



Department of  
Primary Industries

# Grapevine management guide 2015–16

NSW DPI MANAGEMENT GUIDE



Compiled by Darren Fahey

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# Grapevine management guide 2015–16

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NSW Department of Primary Industries

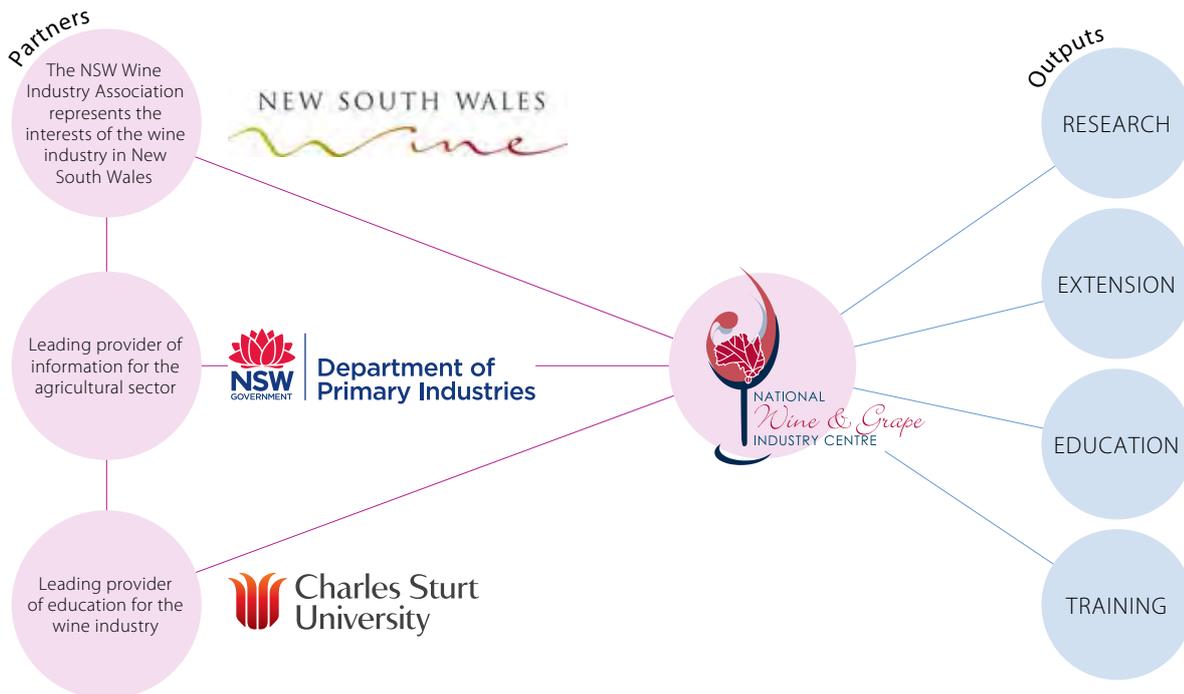
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Pine Gully Road, Wagga Wagga NSW 2650



The National Wine and Grape Industry Centre is an alliance of Charles Sturt University, NSW Department of Primary Industries and the NSW Wine Industry Association.

The National Wine and Grape Industry Centre delivers high value research, education, training and extension to the Australian Wine Industry.



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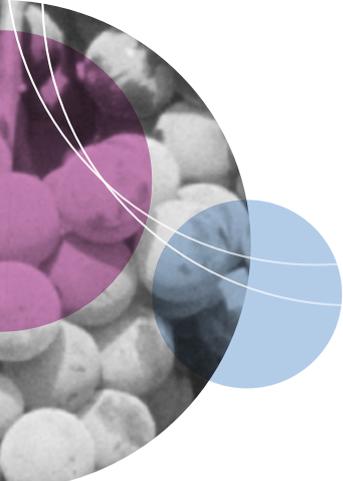
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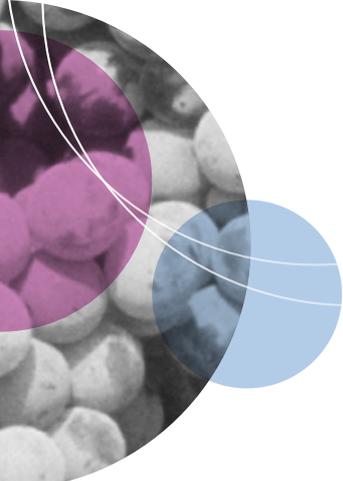
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# Foreword

