcome the opportunity to share the findings with you and discuss the next phase of work to support your industry in adapting to climate changes in NSW. If you would like to contact the team, please email (vulnerability.assessment@dpi.nsw.gov.au).

Figure 53. Fact sheets from the NSW DPIRD climate vulnerability assessment for horticulture and viticulture.


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New Zealand viticulture study tour

Myles Parker, Leader – Southern Horticulture, NSW DPIRD, plus feedback from tour participants

Introduction

NSW DPIRD and NSW Wine led a study tour in New Zealand's South Island from 10–15 December 2023 as part of the NSW Government-funded Skills Development Program. Twelve wine grape growers, viticulturists or vignerons from across NSW's wine regions participated in the tour to study the innovative practices and tools in New Zealand(NZ) that can benefit NSW wine grape growing.

Feedback from the tour participants (highlighted in green boxes) was excellent. NSW DPIRD and NSW Wine will investigate opportunities to do this type of tour again. This article includes observations from tour attendees, which do not necessarily reflect those of the businesses and institutions visited.

Itinerary

Day 1 Sunday 10 December	
7.00 pm	Dinner and introductions
Day 2 Monday 11 December	
9.30 am	The Bragato Institute, Lincoln
2.00 pm	Pyramid Valley, Waipara, North Canterbury
Day 3 Tuesday 12 December	
11.30 pm	Indevin, Blenheim
2.00 pm	David Allen @ Pernod Ricard, Triplebank Vineyard, Seddon
4.30 pm	Lawsons Dry Hills Tasting
Day 4 Wednesday 13 December	
9.30 am	Pernod Ricard, Renwick
1.00 pm	Bragato Research Institute, Blenheim
Day 5 Thursday 14 December	
9.00 am	Dog Point, Blenheim
12.00 pm	Cloudy Bay, Rapaura
Day 6 Friday 15 December	
9.00 am	Greystone Wines, Waipara

Sauvignon Blanc 2.0

The New Zealand wine industry is planted to 85% Sauvignon Blanc (SB). This is primarily one clone and the industry lacks genetic diversity. However, SB is a success story for NZ because most of the production is exported and the value of SB grapes is around AU$2,000 per tonne, which reflects the demand for NZ SB wine. Wine quality is usually improved through lower-yielding crops, but with SB, it is unchanged with increasing yield. Therefore, in NZ, high-yielding SB crops are desired and yields of 20–40 t/ha are reported. SB is highly profitable in NZ and makes their vineyards some of the most valuable in the world.

The Bragato Institute, which is NZ's wine industry research institution, has a large long-term project called Sauvignon Blanc 2.0 (Figure 54), which aims to bring genetic diversity into the SB industry. Sauvignon Blanc 2.0 uses tissue culture to stress SB cells to cause mutation. These mutated cells

Figure 54. Darrell Lizamore, Principal Scientist (Grapevine Improvement) Lincoln University.

are grown into plants, then propagated to vines and planted in a vineyard. The mutated clones are genetically mapped so the mutation sequences are known. Any newly identified traits will be mapped to genetic coding.

This program creates an enormous amount of data and the institute uses super-computers to manage it, which is all part of the project.

Sauvignon Blanc 2.0 aims to create diversity in its single clone industry by developing traits such as drought resistance, disease resistance and yield increases. The initial project is 7 years and they plan to have 12,000 mutations planted for evaluation.

Feedback from tour participants:

"The results could guide breeding programs by indicating which genes could be edited in a variety to derive production or environmental benefits. This project should be monitored because its results will have worldwide significance."

"There is the potential for huge gains in productivity upon the completion of the study, especially if they are successful in generating a disease-resistant clone of Sauvignon Blanc."

"An exciting takeaway from the visit is the potential to insert the disease-resistant genes into other varieties. Having resistance in Chardonnay and Shiraz in Australia would be fantastic."

"The forced/sped-up process of genetic variation being used to look for new SB clones was amazing, but even more amazing were the details and genomic data being collected as part of this project. This has massive potential to help identify what specific genes in the grapevine are responsible for."

Pyramid Valley Wines

Pyramid Valley Wines (Figure 55) is a good example of a premium wine business and its profitability has enabled them to invest in the best technology for viticulture and winemaking.

Pyramid Valley Wines was started by an American who searched Australia and NZ for soil and climate that was equivalent to the Burgundy region of France. The soil is limestone-derived clay on top of soft activated limestone. In Australia, we would think the climate is marginal due to frost prevalence. The vineyard relies on frost fans and lighting candles to produce heat in vineyard areas of high frost risk. The entire vineyard is managed biodynamically.

The vineyard has a very strong narrative covering its history, soil and management, which builds its premium wine status. The wines tasted excellent, and individual wines are made from specific blocks that have unique soil and microclimates. This business showcases 'terroir', and has a premium market, which has helped protect its wines from fraud by using DNA fingerprinting.

Figure 55. Huw Kinch from Pyramid Valley Wines.

Feedback from tour participants:

"Telling your story well gives your product a distinctive difference from others. A good story also requires the quality to be maintained and protected to create a premium product. Creating premium products is a high priority for NSW wine."

"This was a truly inspirational place to visit, and it was a great balance between the complete opposite end of the spectrum of big industrial vineyards. I know we all took away some interesting information regarding frosts and the candles but also the success of close-row plantings and some of the challenges with this type of trellis system."

"The vineyard setup was on the other end of the spectrum from anything I have seen before. The 1 × 1.1 row spacing, high density plantings and multi-species cover crop use was very interesting. The focus on quality over quantity, with 5–6 tonne crop loads (reaching 8 tonne in 2020) was impressive."

"I was interested in their use of tow and blow fans for frost (2 °C temperature rise immediately)."

"I had never heard of a CPP (cow pat pit) before; it seems to act as an organic fertiliser using a mixture of cow pat, basalt and egg shells flicked onto the canopy. As we use cattle around our vineyard, this would be a small change that could be implemented with little fuss."

"Wines were awesome!"

"The Smart Apply spray system would be very effective here in Australia. If the quoted 35% reduction in chemical use can be achieved, then the technology makes a lot of sense and is something that could be implemented in the near future. I will be looking into this technology further to determine how it can be implemented within my current operations."

Pernod Ricard New Zealand Limited

The NZ wine industry was very open to sharing information, and its hospitality to NSW viticulturists was exceptional. Pernod Ricard is an international wine producer with significant holdings in Australia and NZ. They have invested in automation in a large experiment that could be expanded to vineyards worldwide. The Oxin autonomous vineyard tractors (Figure 56) are being developed with Pernod Ricard Winery. Currently they are used for vineyard mowing, vine hedging, leaf thinning, and herbicide spraying, but not fungicide spraying. One person supervises up to 8 autonomous tractors that can run 24 hours a day. They are diesel-powered and are refilled in the field.

Figure 56. Gerard Logan with Oxin, the autonomous and multi-tasking robotic tractor at Pernod Ricard Winery.

Feedback from tour participants:

"Pernod Ricard Winery is continuing with these units, indicating they will become a permanent part of their business. It was an exciting company because they are putting their money where their mouth is and paving the way for others to follow. It was good to see a large company putting so much into working and developing future technologies that have benefits beyond their own business."

"Autonomous vineyard tractors will be the future for some vineyards in NSW. It is helpful to have profitable businesses like Pernod Ricard take the risk of partnering and innovating with companies like Oxin. This example will benefit NSW growers as they make plans to automate and reduce costs once this technology is reliable and affordable."

"Amazing! A great demonstration and very inspiring to see how companies are making moves to be at the forefront of innovation and automation, which will ultimately benefit the industry as a whole. It was interesting to see the comparison between their driverless tractors and Cloudy Bay's. Every time I am mixing my tanks I dream of a safer, more efficient solution, so it was awesome to see the spray shed of the future and see that it was totally possible. It was a worthwhile conversation around spray efficiency, of the capture versus lidar (a device that detects the density of clouds by bouncing laser light off the atmosphere) modifications, and I would definitely take these into consideration."

Kaituna Vineyard

The recycling sprayers (Figure 57) saved 13% of spray. When used with lidar-controlled sprayers, 35% is saved. Most of these savings are because the lidar switches the sprayer off at the end of the rows. Lidar also recognises when there is plant material to spray, so the sprayer does not spray where there are no vines. They said the sprayer would pay itself back in 3 years.

Figure 57. The recycling spray unit used at Kaituna vineyard.

Feedback from tour participants:

"The lidar setup costs approximately AU$80,000 on top of the sprayer price. Would it be possible to design a simpler system that cuts off the sprayer when it finishes a row instead of manually switching it off? Would it give growers the partial benefit of this technology without the costs?"

Lawsons Dry Hills

Lawsons Dry Hills distinguishes itself from other vineyards by being the only NZ wine producer to hold both ISO14001 (Environmental Management Systems) and ISO14064 (International Standard for GHG Emissions) accreditations.

Feedback from tour participants:

"This was a good example of how a point of difference is used to market wine. It also adds to a businesses' sustainability."

Bragato Research Institute

Bragato is the NZ equivalent of the Australian Wine Research Institute. It is considerably younger and more focused. Most of its work is on Sauvignon Blanc. NZ has a similar sustainability program to Australia, but the NZ program is more advanced and has been an important part of NZ wine for a long time. Every wine grower since 1995 must submit their spray diaries. These have been digital in NZ for many years, and as a result, sprays put on NZ grapes have been recorded in a database since 1995. This is a powerful tool used by the Bragato Institute (Figure 58) for research and extension to the NZ industry.

Figure 58. Branden Crosby at the Bragato Research Institute.

