Powdery mildew management: experimental trials

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Introduction

Grapevine powdery mildew is caused by the fungus *Erysiphe necator* and occurs in most Australian vineyard regions. The result is considerable losses in terms of reduced yield and quality, as well as cost of management. Wineries have thresholds for powdery mildew contamination, such as loads that exceed 3–5% of grapes with powdery mildew may be downgraded or rejected. Effective powdery mildew control is paramount to the economic success of not only individual vineyard operators, but the overall industry.

Powdery mildew is driven by the amount of inoculum (spores) inherited from the previous season with the disease progressing more or less independent of the weather. Spray applications that consider the three Ts of type, timing and technique (Magarey 2010) will lead to enhanced control across a growing season and may lead to reduced incident levels in subsequent years.

In 2016 NSW experienced the wettest winter in 100 years and its wettest September in 50 years prior to start of the 2017 vintage. Poor vineyard access, high humidity and a continuation of persistent cloud cover during critical growth stages resulted in powdery mildew outbreaks occurring extensively throughout NSW wine growing regions. Disease severity was so great within some vineyard blocks that complete crop losses eventuated regardless of the disease management practices applied. This raised the question: was it type, timing or technique that resulted in such severe powdery mildew? Or was it something else?

To address this question, two trial sites were established in Canowindra and Hunter Valley wine growing regions where powdery mildew infection had decimated the crop in the 2017 vintage. Different types and timing of management practices were assessed against current vineyard practices for managing powdery mildew.

Application strategy

In 2017–18 a demonstration trial was conducted across two separate vineyards; a conventionally managed vineyard located in Broke (Site 1) and an organically managed site at Canowindra (Site 2). Both synthetic (Table 1) and organic treatments (Table 2) were applied to Chardonnay vines.

Given the importance of fungicide resistance, different groups of fungicide treatments (5, 3 and U8) were used on Site 1 throughout the season, spraying no more than two consecutive sprays from the same group fungicide.

This was compared to the current practice at Site 1 which consisted of sulphur and Horti oil at a rate of 3 kg/ha and 3 L/ha respectively applied on 29/8/17, 18/9/17 and 4/10/17 followed by:

- Cavalry® and Cabrio® on 18/10/17
- Legend™ on 30/10/17
- Thiovit Jet® on 8/11/2017
- sulphur on 22/11/17
- Legend™ on 9/12/17
- sulphur on 27/12/17
- Thiovit Jet® on 13/1/2018

All these were applied at label rates.

Site 2 was split further to evaluate the efficacy of a multi-dimensional foliar fertiliser (Photo-Finish™, supplied by Nutri-Tech Solutions™ http://www.nutri-tech.com.au/) that contains silicon, potassium, kelp and humic acid. This was compared with a dedicated organic derived fungicide, Ecocarb®, supplied by Organic Crop Protectants (http://ocp.com.au/).

Apart from Photo-Finish™, all other products used at Site 2 utilised M2 group fungicides, albeit multi-site modes of action chemistry. This highlights the limitations of choice currently available to organic viticulture if resistance was to ever occur with the use of this group.

Table 1. Timing and treatment dates at Site 1, Broke, 2017–18.

Timing	Tight program product/actives	Extended program product/actives	Group	Date applied
Week 0 Budburst (EL05)	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur	M2	31/08/17
Week 2	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur	M2	14/09/17
Week 4	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur	M2	28/09/17
Week 6 Pre-flowering (EL12)	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur	M2	11/10/17
Week 8	Prosper® @ 60 mL/100 L Active: 500 g/L spiroxamine	Prosper® @60 mL/100 L Active: 500 g/L spiroxamine	5	26/10/17
Week 9 Flowering (EL19)	Prosper® @ 60 mL/100 L Active: 500 g/L spiroxamine	–	5	2/11/17
Week 10	Digger® @ 25 mL/100 L Active: 250 g/L difenoconazole Solvent: 696 g/L liquid hydrocarbon	Digger® @ 25 mL/100 L Active: 250 g/L difenoconazole Solvent: 696 g/L liquid hydrocarbon	3	9/11/17
Week 11 End of flowering (EL27)	Digger ® @ 25 mL/100 L Active: 250 g/L difenoconazole Solvent: 696 g/L liquid hydrocarbon	–	3	16/11/17
Week 12*	Kusabi ® @ 30 mL/100 L Active: 300 g/L pyriofenone	Kusabi ® @ 30 mL/100L Active: 300 g/L pyriofenone	U8	23/11/17
Week 13 Berries pea size (EL31)	Kusabi ® @ 30 mL/100 L Active: 300 g/L pyriofenone	–	U8	30/11/17
Week 14	Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur	Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur	M2	7/12/17
Week 16	Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur	Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur	M2	21/12/17
Week 18	Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur	Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur	M2	4/01/18

*Kusabi 300 SC Fungicide should not be applied later than EL31 (berries pea size) when grapes are to be used to make wine for export. While used in compliance, Site 1 production was destined for domestic market only.