## NSW the first state for wine

### Darren Fahey

Development Officer, Viticulture, NSW DPI

It is with great pleasure that I welcome you to read, benefit and grow from the information contained within the Grapevine Management Guide 2015–2016.

In my first year as Development Officer – Viticulture I have extensively travelled

across NSW visiting the majority of wine regions gathering input and feedback toward priorities that will enhance grape growing and winemaking capacity in NSW and let me say the state is in great hands.

This was made evident when surveying the impact from two initiatives delivered through the NSW DPI's Skills Development program – VineWatch Bulletins and the Weather Station Network, which have already led to practice change with growers adjusting the timing of spray applications based on the information provided, read the case study provided by Jacob Stein which supports this on page 10.

This coming year will see a further roll-out of the Weather Station Network across the Hunter Valley, Canberra, Orange and Tumbarumba and inclusion of their regional seasonal content into regular VineWatch Bulletins, thus providing current at hand information to assist in vineyard management decision making throughout vintage.

Hence this edition is focused on weather, with great articles from Agata Imielska, Senior Climatologist at the Bureau of Meteorology discussing the benefits of using tools such as MetEye and accessing data 'from 3 hours to 3 months ahead' on page 3. David Pickering unravels the technical information and practical application of various weather station systems on page 12. An insight into what was found across the Mudgee and Riverina network is provided by Richard Hamilton on page 6 with Peter Magarey and Kathy Evans updating us all on the main diseases driven by weather on pages 14 and 22 respectively.

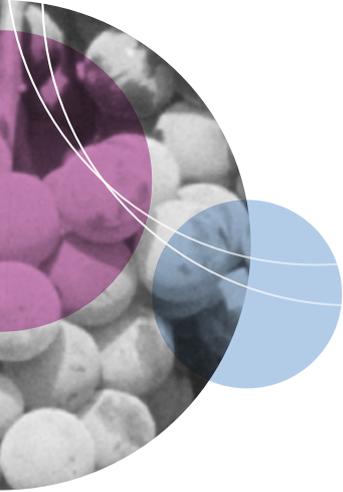
The Grapevine Management Guide 2015–2016 is one of NSW DPI's flagship publications. Such publications are a crucial means of packaging information for producers, and as such I recommend this current edition to you.

### Feedback please

NSW DPI wants to make sure that the information we're providing is what you need to make your business grow. We would like to receive any feedback that you care to offer – good, bad or indifferent. This will help us to make future editions even more useful. Please contact me with your suggestions by mail, phone, fax or email.

### Darren Fahey Development Officer, Viticulture

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# Future projects

## Current research at the National Wine and Grape Industry Centre (NWGIC)

### Dr Gregory Dunn

Leader, Viticulture NSW DPI and Deputy Director, National Wine and Grape Industry Centre (Wagga Wagga)

The National Wine and Grape Industry Centre at Wagga Wagga is an alliance between CSU, NSW DPI and the NSW Wine Industry Association that conducts research in a range of projects spanning the continuum from the grapevine to the wine and on to the consumer. These projects are mainly co-funded by the Australian Grape and Wine Authority (AGWA) and often involve collaboration other R&D providers across Australia. In addition to these research projects, other smaller studies are conducted by post graduate students and visiting scholars. Major research themes and current projects are listed below.