Feedback from tour participants:

"Australian vineyards should have mandatory digital spray diaries that can be used to show sustainability practices and as a research tool."

"I am very interested in the future vineyard program and the data they are hoping to collect with the potted vines to enable better algorithms for the digital vineyard."

"I was very interested to hear that the SWA version in NZ had created a user-friendly records system for growers' spray application and diary, which was compulsory to use. Still, it was then able to remove the need for double entering into the system."

"This was a really interesting setup as basically a mini winery! It was great to see producers running so many trials and experiments; I could have spent the week there with the amount of research being conducted."

Dog Point Wines

Dog Point Wines is a 300-hectare vineyard that was converted to being organic. They supply close to 10% of all organic wines in NZ. Nigel was passionate and presented well. He is an experimenter and was open to sharing his knowledge on:

- cover cropping
- grape marc removal and composting
- reducing under-vine cultivation and replacing it with increasing biodiversity
- converting from conventional farming to organics
- improving soil health and the long-term benefits
- the challenge of nitrogen balance in an organic vineyard.

Feedback from tour participants:

"Where to start!? I learnt so much here about cover crops and microbes, and I know a lot of people took home the carbon to nitrogen ratios and the ammonia to nitrate ratios in the leaf. It was very interesting hearing Nigel's theories on glyphosate's effect on the plant's natural ability to control botrytis. It was also great to see the grape marc management and composting pad set up."

"It was very interesting to see the number of wineries using mineral oils for early spraying because they believed it was too cold for sulfur to be effective."

"Key takeaways were not being too concerned with weeds/what you can see when running an organic vineyard but to be more concerned with what is going on beneath (i.e. soil health and nitrogen management). By using multi-species cover crops and having increased soil health, they do not spray insecticides other than a small amount of copper. Great cost saving effect."

"Great to see how well compost teas and humid acids are benefiting the overall vineyard health. Interesting takeaway was that he has little nitrate in the leaves (pale green colour) but that is ok! More focus on fruit and just enough leaf matter to ripen the crop."

"75% nitrogen, 25% ammonia is a great balance in your soil for improved crop health. You need to start soil remediation approximately 3–5 years before conversion."

"Great to see an effective use of vineyard prunings and grape marc to make a substantial amount of compost."

Cloudy Bay Vineyards

Cloudy Bay Vineyards has a robotic tractor (Figure 59) that was designed in-house (bespoke). This was a good contrast to the Oxin company initiative as it was much cheaper and simpler but has similar outputs.

Figure 59. The robotic tractor that was designed in-house at Cloudy Bay Vineyards.

Feedback from tour participants:

"Dave from Pernod said he thinks that Cloudy are in the sweet spot of Marlborough in regards to their approach; using tech but also focused on regeneration. Jim and the team were nice hosts and very generous with their time. Seeing young Murray's self-built autonomous tractor was a buzz. How clever! Built on Pernod's strategy of hiring non-viti graduates; the students are happy to take the viti pay (probably seems a lot to them that young) but give their expertise in a relevant field that benefits the employer. Lunch was excellent. Again, stunning spot and great hosts."

Greystone Wines

Greystone Wines was one of the most liked visits on the tour due to Mike's open presentation style and the experimentation taking place in the Greystone's vineyard. There was a lot of interest in some blocks about having sheep in the vineyard during the growing season. They modified a vineyard so that sheep could be grazed all year by using a y-shaped trellis (Figure 60) and growing the vines to 1.8 m, after they learned that 1.5 m was not high enough. This has adaptable implications for Australian vineyards where labour costs for mowing could be reduced. The vines at Greystones would need to be hand-picked due to the type of trellising.

This vineyard has a restaurant that uses products from the vineyard including lamb and pork grazed on the vineyard.

Figure 60. A modified 1.8-metre y-shaped trellis to allow sheep grazing.

Feedback from tour participants:

"Modifying a vineyard so that sheep can be grazed all year is being used in some NSW vineyards. This trellis system could be of interest to some."

"This was a highlight of the trip. I really enjoyed their philosophy on regenerative agriculture in the vineyard, running a high trellis block to enable sheep grazing all year round."

"The idea of creating a 'vineyard ferment' was really interesting and came with a great backstory and label that would definitely help sell their product to the consumer in the cellar door. They were doing lots to take care of their soil with multi-species cover crops. The wines were spectacular!"

Acknowledgements

This tour was funded by the NSW Department of Primary Industries and Regional Development through the Viticulture Skills Development Program and co-investment from industry participants.

Scale and mealybug survey update: assessing severity and incidence in the Riverina region

Meena Thakur, Research Horticulturist – Entomology, NSW DPIRD

Introduction

There have been anecdotal reports of a high incidence of scale insects (Figure 61) and mealybugs (Figure 62) in the Riverina region, but no data exist to support this. To determine the incidence, severity, and current management practices being used by growers to manage scale and mealybugs in Riverina vineyards, a survey is currently being conducted as part of the Wine Australia supported Greater NSW–ACT Regional Program. If you have not already done so, please use the QR code (Figure 63) or click here to complete the survey.

Figure 63. The QR code for the survey.

Figure 61. Scale insects on a grape bunch (left) and on a grapevine shoot (right).

Figure 62. Mealybug nymphs on a grape bunch (left) and a mealybug-infested grapevine (right).

Appreciation is extended to those who have already responded to the survey. Data so far indicate that 93% (27/29) of the respondents reported issues with scale and mealybugs, while 7% had no problems with these pests. Mealybugs were a primary concern for 38% of participants, while scale was a primary concern for 28%. Additionally, 24% of the participants expressed equal concern for both pests (Figure 64).

Results so far

Almost half (52%) of the growers reported scale as an intermittent issue, whereas 32% reported it as a consistent issue on most varieties in the past 3–20 years. The past 3–4 years have been particularly challenging for most growers due to warm and humid weather, with some growers noticing that white varieties are more susceptible to scale infestation than red varieties. Similarly, mealybugs have been reported as a consistent issue by 32% of respondents and as an intermittent issue by 48% of respondents in the past 3–20 years. While Traminer, Pinot Noir, Pinot Grigio, and Merlot have been heavily affected, other varieties including Cabernet Sauvignon, Chardonnay, Semillon, and Shiraz have also had significant mealybug infestations over the years. This year (2024) has been especially severe, with 7% of growers reporting the loss of entire blocks of grapes due to mealybug infestation.

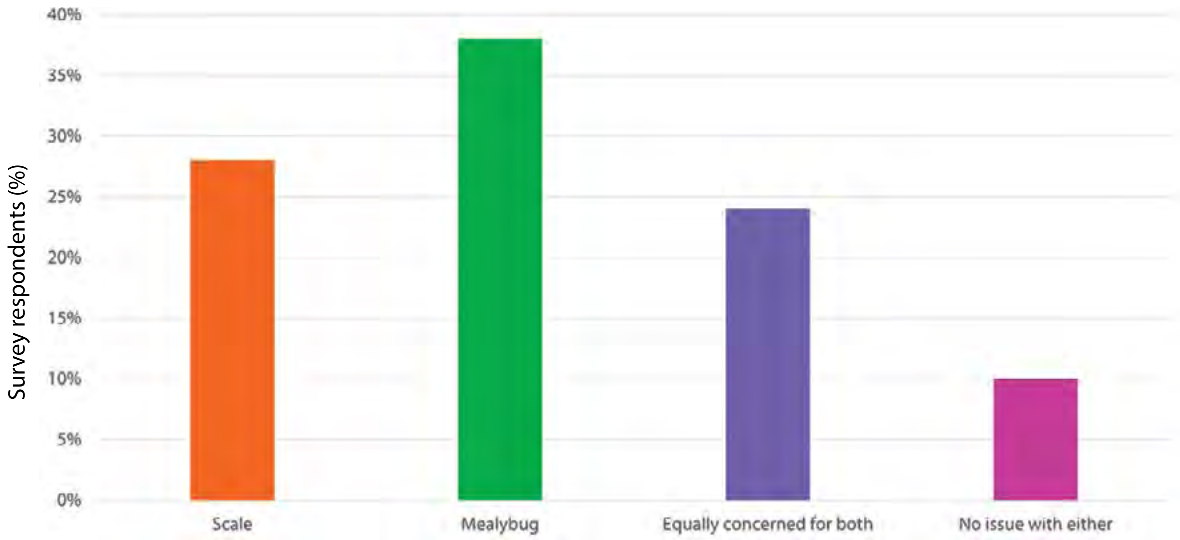

Figure 64. Respondents' concern with scale and mealybug in their vineyard.

Good control (low infestation and no loss/fruit degradation) with existing control measures was reported by 35% of respondents for scale and 14% of respondents for mealybugs (Figure 65). Adequate control (with high infestation and some/no fruit degradation) was reported by 44–46% of participants. In contrast, 9% reported poor control (severe infestation and major crop losses) for scale insects, while 23% reported poor control for mealybugs. During face-to-face and telephone discussions with the growers reporting adequate to poor control, most expressed a need for more management solutions for these pests.

Most growers (75%) rely on personal experience and agronomists' advice when making pest management decisions, and 36–54% also seek information through websites, workshops, and fact sheets. About 77% of respondents reported using insecticides with a low effect on beneficial species, including the 60% that are also using broad-spectrum insecticides to manage these pests.