Table 2. Timing and treatment dates at Site 2, Canowindra, 2017–18.

Timing	Tight program product/actives		Extended program product/actives		Group	Date applied
Week 0 Budburst (EL05)	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur		Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur		M2	26/09/17
Week 2	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur		Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur		M2	10/10/17
Week 4	Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur		Microthiol® Disperss® @ 600 g/100 L Active: 800 g/kg sulfur		M2	24/10/17
Week 6 Pre-flowering (EL12)	Ecocarb® @ 400 g/100 L Active: 950 g/kg potassium bicarbonate	Photo-Finish™ @ 500 mL/100 L	Ecocarb® @ 400 g/100 L Active: 950 g/kg potassium bicarbonate	Photo-Finish™ @ 500 mL/100 L	M2	7/11/17
Week 7	Ecocarb® @ 400 g/100 L Active: 950 g/kg potassium bicarbonate	Photo-Finish™ @ 500 mL/100 L	–	–	M2	14/11/17
Week 8 Flowering (EL19)	Ecocarb® @ 400 g/100 L Active: 950 g/kg potassium bicarbonate	Photo-Finish™ @ 500 mL/100 L	Ecocarb® @ 400 g/100 L Active: 950 g/kg potassium bicarbonate	Photo-Finish™ @ 500 mL/100 L	M2	21/11/17
Week 9	Ecocarb® @ 400 g/100 L Active: 950 g/kg potassium bicarbonate	Photo-Finish™ @ 500 mL/100 L	–	–	M2	28/11/17
Week 10 End of flowering (EL27)	Ecocarb® @ 400 g/100 L Active: 950 g/kg potassium bicarbonate	Photo-Finish™ @ 500 mL/100 L	Ecocarb® @ 400 g/100 L Active: 950 g/kg potassium bicarbonate	Photo-Finish™ @ 500 mL/100 L	M2	5/12/17
Week 11	Ecocarb® @ 400 g/100 L Active: 950 g/kg potassium bicarbonate	Photo-Finish™ @ 500 mL/100 L	–	–	M2	12/12/17
Week 12 Berries pea size (EL31)	Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur		Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur		M2	21/12/17
Week 14	Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur		Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur		M2	4/1/18
Week 16	Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur		Microthiol® Disperss® @ 300 g/100 L Active: 800 g/kg sulfur		M2	18/1/18

The treatments were applied to individual rows of vines and replicated three times on adjacent rows within an area where powdery mildew was evident the previous vintage. These row treatments were compared to current vineyard practice.

These row treatments were compared to current vineyard practice at Site 2 which included sulphur at 15 kg/4 ha applied on the 13/10/2017, 24/10/2018 and 4/11/2017 in addition to seaweed and humics applied at 20 L/4 ha on 20/11/2018 and 9/12/2017, with boron and zinc also applied at a rate of 3 kg/4 ha.

Timing of spray applications across both sites was initially undertaken every fourteen days from budburst (EL05) until pre-flowering (EL12), followed by either a 'tight' seven-day cycle or an 'extended' fourteen-day cycle until the beginning of bunch closure (EL32), where the program reverted back to a fourteen-day cycle. This timing was consistent with the manufacturer's label recommendations for the application of all products used within the trial. Applications of products to all treatments were carried out on the same day using individual 15-litre calibrated knapsack spray equipment for each separate product. All products were applied at manufacturer's application and water rates per hectare.

Spray applications to control botrytis and downy mildew were also undertaken however, are not listed here.

Outcomes

The three Ts of type, timing and technique coupled with extremely favourable weather conditions throughout the season resulted in no detection of powdery mildew outbreaks at either site across both tight and extended programs. The extended program was effective in its control, more efficient and less costly overall compared to the tight program which can be viewed as a luxury program for this season. No incidence resulted where spray programs were split between nutrient applications of Photo-Finish™ and compared to Ecocarb® at Site 2. The control treatments undertaken at both sites managed by each landholder also resulted in no incidence of powdery mildew during the 2017–18 vintage.