### Vine health and biosecurity theme

- » Practical management of grapevine trunk diseases: contact Dr Sandra Savocchia, [ssavocchia@csu.edu.au](mailto:ssavocchia@csu.edu.au)
- » Understanding fungicide resistance in powdery and downy mildew: contact Dr Sandra Savocchia, [ssavocchia@csu.edu.au](mailto:ssavocchia@csu.edu.au)
- » Determination of thresholds for bunch rot contamination of grapes and techniques to ameliorate associated fungal taints: contact Professor Chris Steel, [csteel@csu.edu.au](mailto:csteel@csu.edu.au)
- » Brassica biofumigation of black foot fungi in vineyard soil: contact Dr Melanie Weckert, [melanie.weckert@dpi.nsw.gov.au](mailto:melanie.weckert@dpi.nsw.gov.au)
- » Entomopathogenic fungi as potential biocontrol agents of grape Phylloxera: contact Dr Sandra Savocchia, [ssavocchia@csu.edu.au](mailto:ssavocchia@csu.edu.au)

### Vine quality and yield theme

- » Improved yield prediction for the Australian wine industry using real time image capture and analysis: contact Associate Professor Gregory Dunn, [gregory.dunn@dpi.nsw.gov.au](mailto:gregory.dunn@dpi.nsw.gov.au)
- » Improving industry capacity to manage yield and wine quality relationship through understanding the influence of vine carbon balance and berry composition: contact Jason Smith, [jasmith@csu.edu.au](mailto:jasmith@csu.edu.au)

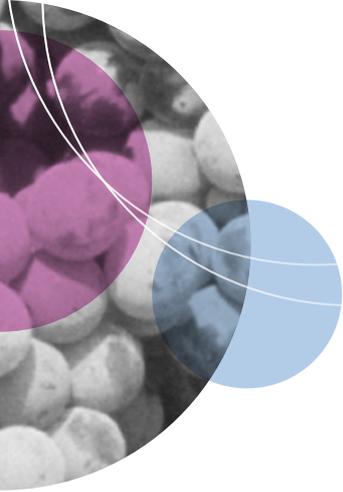
- » The role of potassium in sugar unloading into grape berries with the objective to manage berry sugar accumulation from a viticultural perspective and identifying the instigators of cell death in the berry mesocarp cells and understand the implications on berry composition: contact Dr Suzy Rogiers, [suzy.rogiers@dpi.nsw.gov.au](mailto:suzy.rogiers@dpi.nsw.gov.au)
- » Evaluating and demonstrating new white and red disease resistant varieties for the Riverina: contact Dr Bruno Holzapfel, [bruno.holzapfel@dpi.nsw.gov.au](mailto:bruno.holzapfel@dpi.nsw.gov.au)

### Fruit and wine composition and style theme

- » Fruit and wine composition and sensory profile: sequential harvest, searching for the sweet spot in Australian regions: contact Dr Leigh Schmidtke, [lschmidtke@csu.edu.au](mailto:lschmidtke@csu.edu.au) or Professor Alain Deloire, [adeloire@csu.edu.au](mailto:adeloire@csu.edu.au)
- » Metal ion speciation, understanding its role in wine development and generating a tool to minimise wine spoilage: contact Dr Andrew Clark, [aclark@csu.edu.au](mailto:aclark@csu.edu.au)

### Wine and consumers theme

- » Objective measures of Australian sparkling wine style and quality: contact Professor Anthony Saliba, [asaliba@csu.edu.au](mailto:asaliba@csu.edu.au)
- » Characterisation of wine avoiders and how to transition avoiders to consumers: contact Professor Anthony Saliba, [asaliba@csu.edu.au](mailto:asaliba@csu.edu.au)



# Vineyard management: introduction

## Dr Gregory Dunn

Leader, Viticulture, NSW DPI and  
Deputy Director, National Grape and Wine  
Industry Centre (Wagga Wagga)