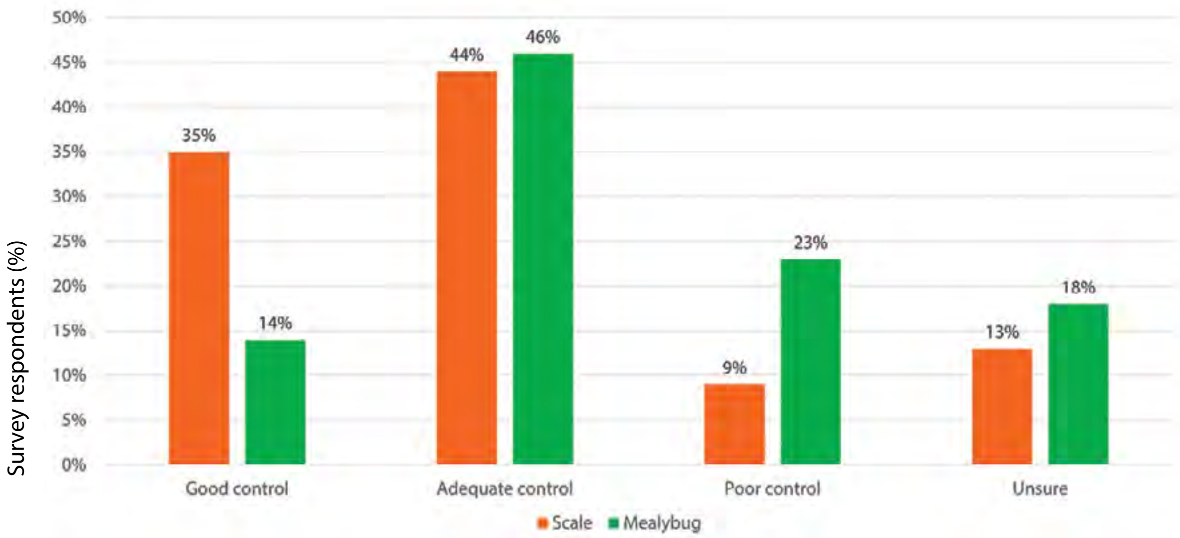

Figure 65. The current level of scale and mealybug control with existing measures.

Conversations with a grower who does not have problems with either of these pests suggest that factors such as dry sandy soil and less vigorous vines might contribute to reduced pest incidence, as observed in the Nericon area. For growers in other areas with low infestations, minimal fertiliser use, reduced or no broad-spectrum insecticide use, and regular canopy trimming might have contributed to lower scale and mealybug incidence.

Visual observations revealed that the natural enemy population (Figure 66 to Figure 68) was higher in vineyards with reduced or no broad-spectrum insecticide use.

However, additional data are necessary to confirm these observations. Hence, we are still seeking more responses from growers, agronomists, vineyard managers, and pest scout companies to better understand the scale and mealybug incidence and the basic cultural and management practices that are being used in different areas in the Riverina. Please scan the barcode (Figure 63) to fill out the survey. Input from growers who do not have issues with either of these pests is also valuable, as it will help us understand what strategies are effective in managing these pests. This will help us draw robust conclusions, identify areas requiring further research, and develop more effective pest management strategies tailored to the Riverina region. Additionally, it will ensure the content provided in our workshops, fact sheets, and video tutorials aligns with your needs and assists you in implementing appropriate management practices for your vineyard.

As the new entomologist at NSW DPIRD, based at Yanco, I am looking forward to connecting with the wine industry. I am more than happy to answer any questions you have about the survey or any other pest issue in your vineyards. Please feel free to contact me at meena.thakur@dpi.nsw.gov.au.

Acknowledgement

This case study was part of the Greater NSW–ACT Regional Program delivered by NSW DPIRD in partnership with NSW Wine. The Regional Program is supported by funding from Wine Australia. Wine Australia invest in and manages research, development and extension of behalf of Australia's grape growers and wine makers and the Australian Government.

Figure 66. Green lacewing eggs on a grape bunch.

Figure 67. Overwintering *Cryptolaemus* larvae under grapevine bark.

Figure 68. *Cryptoleamus* larvae on a grape bunch infested with scale insects.

Managing mealybug in vineyards

Meena Thakur, Research Horticulturist – Entomology, NSW DPIRD

Grapevine (*Vitis vinifera*) production has many abiotic and biotic constraints, including insect pests, diseases, and environmental conditions. Mealybugs are becoming one of the most serious issues in many grape-growing regions in Australia due to their ability to reproduce rapidly, causing direct crop losses by desiccating wine grape bunches and excreting unsightly honeydew on grapevines and bunches, which leads to sooty mould development (Wine Australia 2023). Sooty mould reduces photosynthesis and can cause bunches to rot (Figure 69). High infestations can result in early leaf loss, weakened vines, and the spread of viruses. Mealybugs on the grapes also negatively affect wine quality (Bordeu et al. 2012). Three species of mealybugs in the genus *Pseudococcus* (Hemiptera: Pseudococcidae) are generally found in Australian vineyards: the citrophilus mealybug (*P. calceolariae* Maskel), long-tailed mealybug (*P. longispinosus* Targioni-Tozzetti), and obscure mealybug (*P. viburni* Signoret).

Description of mealybugs

Mealybugs are small, soft-bodied, sap-sucking pests covered with a fine mealy or cottony wax secretion that often extends from along the sides in a series of short filaments, usually with 2 longer ones at the posterior end of the body. These waxy filaments give them a distinctive segmented appearance. The citrophilus mealybug has short, thick-tail filaments (Figure 70); the long-tailed mealybug has long-tail filaments (Figure 71), and the obscure mealybug has short, thin-tail filaments (Figure 72). It is mostly the nymphs and females that are found on the plants. The females are wingless with an elongate-oval body, about 3–6 mm long. The males are about 2 mm long gnat-like insects with 2 pairs of wings.

Figure 69. Mealybug-infested grapevine with rotting grape bunches.

Figure 70. Citrophilus mealybug. Photo: Baker and Huynh (2016).

Figure 71. Long-tailed mealybug.

Figure 72. Obscure mealybugs.

Life history

The mealybug life cycle mirrors the seasonal changes as the grapevine develops. They can survive over winter under bark (Figure 73) and in cracks in trellis posts. In spring, the overwintering generation moves out onto vines soon after budburst. Adult female long-tailed mealybugs lay up to 200 eggs that hatch almost immediately. The first-instar nymphs, or crawlers, spend several days sheltering under the female before moving out to feed. Adult citrophilus and obscure mealybug females lay eggs into silky or cottony egg sacs, which hatch after several days. The crawlers (Figure 74) have the least amount of wax present on their bodies and are most vulnerable to spray applications and environmental conditions. There are slight variations among the species, but generally, they all have 3 larval stages for the females and 4 for the males (Wakgari and Gilimoee 2005). The duration of each generation for these mealybug species varies from 1–4 months, so there can be 3–4 generations of mealybugs per year, depending on the temperature. As a result, mealybug numbers can increase rapidly in seasons where conditions are favourable and levels of natural predation and parasitism are limited.

Figure 73. Overwintering mealybugs under grapevine bark.

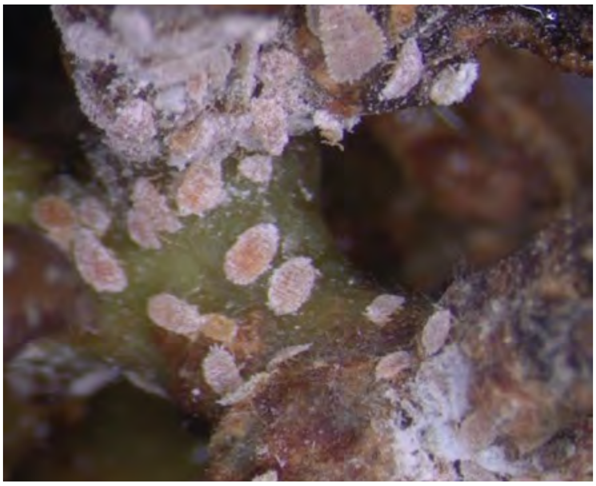

Figure 74. Mealybug crawlers.

Managing mealybugs

Chemical control of mealybugs is often ineffective due to their high reproductive rate, waxy covering, cryptic behaviour, and difficulty achieving effective spray coverage. Insecticide resistance is another issue, and there are increasing restrictions on insecticides that can be used to manage grapevine pests. Broad-spectrum insecticides also interfere with natural biological control and cause secondary pest issues. Hence, moving away from broad-spectrum synthetic chemicals and adopting a multidisciplinary approach is best for managing mealybug infestations in grape vines. This includes integrating cultural practices, biological control, and need-based use of selective chemistry that is gentle on beneficial organisms to implement integrated pest management (IPM) in vineyards.

Cultural practices such as pruning, canopy management, and vineyard floor management (providing cover crops as alternative food sources for beneficial organisms) can reduce the mealybug population and encourage and sustain the natural enemy population in vineyards.

Two very efficient predators of mealybugs, lady beetles (*Cryptoleamus montrozuieri)* and green lacewings (*Mallada signata)*, are also available commercially. They can be released to boost the existing natural enemy populations, especially early in the season, for better control. *Cryptoleamus* is an Australian native beetle, also called a mealybug destroyer beetle, that feeds on a wide range of mealybug species. Lady beetles are supplied both as adults and larvae, whereas lacewings are supplied as eggs that hatch during transit and are dispersed as young larvae in the vineyards. Lady beetle larvae look similar to adult mealybugs (Figure 75), with a slight difference in body size and thicker waxy filaments in the final larval stages. It is recommended that predators, especially their larval stages, be released in hotspots so they have an immediate food supply. Depending on mealybug populations, 2 predator releases at fortnightly intervals might be necessary.