Discussion

It was expected that both sites would have a significant level of inoculum from the preceding year (Figure 1), hence the establishment and application of a very extensive spray program. However, if the overwintering inoculum was present, its suppression was probably due to the use of multi-site mode of action chemistry early in the season. Magarey (2010) suggests "The principle of 'lag phase control' is to apply fungicides while initial inoculum levels are low and more manageable, and sufficiently early in the epi-season to prevent the development of overwintering inoculum for Season 2".

Moreover, weather conditions experienced during the spring of 2017 assisted in minimising outbreaks. Rainfall for both sites was well below the long term average (LTA) in the months of September and November (Table 3). Contrasted with the high rainfall in September 2016, this highlights the fact that this rainfall caused the increased risk of disease in that year, where monthly rainfall was twice the LTA at Site 1 and almost four times the LTA at Site 2.

Mean global solar exposure was above the long term average at both sites during September 2017 (Table 4) and above the figures recorded in September of 2016. Whereas the 2016–17 season commenced with saturated soil profiles prior to budburst leading to vigorous dense canopy growth and lush midrow growth, the 2017–18 season was the opposite with very dry soil conditions at both sites reducing canopy growth (Figure 2).

Figure 1. Bunch structures infected with powdery mildew, Site 2, December 2016. Photo: Darren Fahey.

Table 3. Monthly rainfall figures in millimetres (mm) for Site 1 (Broke) and Site 2 (Canowindra) BOM stations.

Rainfall (mm)	Site 1			Site 2		
	2016	2017	LTA 061397	2016	2017	LTA 065111
September	79.2	13.4	38.9	163.2	11.2	45.1
October	52.2	59.8	44.5	84	65.6	37.8
November	50.5	24.2	78.1	43.4	45.0	65.8

Sources: http://www.bom.gov.au and https://www.dpi.nsw.gov.au/agriculture/horticulture/grapes/weather-stations-network/wsn.

Table 4. Mean monthly global solar exposure (MMGSE) in Mega Joules per square metre (MJ/m^2) for Site 1 (Broke) and Site 2 (Canowindra) BOM stations.

MMGSE (MJ/m^2)	Site 1			Site 2		
	2016	2017	LTA 061397	2016	2017	LTA 065111
September	18.7	16.3	17.5	17.0	13.1	16.6
October	20.1	20.1	20.6	22.4	21.4	21.5
November	22.8	26.1	22.2	24.8	25.8	24.6

Source: http://www.bom.gov.au.

Table 5. Mean monthly relative humidity (MMRH) as a percentage (%) for Site 1 (Broke) and Site 2 (Canowindra) BOM stations.

MMRH (%)	Site 1		Site 2	
	2016	2017	2016	2017
September	65	38	83	62
October	97	66	99	67
November	90	68	96	57

Source: http://www.bom.gov.au.

Additionally, midrow swards were sparse in cover and biomass reduced in size due to lack of available soil moisture and limited rainfall. This would have also influenced microclimate humidity (Table 5) in and around vines. Magarey (2010) writes "Canopies open to airflow and UV light therefore have less risk of disease while dense, shaded canopies provide a favourable microclimate".

Given the level of control of powdery mildew experienced at both sites in the 2017/18 season, inoculum levels should be further reduced going into the next season, providing an opportunity to save on inputs whilst maintaining effective control.

Take home messages

- be vigilant with early season 'lag phase' spraying to reduce inoculum levels carried over from the previous season
- rotate chemistry groups and products within the same groups to maintain efficacy and limit resistance
- coverage is paramount, ensure all spray equipment is set up correctly to cover canopy, flower and bunch structures
- manage canopies to promote light penetration which is known to kill powdery mildew spores.

Figure 2. Short internode spacing highlighting the drier conditions experienced at Site 2, December, 2017. Photo: Darren Fahey.

Acknowledgements

This work was funded through the Wine Australia Regional Program. The following people contributed to the project: Jenny Bright (Bright Vine Services), Ken Bray (Hunter Vineyard Management) and Sam Statham (Rosnay Organic Wines) provided vineyard sites and assistance in the trial. James Gardner (Organic Crop Protectants) is acknowledged for supplying products used in this demonstration.

Further information

Australian Wine Research Institute: www.awri.com.au/information_services/fact-sheets/

Magarey, PA 2010 www.wineaustralia.com.

Tasmanian Institute of Agriculture: utas.edu.au/tia

Wine Australia: www.wineaustralia.com.