Like other agricultural activities, weather has a profound effect on viticulture. Temperature has a dominant role in controlling grapevine growth and phenology, determining the timing of key growth and development stages. Reproduction and, therefore, yield is highly responsive to both temperature and light during critical stages of sensitivity. In the previous season the development of inflorescence primordia inside grapevine buds determines potential yield. During the season, there are other critical phases of sensitivity to weather that affect the realization of yield potential. These include bud burst when flowers are formed and during flowering and fertilization, when adverse conditions relating to temperature, humidity and wind can substantially reduce fruit set. Light and temperature also significantly affect fruit development and composition and eventually wine quality. Weather also has a key role in determining grapevine water use and thus irrigation requirements.

Arguably one of the most important impacts the weather has on viticulture relates to how it affects risks to production. These include unpredictable episodic events such as frost and heat stress but also the role the weather has in determining susceptibility to pests and disease. Continued research is being conducted to better refine our quantitative understanding of how the weather affects disease incidence and severity. Also, improved management of pests and disease in response to unfavorable weather conditions is very much an active area of research.

At the same time, our ability to measure weather conditions more accurately and more cheaply and access weather data in real times at various scales across the landscape continues to improve. The skill with which we are able to predict weather conditions has also improved significantly. Furthermore, the provision of real time weather data to wine regions in NSW in order to assist in better management of pest and disease has been a strong focus of the NSW DPI funded Skills Development Program, in collaboration with the NSW Wine Industry Association. Thus, it is timely for this year's Grapevine Management Guide to review recent developments in measuring weather conditions in the vineyard and our ability to predict weather conditions at a range of time scales and how these have the potential to significantly change the way that pests and disease are managed in the vineyard.

# Weather and climate at your doorstep: from 3 hours to 3 months ahead

## Agata Imielska

Senior Climatologist  
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### Preparing for what's to come

Managing weather and climate in any region can be a challenge; the more variable the climate, the greater the challenge. Detailed weather forecasts can provide invaluable information for planning for the week ahead, while climate outlooks and tracking the El Niño-Southern Oscillation (ENSO) can tell you if we're likely to be in wet and humid year or a dry and warm one.

The Bureau of Meteorology has a wealth of information ranging from detailed weather forecast, historical climate data, trends, water and flood forecasts, through to climate outlook information for the season ahead. In this article we'll highlight a number of useful tools to assist with managing and preparing for what's in store:

**MetEye:** forecast mapping tool

**Climate outlooks:** rainfall and temperature for the season ahead

**ENSO tracker:** risk of El Niño or La Niña

### MetEye: weather forecasts at your doorstep

Australians anywhere can view maps of seven-day weather forecasts, following completion of the nationwide rollout of the Bureau's Next Generation Forecast and Warning System.

The MetEye mapping tool allows people to view the data behind the general weather forecasts in greater detail. The forecast maps are created by the Bureau's meteorologists who use sophisticated tools and techniques to refine forecasts for local conditions.

As well as simple overviews of the day's forecast, you can 'pick and choose' from a host of detailed meteorological data – from three-hourly temperature and rainfall parameters, to wind, humidity, significant weather events, and nautical features such as wave heights and sea surface temperatures.

With the same intuitive logic as the best online mapping tools, MetEye lets you pan and zoom to specific locations, save your favourite locations and play animations of unfolding weather events. The forecasts

are grid-based which allows anyone to view detailed weather forecast information for each individual grid (size 3 to 6 km). Simply point and click at your location.

MetEye also includes a number of practical features for risk management including probabilities of rainfall (10, 25 and 50%) as well as the chance of any rain. It includes 3-hourly forecasts out to 7 days for rainfall, temperature, wind and humidity to name a few of the variables. You can also view current observations, overlay river conditions and radar. This is only the beginning for MetEye with more features to come!