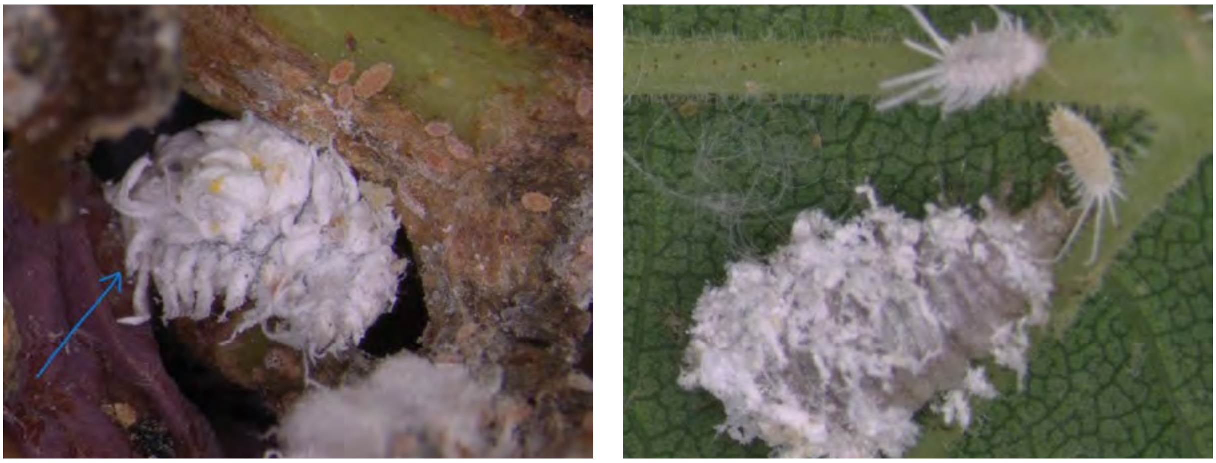

Figure 75. *Cryptoleamus montrozuieri* larva (left); *Mallada signata* larva feeding on mealybugs (right).

Releasing these predators not only manages the mealybug population but also controls other vineyard pests. For example, scale insects are also attacked by lady beetles and green lacewings. Lacewings are generalist predators that also feed on caterpillars and mite pests. Excellent results have been observed with green lacewing releases in vineyards with scale and mealybug.

Pheromone-based management

Other sustainable strategies for mealybug control include pheromone-mediated population monitoring and mating disruption, which have proven effective in various countries worldwide (UC IPM 2018; Daane et al. 2020) but have yet to be tested in Australian vineyards. Pheromone-based control tactics offer new eco-friendly control solutions (Franco et al. 2003; Ricciardi et al. 2019). Mating disruption is when sex pheromones, which adult males use to locate females, are released in large amounts into the atmosphere, interfering with communication and mating. Mating disruption is safe for beneficial insects and not dependent on direct contact with the pest. Once applied, the pheromone is released from the source and propagates through the vineyard by diffusion and wind. Mating disruption of grapevine mealybugs has been one of the most successful and widely used semiochemical programs for a non-lepidopteran pest since its introduction in 2009 (Daani et al. 2021).

Mealybug pheromones have also been reported to enhance the efficacy of biological control by acting as an attractant to certain species of parasitoids (Franco et al. 2008; 2011). Increased parasitism levels have been reported in vineyards with mating disruption (Walton et al. 2006), possibly due to parasitoid females spending more time searching for mealybugs in vineyards with a mating disruption program, thus increasing parasitism rates (Mansour et al. 2010).

Ants and their role in mealybug populations in vineyards

Ants have long been associated with outbreaks of honeydew-producing insects. Ants and mealybugs share a complex, symbiotic relationship where ants benefit from a carbohydrate food source (honeydew) from mealybugs and, in return, farm and protect them from predators and parasitoids to secure their consistent food source. Ants also help disperse mealybugs throughout the vineyard. The presence of ants has been reported to reduce the effectiveness of biological control of mealybugs, reducing the success of the overall integrated pest management program in South Africa (Mgocheki and Addison 2009) and North America (Daane et al. 2007). Hence, controlling ant populations in vineyards is also very important. Combining ant suppression with the release of beneficial organisms can improve the effectiveness of biological control.

Planting cover crops that produce nectar more attractive than honeydew can divert ants from vines. Soil tilling can also disrupt ant nests in vineyards. In some cases with high ant populations throughout vineyards, chemical control targeting ants might be necessary. In general, spot spraying or using bait to kill ants is the most effective and is least disruptive to the beneficial species in vineyards. The type of bait and overall treatment will depend on the ant species present. Consult your pest control adviser for more information on ant control in your vineyard.

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Crown gall in NSW

Penny Flannery, Development Officer – Viticulture, and Toni Chapman, Senior Research Scientist –Plant Bacteriologist, NSW DPIRD

Key messages

Crown gall-like symptoms have been reported in NSW vineyards since 2022.

NSW DPIRD is currently:

- determining which regions are affected and which pathogens are present
- establishing which isolated bacteria are capable of causing disease and which symptoms are caused by each pathogen to provide a visual aid for disease monitoring and identification
- collaborating with several industry bodies for diagnosis, prevention awareness and further research
- working on pathogen assays, consulting with industry and contributing to the development of information on potential risk mitigation and management strategies for industry.

Current situation

Crown gall-like symptoms (Figure 76) have been found on grapevines in several NSW wine regions, mainly affecting new plantings. NSW DPIRD plant pathologists have analysed numerous samples from NSW and interstate since 2022 at the Elizabeth Macarthur Agricultural Institute (EMAI) laboratory. This analysis indicated the presence of *Agrobacterium* spp. (biovar 1) (Figure 77 and Figure 78).

Agrobacterium spp. are endemic in Australia's horticulture regions and are known to induce crown gall-like symptoms in other plant species, including pome fruit, stone fruit, and nut trees. NSW DPIRD is investigating why this species is now causing problems in grapevines.

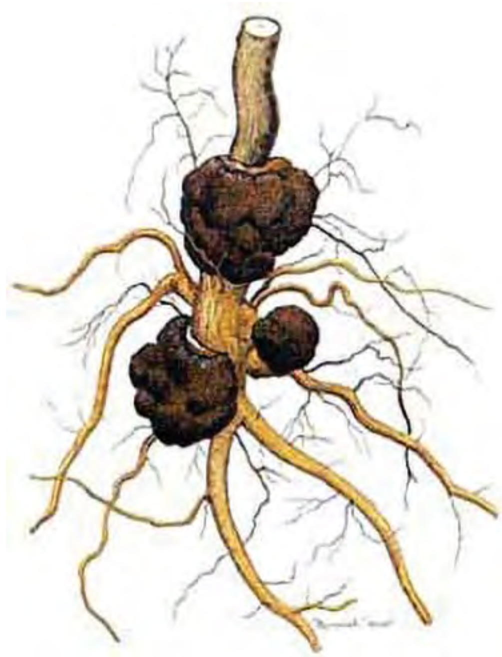

Figure 76. Crown gall symptoms. Source: Fahy (2012). Original drawing: Margaret Senior.

Background

Crown gall is caused by 2 bacterial genera: *Agrobacterium* and *Allorhizobium*, belonging to the *Rhizobiaceae* family. These gram-negative, motile, rod-shaped bacteria do not form spores and are closely related to the nitrogen-fixing *Rhizobium* bacteria. Previously, the main causal agent for crown gall disease in Australian vineyards was *Allorhizobium vitis* (biovar 3) (Figure 77 and Figure 79). However, since mid-2022, *Agrobacterium* spp. (biovar 1) have been detected in vines exhibiting symptoms resembling crown gall.

Allorhizobium vitis primarily infects *Vitis vinifera* (grapevines), whereas *Agrobacterium* spp. can infect more than 140 species of plants.

Agrobacterium and *Allorhizobium* species are found in soil and water worldwide, where they survive independently of a host. When found in plants, they can either be non-pathogenic or act as pathogens and cause diseases. Pathogenicity is linked to virulence genes on a tumour-inducing plasmid (Ti plasmid) that is in *Agrobacterium* and *Allorhizobium* species.

Agrobacterium classification

The classification of *Agrobacterium* has changed over the years. Initially based on symptoms in host plants, physiological and biochemical analyses, *Agrobacterium* species were divided into 3 biovars. Biovar 1 is now considered a complex of *Agrobacterium* species, including *A. tumefaciens* (Figure 77). Biovar 2 was later reclassified as a genus in *Rhizobium* spp. and biovar 3 includes *Allorhizobium vitis*.