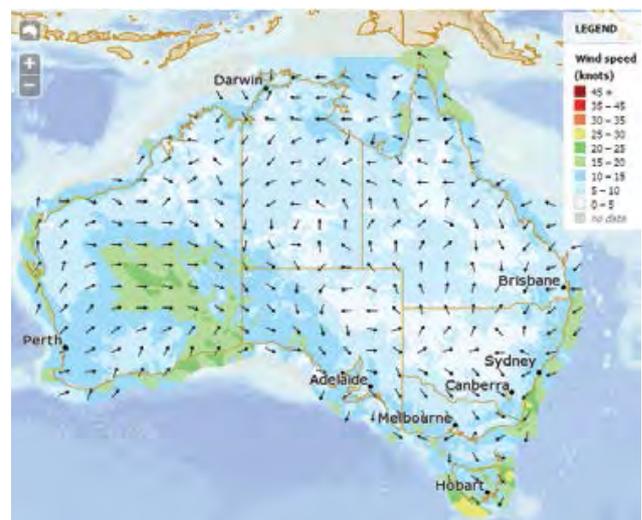


Figure 1. MetEye 3-hourly wind forecast for Australia (Bureau of Meteorology).

### Climate outlooks: rain and temperature for the season ahead

We all find the seven-day forecast useful when planning our week's activities, work events, holidays and travel. But for anyone managing land and crops, knowledge of whether this year is going to be a wet and humid or dry and warm can spell the difference between a good year and a bad one.

Fortunately, the Bureau of Meteorology is providing an increasingly detailed array of climate outlooks, which apply some of the world's most sophisticated atmospheric and ocean modelling to assess how Australia's rainfall and temperatures may evolve over the next three months.

A new outlook service was launched back in 2013 providing a probabilistic outlook for rainfall, maximum and minimum temperature for the three months ahead, as well as the first two individual months. The outlook service is an interactive tool and allows for all the familiar online mapping tool options (panning, zooming etc.). You can point-and-click at your location of interest to see what your odds of having a wetter or drier season may be, and the odds of receiving a certain amount of rainfall for the period. Seasonal climate outlooks are not weather forecasts. Rather than say it **will** be warm and dry, seasonal outlooks say it is **likely** to be warm and dry. This can provide valuable information for the season ahead, particularly when heading into an El Niño or La Niña which often results in drier or wetter conditions across large parts of Australia.

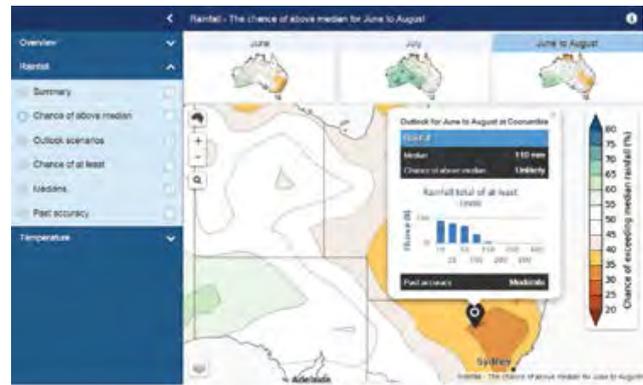
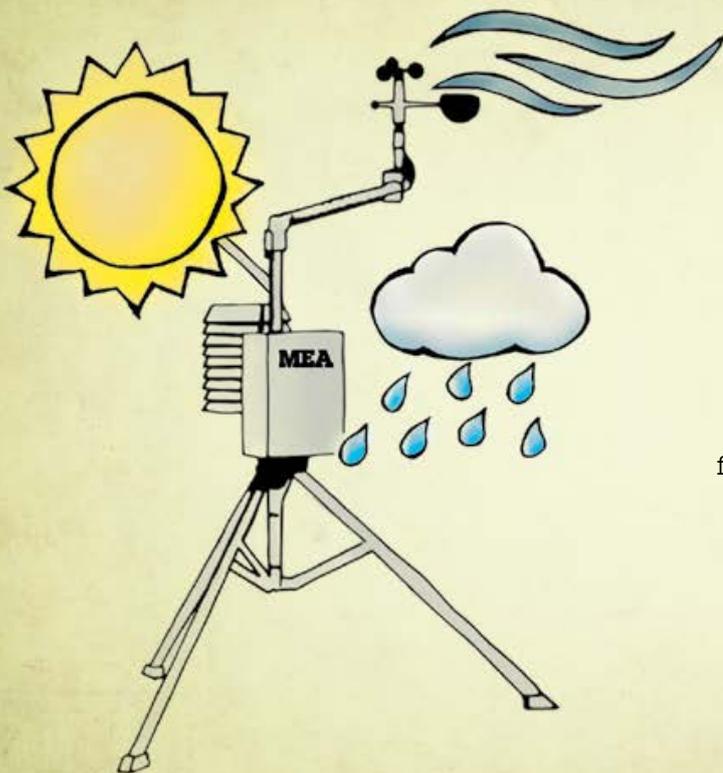


Figure 2. Rainfall outlook for June – August (Bureau of Meteorology).



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# MEA

### ENSO tracker: status and risk of El Niño or La Niña

El Niño and its opposite phase, La Niña, are the result of periodic changes in the temperature of the tropical Pacific Ocean and the atmosphere above it, as part of a natural cycle known as the El Niño – Southern Oscillation. In the case of El Niño, these changes are associated with a warming of the central and eastern tropical Pacific Ocean, whereas La Niña events are a result of cooling of these same areas.

La Niña events can also have significant outcomes, with the most recent **double-dip La Niña** in 2010–12 causing widespread flooding over much of eastern Australia.

An early indication that an El Niño or La Niña could be developing can give those most susceptible to our variable climate time to prepare – potentially preventing or mitigating financial losses and other adverse consequences.

An El Niño (or La Niña) and its impacts don't happen overnight; it's not like flicking a switch. The transition from normal or 'neutral' conditions to El Niño should be considered more as a continuum. Changes happen gradually, usually over a period of several months, and can fluctuate back and forth over shorter time scales.

The ENSO tracker is based upon a comprehensive analysis by Bureau climatologists, including the **survey** of eight international climate models as well as current conditions for key atmospheric and ocean indicators of El Niño. It provides a simple and convenient snapshot of the current status of ENSO, and the likelihood of an ENSO event developing later in the year.