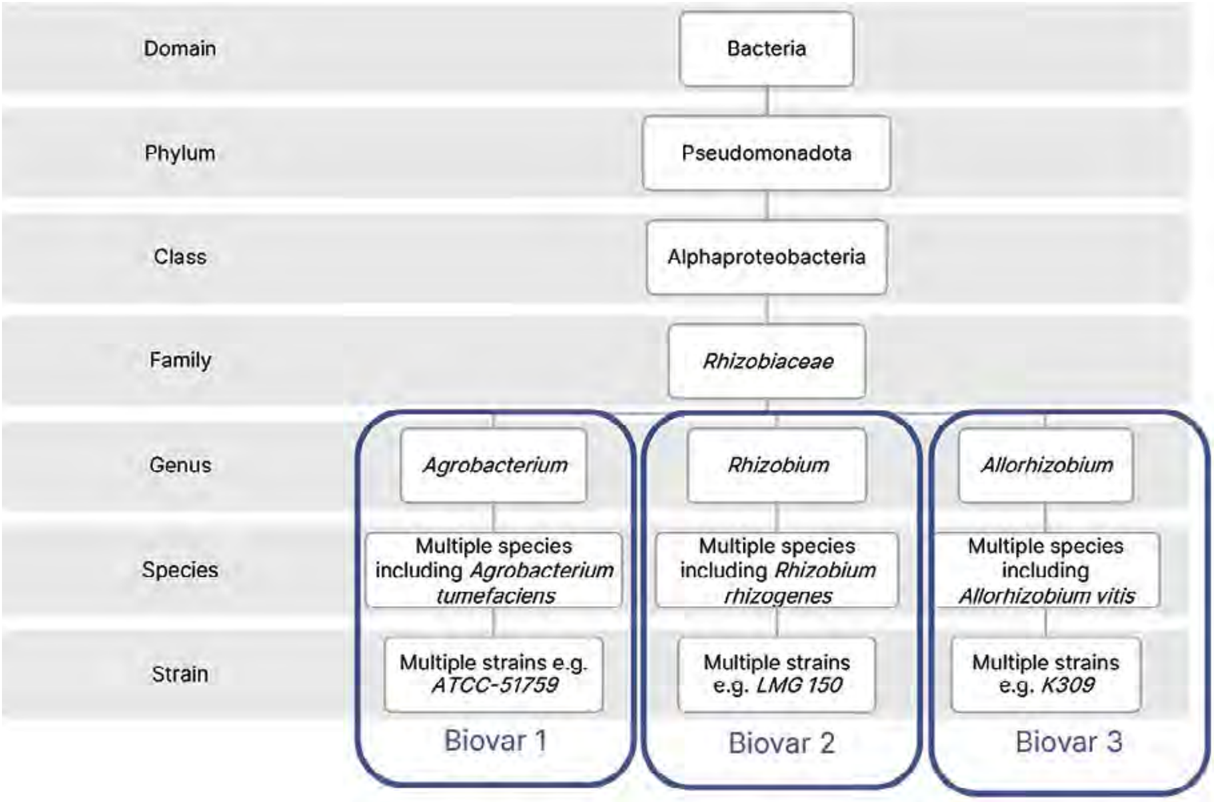

Figure 77. Taxonomic classification of bacteria in the *Rhizobiaceae* family. Source: *AWRI Crown gall fact sheet* (https://www.awri.com.au/wp-content/uploads/2024/03/Crown-Gall-in-Australian-Vineyards.pdf).

Symptoms

Symptoms of crown gall caused by *Allorhizobium vitis* are galls on the crown of vines, where the main roots join the trunk, but can also be around the propagation point on established vines (Figure 79).

Observations to date have revealed that when the crown gall is caused by *Agrobacterium tumefaciens*, the symptoms being observed are on wounds caused by frost and wet, windy conditions. Initially, the galls are white, yellow, or green and are inside cracks on the vine. Over time, they darken and lignify. Declining vine vigour due to restricted xylem and phloem has been noted by growers. Very young and small vines tended to die while older vines seem hardier. Aerial root formation was also observed in the current disease scenario (Figure 78).

Figure 78. Crown gall-like symptoms currently being investigated on young vines (2021 planting).

Figure 79. Symptoms of crown gall caused by *Allorhizobium vitis* (biovar 3) on reworked vines (originally planted in 1998, reworked in 2022).

Disease cycle

The disease cycle for *Agrobacterium* and *Allorhizobium* species encompasses several stages:

- initial injury to the host plant
- subsequent secretion of plant wound exudates that serve as attractants for the bacteria
- adherence of bacteria to the plant cell surface
- activation of virulence genes and synthesis of Ti plasmid within the bacteria
- transfer of Ti plasmid into the plant cell
- integration of Ti DNA into the plant cell genome.

This then triggers the production of plant hormones, leading to tissue overgrowth. Additionally, Ti DNA genes encode enzymes that produce compounds called opines, which serve as energy sources for the bacteria. Opines also help spread the Ti plasmids among bacteria within tumours, promoting their proliferation.

Potential sources of *Agrobacterium* spp. and *Allorhizobium vitis* in vineyards include infected planting material, soil, and plant debris. In new and reworked vineyards, the bacteria can be spread from infected vines to healthy vines during grafting via contaminated tools, water or soil (Dodds and Fearnley 2023). Irrigation, rainfall, and flooding can also spread the bacteria, which can survive on the roots of vineyard weeds or the remnants of previous crops (including the roots of previously planted vines).

In established vines, bacteria are spread by pruning with contaminated secateurs or through wounds to roots (e.g. by soil-dwelling insects such as nematodes, mechanical damage or waterlogging). In already affected vines, galls can develop in any part of the vine from wounds caused by mechanical damage, hail, pruning or frost.

Testing and identification at NSW DPIRD

Dr Toni Chapman (Senior Research Scientist) at the EMAI has analysed 272 vine samples looking at symptomatic and asymptomatic vines. These samples were dissected to isolate the targeted bacteria from xylem vessels in the stems and the gall material. *Agrobacterium tumefaciens* was isolated from 53% of samples (Figure 80).

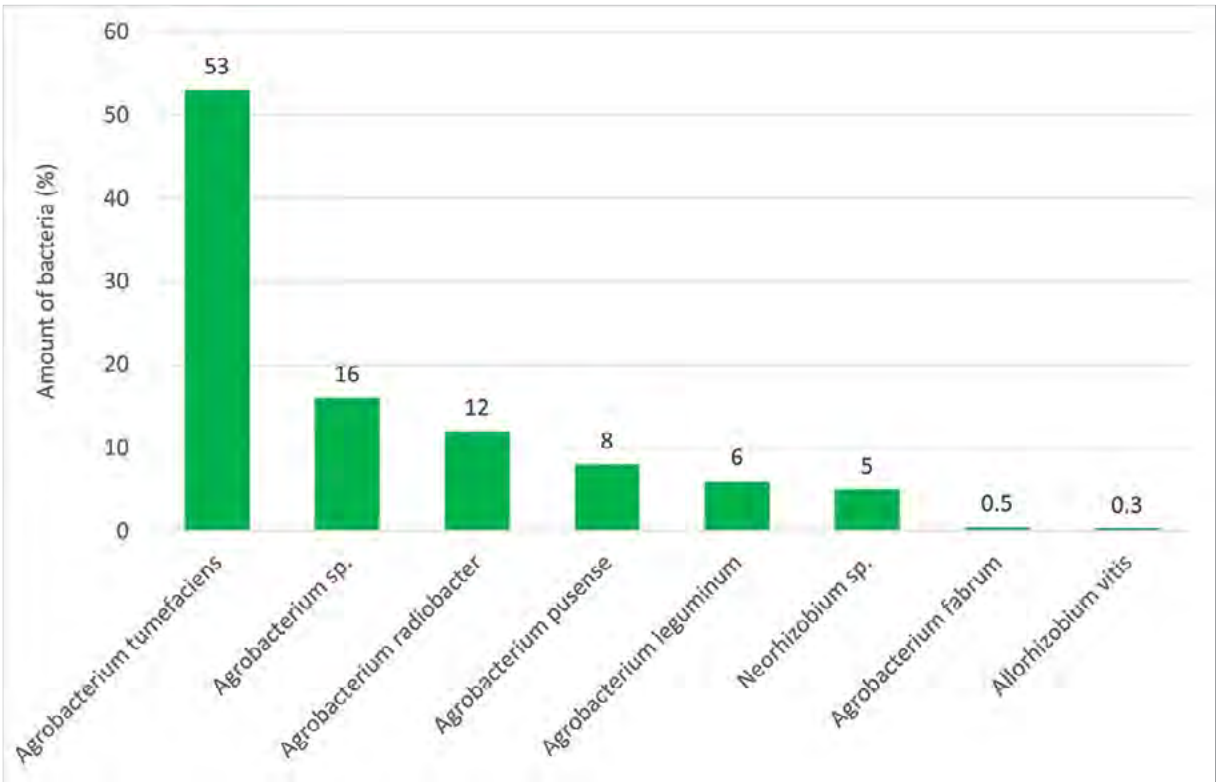

Figure 80. The bacterial species isolated from the vines submitted to NSW DPIRD plant health diagnostic service.

Site selection for new plantings is essential for reducing the risk of crown gall disease. Horticultural areas with a history of crown gall are not recommended for new plantings. Warmer, drier regions with a low risk of frost and wet conditions are ideal

Vinehealth Australia (https://vinehealth.com.au/tools/) provides the top 10 farm-gate hygiene activities to minimise the potential transmission of pests and diseases. While these protocols were designed for phylloxera, not *Agrobacterium* spp. or *Allorhizobium* spp. bacteria, they are still relevant. Vinehealth Australia recommends disinfecting footwear and tools to prevent the spread using undiluted methylated spirits (95% ethanol). Ensure footwear is immersed for 60 seconds in the ethanol and not rinsed after immersion. Caution is advised as 95% ethanol is highly flammable.

Current situation

NSW DPIRD is continuing to investigate the type and prevalence of crown gall-like symptoms in NSW by:

- Conducting genome sequencing on *Agrobacterium* spp. that have not been identified.
- Determining the pathogenic potential of isolated bacterial species using carrot disk assays, tomato tumorigenic assays and grapevine infection models.
- Consulting with growers, both affected and not affected, about environmental conditions and cultural practices to determine how these affect spread and severity.

- Consulting with industry and contributing to the development of information and potential risk mitigation strategies for industry.

NSW DPIRD will continue working with NSW Wine, Wine Australia and others on this.

What to do if you observe crown gall-like symptoms

- Photograph and record the location of affected vines.
- For new plantings, contact your nursery supplier and the Vine Industry Nursery Association (VINA).
- Contact the AWRI on helpdesk@awri.com.au or 08 8313 6600 for advice on testing, identification and database recording and Penny Flannery, NSW DPIRD Viticulture Development Officer, on penny.flannery@dpi.nsw.gov.au or 0439 230 829.