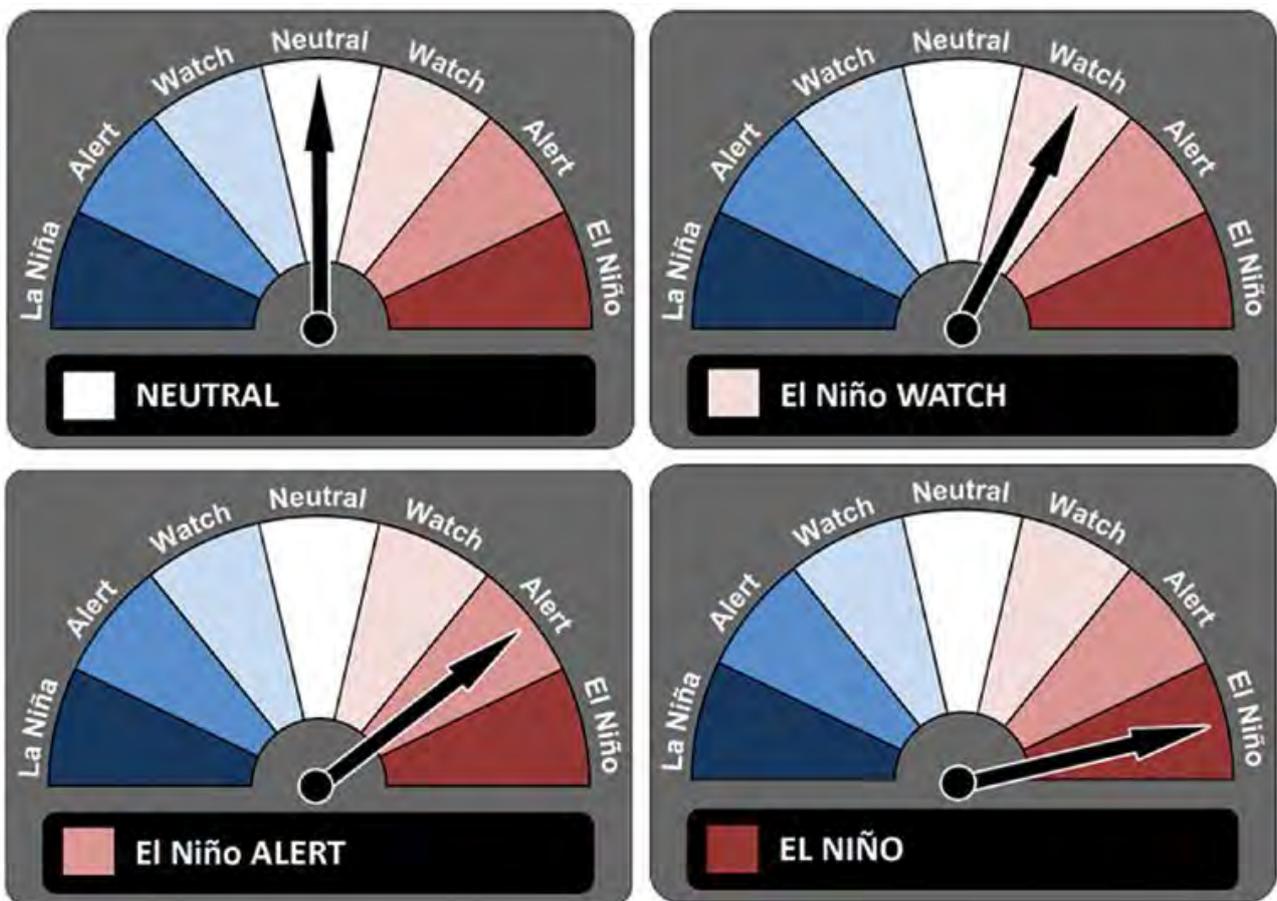
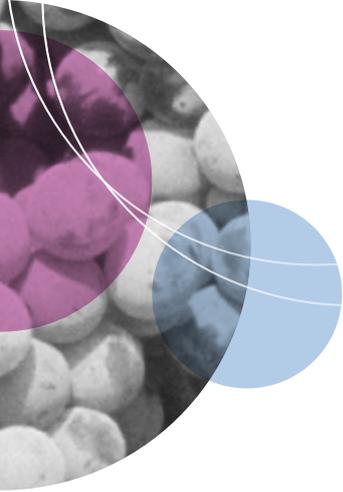


Figure 3. ENSO tracker showing four key states: NEUTRAL, El Niño WATCH – double the normal likelihood of El Niño (or La Niña), El Niño ALERT – at least a 70% chance of El Niño and the final phase 'El Niño' when the event fully develops (Bureau of Meteorology).



# Using weather tools to make vineyard management decisions

## Dr Richard Hamilton

Hamilton Viticulture  
[hamilton.viticulture@bigpond.com](mailto:hamilton.viticulture@bigpond.com)

Prevailing weather conditions affect both the growth and health of vineyards. Following weather forecasts is a critical step to planning vineyard activities. It is also valuable to review past weather conditions and their effect on vineyard management.

A weather station is an invaluable tool to help understand seasonal conditions and their impact on the vines in a particular location. The most important measures for grape growing include:

**The recording of temperature:** Monitoring of extremes as an indication of what is happening on the vineyard. For example readings close to and below 0°C are critical for frost protection systems. Equally, monitoring periods of extreme heat is important in planning irrigation to minimise heat damage to vines.