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Disease resistant selections

Dr Bruno Holzapfel, Senior Research Scientist – Perennial Crop Physiology, NSW DPIRD

Fungicide applications to control powdery mildew and downy mildew, the two most important diseases of wine grapes in Australia, could be significantly reduced by growing new mildew-resistant wine grape selections.

As part of the 'generation one disease resistant variety evaluation' project (led by CSIRO and funded by Wine Australia), 20 first-generation white and red mildew-resistant wine grape selections containing the Run1/Rpv1 resistance locus from *Muscadinia rotundifolia* were evaluated in 3 unsprayed replicated trials in warm/hot (Irymple in Victoria and Wagga Wagga in NSW) and cool (Orange in NSW) climate grape-growing regions over the past 5 years.

The selections were evaluated for viticultural performance (e.g. disease resistance and yield) and wine sensory characteristics (e.g. high acid at harvest).

In the warm/hot regions, all first-generation white and red selections were highly resistant to powdery mildew and downy mildew infection, even without fungicide applications. Vines are generally maintained under a 'minimal spray' program to reduce the risk of a breakdown in resistance.

In the cool region, the first-generation selections were also free of powdery mildew and downy mildew, except in the 2021–22 season, which had high rainfall, resulting in limited infection on some leaves. However, the level of downy mildew infection on unsprayed first-generation selections was still much lower than on premium (susceptible) selections planted elsewhere in the district that received full spray programs.

Small-scale ferments (40–80 kg) of grapes harvested from each site were made at the Charles Sturt Winery using the same small-scale protocol to minimise variation in chemical and sensory attributes due to the winemaking process.

Sensory analyses of wines made from first-generation selections grown in Irymple and Wagga Wagga were done 4–6 times by different tasting panels comprising winemakers, growers, and wine industry representatives. In blind tastings, several of the first-generation wines were ranked equal to or higher than the reference wines, which were made from premium white (Chardonnay and Riesling) or red (Cabernet Sauvignon and Shiraz) selections grown at the same locations.

From these results, a subset of first-generation lines (Figure 81) has been selected for further large-scale evaluation by industry. These selections have shown they only require minimal protective sprays to be free of powdery and downy mildew.

NSW DPIRD is now trialling the second-generation selections, which contain two genes each for resistance to downy and powdery mildew.

CSIRO and Wine Australia are working together to implement a commercial path to market for the first-generation selections. For further information on these, please contact CSIRO Business Development Manager Susan Hani at susan.hani@csiro.au.

Figure 81. R01 (Dunkelfelder × VRH3294), one of the red varieties selected for further large-scale evaluation by industry.

Acknowledgement

This work is funded by Wine Australia and led by CSIRO.

The full report is published on the Wine Australia website (https://www.wineaustralia.com/research_and_innovation/projects/regional-evaluation-of-new-germplasm-pat).

Boutique Wine by CSU

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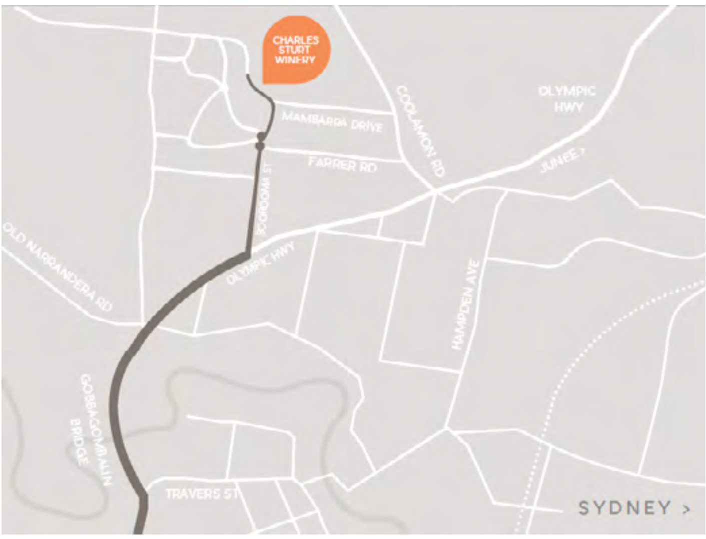
e: csuwinery@csu.edu.au
www.csu.edu.au/winery

Charles Sturt University



What the blotch is that?

Leonie Martin, Plant Biosecurity Officer, NSW DPIRD

Introduction

Grapevine red blotch disease is caused by a virus known as grapevine red blotch virus (GRBV) or grapevine red blotch-associated virus (GRBaV). This single-stranded circular DNA virus is a member of the *Grablovirus* genus.

GRBV was first identified by researchers at the University of California, Davis in the Napa Valley, in 2008 on Cabernet Sauvignon and is present in many wine production areas in the United States. GRBV has since been found in several table and wine grape varieties, as well as rootstocks and hybrids (Australian Wine Research Institute 2023). The virus is also present in India, South Korea, Italy, Switzerland, Canada, Mexico, and Argentina.

Current situation

Grapevine red blotch disease was detected for the first time in Australia in September 2022 in Western Australian and Victorian germplasm and in South Australian vines. The detection occurred as part of routine screening and not from visual symptoms. This indicates that GRBV has most likely been present in Australia for many years, and this is not a new incursion, but rather the detection of a long-standing infection.

GRBV has not yet been detected in New South Wales vineyards.

Symptoms – what to look for

Where the disease is present, irregular red blotches start to appear in autumn on both foliage (Figure 82) and fruit. Blotches might also appear on the leaf blades at the base of the infected grapevine and, over time, spread upwards from the base to the top of the canopy later in the season.

Both red and white grapevine varieties are susceptible to GRBV, but symptoms are more evident in red varieties. In red grape varieties, the blotches are red, while in white grape varieties, the blotches might be pale green to pale yellow.

Severely infected vines defoliate later in the season, meaning that symptoms are generally more evident in autumn. Look for primary and secondary veins on leaves turning red and for red blotches between the interveinal margins.

The virus prevents photosynthesis in grapevines. The sugars stay in the leaf instead of going into the grape, reducing sugar levels by up to 5°Brix. It also alters berry colour, reduces berry size and delays berry ripening, with some bunches never ripening. It can also affect pH, anthocyanin, and tannin levels, as well as phenolic factors, reducing the overall quality and potential market value of wine made from infected grapes.

Figure 82. Grapevine red blotch virus symptoms around the leaf edge and through primary and secondary veins. Photos: Sudarshana et al. (2015).

Is it red blotch or leafroll: what is the difference?

GRBV can be confused with grapevine leafroll virus because both have similar symptoms. Phosphorus, potassium, and various macronutrient deficiencies also produce symptoms similar to those of GRBV. This is one reason why GRBV can be overlooked and also why diagnostic testing is essential to confirm the presence or absence of GRBV (AWRI 2023).

Several characteristics distinguish red blotch from leafroll. Red blotch causes pink to red veins and the leaves remain flat, not curled, whereas with leafroll, the symptoms are often more uniform across the leaf blade, the veins remain green and there is a downward rolling of the leaf edge (Figure 83).

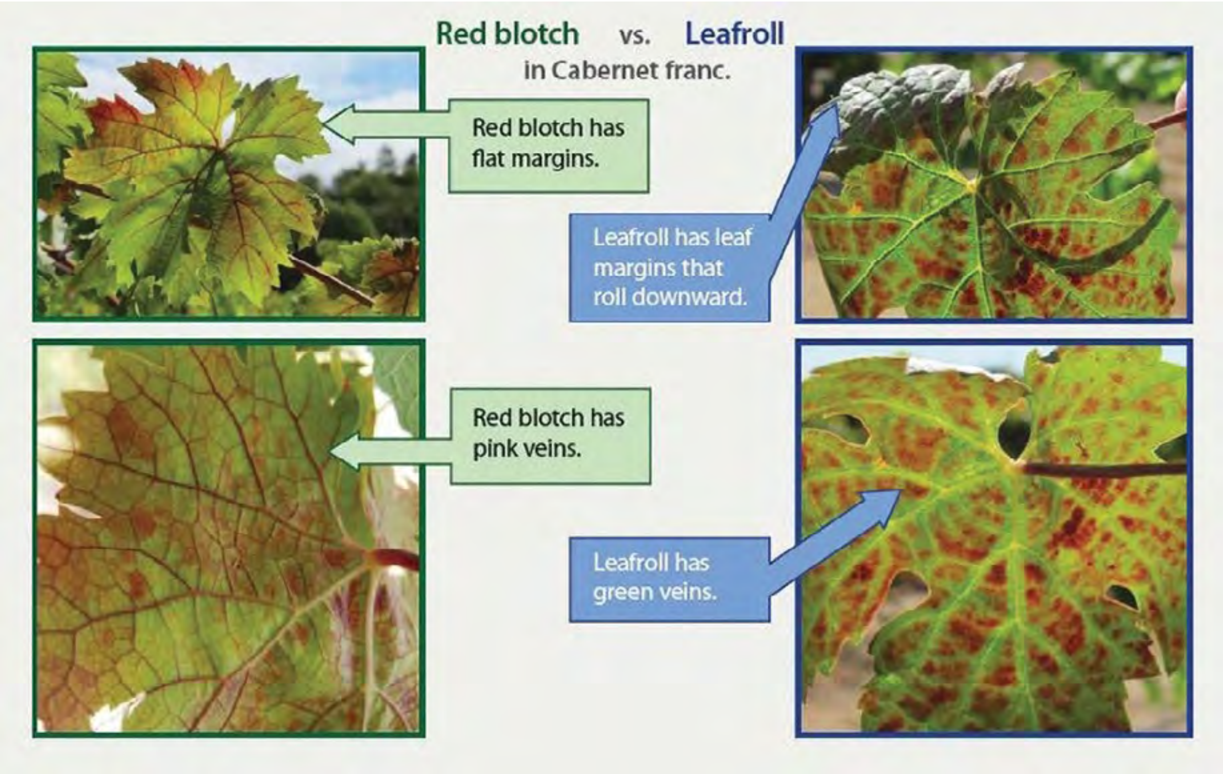


Figure 83. Symptoms of red blotch virus (left) and leafroll virus (right). Photos: Sudarshana et al. (2015).

Spread

Research indicates the main way the virus spreads is by propagating planting stock or grafting non-infected vines using infected budwood (IRP 2023). There has been no record of transmission via equipment, vineyard machinery or pruning tools. The spread of GRBV into Australia is thought to have been through infected propagation material.

Several insects are vectors of the virus overseas, all of which are considered exotic to Australia:

- three-cornered alfalfa hopper (*Spissistilus festinus*)
- some treehopper species (e.g. *Entylia carinata*, *Enchenopa binotata*)
- some leafhopper species (e.g. *Colladonus reductus*, *Onbornellus borealis*).

In Victoria and Western Australia, GRBV was detected in the table grape, Perle de Csaba. In Western Australia, GRBV was also detected several wine grape varieties. In September 2022, the WA Department of Primary Industries and Regional Development published a list of positive variety clone combinations, which include:

- Brachetto (H102)
- Chardonnay (G9V7 HT90.1)
- Chardonnay (unknown)
- Harslevelu (LN-B)
- Kadarka (F13V3)
- Malbec (Kalimna1)

- Merlot (D3V5 HT81)
- Perle de Csaba (L6V13)
- Pinot Noir (D2V5)
- Sauvignon Blanc (Galicia1989).

At Irymple in April 2023, there were 6 confirmed positive varieties:

- Husseine
- Kandahar
- Montepulciano (IC78.8469)
- Opuzensia Rana
- Peloursin ex VRS Rutherglen
- Perle de Csaba (L6V13 (LH))
- Petit Bouschet.

In South Australia, a small number of vines tested positive in Winter–Spring 2022:

- Harslevelu (LN-B)
- Malbec (Kalimna 1)
- Perle de Csaba (L6V13).

How to protect your vineyard from grapevine red blotch virus

As the disease's insect vectors are not present in Australia, the disease can only reach your vineyard through infected planting or grafting material.

- Ensure you only source certified or high-health status plant material from reliable and accredited sources.
- Frequently check your vineyard for signs of unhealthy grapevines and investigate symptoms closely.
- Clearly mark unhealthy vines (e.g. with flagging tape).
- Know what pests and diseases are present and remain vigilant in checking for potential new pests and diseases.
- Keep good records, especially of anything unusual.
- Ensure all staff and visitors adhere to your biosecurity practices.
- If you see anything unusual, report it straight away to the Exotic Plant Pest Hotline.

EXOTIC PLANT PEST HOTLINE
1800 084 881

What do I do if I suspect grapevine red blotch virus?

1. Submit a sample to the NSW Plant Health Diagnostic Service, making them aware that you suspect GRBV.
2. Inspect any vines in your vineyard that have been the source of grafting material for the suspect vine or have received grafts from the suspect vine.
3. Inspect other vines that might have used the same source stock.
4. Stop all movement to and from the area of the vineyard that is potentially infected until you receive laboratory confirmation.
5. Ensure staff follow on-farm biosecurity hygiene practices.
6. The test results might come back negative, but until then, think about:
   - where those particular vines came from and any other tracing information
   - any interactions between those vines and other vines in the vineyard
   - was the same stock used in other blocks
   - any information that might assist and limit the potential infection area.
7. Where GRBV is confirmed, remove the vine and burn it.

How do I submit a sample?

Please call the laboratory on 1800 675 623 to discuss how to submit your sample or email laboratory.services@dpi.nsw.gov.au

Laboratory hours are 8:30 am to 4:30 pm, Monday to Friday.

Specimens must be packaged correctly to ensure that the plant remains intact. Wrap plant samples in slightly damp newspaper to help maintain freshness. Do not package plant material in plastic bags during summer.

Specimens can be sent by courier mail or delivered in person. The package must contain a sample submission form that can be downloaded from Plant Health Diagnostic Service – Specimen Advice Form (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0020/710912/PHDS-specimen-advice.pdf) and which must be enclosed in a sealed plastic bag.

Send plant samples to:

Plant Health Diagnostic Service

EMAI, Woodbridge Road

Menangle NSW 2568

or

Private Bag 4008, Narellan NSW 2567.

References and further reading

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NSW wine industry biosecurity preparedness

Leonie Martin, Plant Biosecurity Officer, NSW DPIRD

Viticulture emergency response training (VERT) was created to improve industry and grower awareness of viticulture biosecurity, encompassing prevention, preparedness and monitoring. This benefits the NSW wine industry by educating people about biosecurity preparedness and incursion responses.

VERT workshops were held in the Hunter Valley and Griffith (Figure 84). The training included structural and operational activities and how roles fit into an emergency response.

Course participants were assessed throughout the program and had to complete 2 practical field operational tasks focused on a mock scenario of phylloxera and *Xylella fastidiosa*. The tasks included decontamination procedures on and off the premises, looking for symptoms, sample collection, packaging, labelling, and sample submission.

Over 50 growers and industry representatives are now trained to assist in a plant biosecurity emergency response.

Figure 84. Hunter Valley and Griffith viticulture emergency response training (VERT) workshops.

BIOSECURITY ACT 2015

Biosecurity Regulation 2017

GRAPEVINE PHYLLOXERA

NSW produces around 450,000 tonnes of wine grapes and 380 million litres of wine annually. NSW grape production is worth over $170 million a year and contributes $1.6 billion to Australia's $5 billion viticulture industry. Phylloxera is a very small yellow aphid-like insect that infests the roots of grapevines and occasionally causes distinctive galls on grapevine leaves, severely impacting production.

The biosecurity framework and tools safeguard our economy, environment and community.

This factsheet provides a summary of management arrangements for grapevine phylloxera biosecurity risks in NSW. More detailed information is available in the Biosecurity Regulation 2017, Biosecurity Order (Permitted Activities) 2017 and other documents at dpi.nsw.gov.au/biosecurityact

GENERAL BIOSECURITY DUTY

OUTCOME IS TO PREVENT, ELIMINATE & MINIMISE RISK

- Any producer or person dealing with grapevine plants has a responsibility for managing biosecurity risks that they know about or could reasonably be expected to know about
- Implementing an on farm individual farm biosecurity plan and/or 'come clean go clean' practices are both ways to discharge your general biosecurity duty

BIOSECURITY ZONE

OUTCOME IS TO MANAGE AND CONTROL THE RISK OF GRAPEVINE PHYLLOXERA

- Grapevine phylloxera is a very serious risk to industry
- Regulates movement of potential carriers of grapevine phylloxera into and within NSW
- Grapevine phylloxera biosecurity zone will encompass all of NSW, and includes a Phylloxera Exclusion Zone (PEZ) and two Phylloxera Infested Zones (PIZ)
- Carriers include anything that could be contaminated with grapevine phylloxera, such as grapevine plants, grapes, unprocessed grape juice, machinery or equipment that have been used in a vineyard or vineyard soil

CERTIFICATION

- Existing Interstate Certification Assurance and Certification Assurance schemes are recognised in Parts 13-17 of the Biosecurity Act to facilitate market access
- Transitional arrangements are in place for accredited businesses to continue to self-certify produce that meets the requirements of the relevant arrangement

PROHIBITED MATTER

OUTCOME IS TO PREVENT ENTRY OF GRAPEVINE PHYLLOXERA INTO NSW OR PART OF NSW

- Grapevine phylloxera is prohibited matter, except in the Albury/Corowa PIZ and the Sydney Basin PIZ
- Listed under Schedule 2 of the Biosecurity Act
- Duty not to deal with matter unless in accordance with conditions specified in the Grapevine Phylloxera biosecurity zone
- Duty to notify presence or suspected presence immediately outside of the PIZ through the Exotic Plant Pest Hotline on 1800 084 881
- Offence to deal with or possess prohibited matter

Evaluating a robotic mower for vineyard maintenance

Penny Flannery (Development Officer – Viticulture) and
Myles Parker (Leader – Southern Horticulture), NSW DPIRD

Introduction

The Husqvarna Automower® 550 EPOS™ is a high-capacity commercial robotic mower capable of mowing areas up to 10,000 m^2 and can manage slopes up to 24°. To determine the mower's suitability for mowing and maintaining all or part of a 1.6-hectare (ha) vineyard, a trial was initiated at the NSW DPIRD Orange Agricultural Institute (OAI). The vineyard consists of established vines and rootlings.

The Husqvarna Automower® 550 EPOS™ uses virtual boundaries instead of physical wires, allowing several work areas with different settings to be defined, including temporary stay-out zones. With the appDrive feature, users can steer the automower using their mobile phone as a remote control. This is helpful for defining a map or moving the mower without having to carry it (it weighs about 15 kg).

Set up

The charging station for the Automower® 550 EPOS™ was set up in the middle of the vineyard (Figure 85). To charge the mower and power the EPOS station, 240 V is required, so a 12 V solar battery system with a 240 V inverter was installed. This system costs approximately $1,000 using off-the-shelf components that are commonly used for camping. They were installed in a cool, water-tight box with added insect-proof ventilation. The solar-powered system was reliable for the length of the trial (October–December 2023).

An area of 0.3 ha was initially mapped around one of the 6 blocks that included the charging station at the OAI (Figure 86). Mapping the stay-out zones took approximately 3 hours.

Figure 85. The charging station, battery, and solar panel.

Figure 86. A work zone and a stay-out zone were mapped around one established block.

Results

The Husqvarna Automower® 550 EPOS™ completed maintenance mowing well (Figure 87) in an area when conditions were suitable. However, the mower struggled when the ground was muddy and when the grass or weeds were too high or had bulky bases. These conditions seemed to alter the course of the mower, sometimes into stay-out zones under the vines, or the mower became bogged or set into error. When this occurred, the mower had to be moved manually to the charging station, recharged and reset to start mowing again. Ideally on wet days, it is best to break the mowing schedule and send the mower to the charging station through the app until conditions are suitable for mowing again.

It took 3 hours to map the work zone and the stay-out zone within the block. While manually driving the mower, it had difficulty negotiating certain obstacles in the vineyard. For example, slashed clumps of grass, large weeds, holes in the ground, sticks from the vines, and any vine draped across the ground became caught in the mower, causing it to get stuck.

Figure 87. An inter-row area after being mown.

Conclusions

The Husqvarna Automower® 550 EPOS™ has the potential to maintain grass in an area of up to 1 ha if the conditions are suitable. In our small area demonstration trial, the mower could maintain several rows in the vineyard, but it did not respond well to muddy conditions, excess debris, uneven ground, vine material or large weeds. Setting up the mower was time-consuming due to having to drive the mower manually around each row to set up the mowing and non-mowing areas. This made the process open to errors, which occurred frequently. A vineyard is much more complicated to set up than most common turf areas, for which this model of robotic mower was intended.

This mower would be better suited to lawns and gardens than a vineyard with many obstacles. It would be more suitable for a cellar door area or established lawn area rather than the vineyard. The software does not allow the mowing areas to be plotted on a map using GPS coordinates on a computer. From our experience, this mapping capability would improve the mower's usability.

Husqvarna recommends that a trained Husqvarna representative visit a site to determine its suitability and install the mower.

Acknowledgement

This case study was funded by the NSW Department of Primary Industries and Regional Development (DPIRD) through the Viticulture Skills Development Program.

Autonomous tractors for viticulture

Associate Professor Jay Katupitiya, The School of Mechanical and Manufacturing Engineering, The University of New South Wales, Sydney

Introduction

In the ever-evolving landscape of unmanned vehicles, advances in agricultural vehicle technologies continue to revolutionise how we cultivate crops and manage farmland. Among the most promising developments are autonomous agricultural vehicles, representing a paradigm shift in farm operations. These vehicles, equipped with cutting-edge sensors, advanced control systems, and sophisticated guidance algorithms, can deliver precision machinery with the potential to significantly enhance efficiency, sustainability, and productivity in agriculture.

Gone are the days when farming relied solely on manual labour or traditional machinery operated by humans. Today, autonomous agricultural vehicles stand at the forefront of innovation, offering farmers unprecedented levels of automation and control over their operations. Whether it is ploughing fields, planting seeds, applying fertilisers and pesticides, harvesting crops, mowing grazing lands, or tending to vineyards, these intelligent machines can perform a range of tasks with remarkable precision, accuracy, and repeatability, while ensuring reliable operation. An integral part of these rapidly evolving machines is the unprecedented level of safety they can deliver by eliminating human error.

The significance of autonomous agricultural vehicles extends beyond mere automation. By leveraging real-time data and analytics, these vehicles can optimise farming practices, ensuring that resources such as water, fertilisers, and energy are used efficiently. This approach, traditionally called precision agriculture, not only reduces waste but also minimises environmental impact, making agriculture more sustainable, environmentally friendly, and cost-effective.

The adoption of autonomous agricultural vehicles could address some of the most pressing challenges facing modern farming, including labour shortages and the need to feed a growing global population. With the ability to work around the clock, without fatigue or human error, these machines can help farmers maximise productivity while minimising reliance on manual labour.

One notable challenge facing developers of autonomous agricultural machinery is establishing a high level of dependable confidence in these machines. This is especially critical for grapevine crops, where the stakes are significantly higher than ploughing, mowing, or harvesting for broadacre crops. Grapevines take 1–5 years for replacement plants to contribute to the harvest, magnifying the potential for economic damage. This underscores the importance of the safe and reliable operation of autonomous machinery deployed in vineyards.

The autonomous mower

Work at the University of New South Wales (UNSW) has been developing tractors that can operate in vineyards safely and efficiently. These tractors have the potential to deliver most of the benefits mentioned above. The machine (Figure 88) is equipped with several sensors, giving it access to:

1. A data stream from GNSS (global navigation satellite system), including GPS (global positioning system operated by the United States), GLONASS (global navigation satellite system operated by Russia), Galileo (operated by the European Space Agency), and BeiDou (operated by China). Together with other products such as Trimble's CenterPoint RTX, which the UNSW machine uses, these systems provide precise positioning information. Being able to determine the machine's exact location allows for accurate navigation and guidance.
2. A data stream from an IMU (inertial measurement unit), which helps compensate for external factors such as uneven terrain, ensuring smooth and precise operation.
3. A steering control system that is responsible for directing the vehicle along its intended path. In autonomous agricultural machines, steering control is often achieved through advanced algorithms. UNSW has developed these algorithms over many years and published them

internationally, allowing others to use them. Depending on the vehicle's design, steering can be controlled by hydraulic actuators, electric motors, or a combination of these. The UNSW machine's steering is controlled using electric motors.

Operating the mower

The tractor has a user interface that can run on a smart device, such as an iPad (Figure 89) or a smartphone, allowing the vineyard operator to select a path file specifically generated for a particular purpose, whether for open field mowing or vineyard mowing. The path will then be graphically shown on the map, with the tractor's location indicated by a red or green triangular icon. The icon, usually red, changes to green when the tractor can automatically lock onto the currently loaded path.

The machine is equipped with a remote controller that allows the operator to position the machine to the proposed starting point of the selected travel path. Before this, the operator should set the specified engine RPM and the proposed drive gears. If desired, the operator can drive the tractor manually instead of using the remote controller. However, it is recommended that the remote controller be used to position the machine.

Figure 88. The 75-hp autonomous tractor developed for vineyard mowing.

The operator can confirm proper positioning by verifying the tractor icon has turned green. Before launching, the operator can start the mower operation manually, or remotely by engaging the PTO and pressing the launch button on the user interface to initiate the autonomous operation.

The machine will automatically adjust its speed to suit the terrain and when going around corners. At the end of the operation, the machine will stop at the designated stop position.

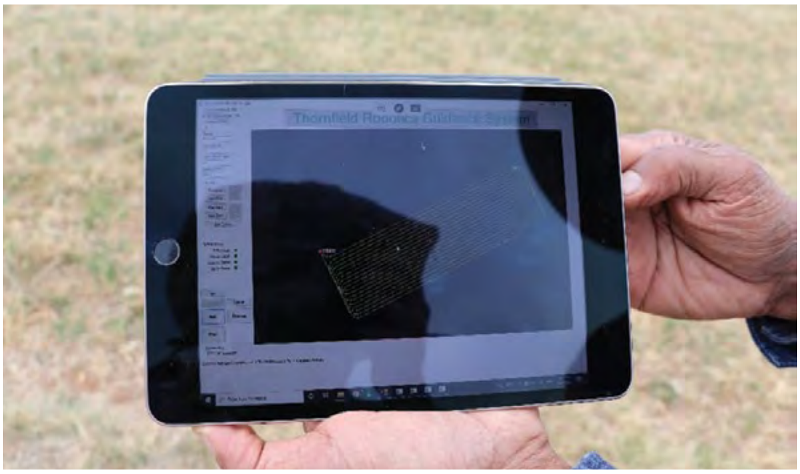

Figure 89. The set up on the iPad of the Thornfield robotics guidance system.

The tractor's safety system includes independent software and hardware systems with equal rights to make safety decisions, ensuring crop safety from all imaginable adverse consequences. The software and hardware also provide substantial redundancies to ensure reliable and safe operation.

Currently, the tractor can mow one hectare in 55 minutes using a mower that is 1.7 m wide. Given that the tractor is 75 hp, if a mower that is 2.5 m wide is used, a hectare can be mowed in 37 minutes.

To see a video of the machine in action, please visit (https://drive.google.com/file/d/1OkzQ-9qoefrfhK4G2E4TzmFskfRw5rPP/view).

Work on vineyard mowing is progressing, and a video showing the complete operation will be available at the end of September this year.

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Seasonal Conditions Monitoring Program

State Seasonal Update: Conditions and Outlook

The **State Seasonal Update** is produced monthly and is the official point of reference of seasonal conditions across NSW for producers, government, stakeholders and the public.

Combined Drought Indicator: Latest NSW Drought Maps

Is an interactive tool that provides a snapshot of current seasonal conditions for NSW, factoring in rainfall, soil moisture and pasture/crop growth indices.

Seasonal Conditions Information Portal

Uses technology that allows fast, stable transfer of data and information direct from the EDIS system to your computer. The portal contains several downloadable features from the **NSW Combined Drought Indicator.**

Farm Tracker Mobile Application

Farm Tracker is a tool you can use to record seasonal conditions. You can:

1. Complete a simple crop, pasture or animal survey
2. Keep and manage a photo diary of your farm
3. Monitor the same paddock over many years

Have your say

Complete this survey and tell us what is important to you as DPI continues to improve our Seasonal Conditions monitoring program. Eg. improved local accuracy of data and climate networks, better ways of communicating, or strengthening linkages to drought management and relief measures.

Department of Primary Industries
www.dpi.nsw.gov.au

NSW GOVERNMENT