**Monitoring rainfall:** Rainfall recording is also an integral part of planning of irrigation schedules. This is also critical to managing downy mildew and *Botrytis* infection periods.

**Humidity:** This is another critical measure, providing indication of the likelihood of downy mildew and *Botrytis* infections maintaining active growth.

**Leaf wetness:** A useful tool, that is not available from Bureau of Meteorology stations, is a measure of leaf wetness. This sensor provides information critical to knowing whether or not a downy mildew infection period has occurred.

**Wind speed and direction:** Wind impacts particularly on fungicide spray programs, as it helps optimise the timing of spray applications to match expected conditions. This measure has not previously been integral in vineyard owned weather stations. However in some countries it is mandatory to record weather conditions at the time of spraying.

Like all tools the usefulness of the information that it provides is enhanced by its accuracy. Bureau of Meteorology sites provide detailed, accessible and accurate data within the district, however data from an onsite weather station is the most useful as it indicates how the vineyard site is responding to the local prevailing weather conditions. Being even a small distance from a Bureau of Meteorology site can significantly change the nature of the data

collected. Similarly the usefulness of weather station data is enhanced by careful siting within a vineyard to ensure it measures representative data. In large vineyards weather conditions can vary considerably and is affected by topography (height above sea level, aspect, windbreaks etc.) as well as by other factors such as the method of application of irrigation (dripper as compared to overhead sprinkler). All of these factors need to be taken into account when deciding on where to place a weather station

The accuracy of weather data is also enhanced by the number of years of past data that can be accessed to compare the influences of the current season on expected vine growth and fruitfulness.

Comparison of this data with a local network (such as the NSW DPI networks at Griffith and Mudgee) also provides a good indication, particularly where the vineyard in question has been calibrated against other stations in the district.

## NSW DPI weather station networks at Griffith and Mudgee

NSW DPI installed 5 stations each at Griffith and Mudgee in July 2014 as part of the Skills Development Program in order to provide growers with regional information on weather conditions. This network provided the basis for the fortnightly VineWatch Bulletins produced for the 2014–2015 growing season [www.awri.com.au/industry\\_support/viticulture/vine-watch](http://www.awri.com.au/industry_support/viticulture/vine-watch)

The data is available at all times at [www.awri.com.au/industry\\_support/weather-nsw](http://www.awri.com.au/industry_support/weather-nsw). This website shows current conditions, as well as a summary of the current day's conditions, the previous day's conditions and weekly, monthly and annual summaries. Most importantly it is possible to download data from each of the 10 sites; with the ability to select information from any period of interest (e.g. daily, weekly or monthly data which may then be manipulated in a spreadsheet).

An example of this is shown in Table 1. Rainfall data from the 5 Mudgee stations is compared with the Bureau of Meteorology Mudgee Airport station [www.bom.gov.au/climate/data](http://www.bom.gov.au/climate/data). For the period from September 2014 to April 2015 the Mudgee Airport station recorded significantly less rain than the other stations (329 mm as compared to a range of 413–445 mm for the five stations).

Comparison of the monthly rainfalls shows considerable variation across Mudgee, highlighting the value of monitoring weather events in relation to a particular vineyard site. This can be from a weather station on the vineyard or by utilising resources such as a nearby Bureau of Meteorology station or from a local network such as those installed at Mudgee and Griffith.

When installing a weather station on a vineyard it is useful to retrieve data from the local Bureau of Meteorology network in order to compare the readings from other stations with the new station. This calibration then provides an indication of how the vineyard relates to local conditions. As an example it would seem that the Bureau of Meteorology station at Mudgee Airport is a drier site as compared to the five stations in the local network. This then allows understanding of what a regional forecast means for a particular vineyard, by comparison to the readings gathered from the vineyard.

Figure 1 shows comparison of average monthly humidity data from the NSW DPI network at Griffith (data downloaded from [www.awri.com.au/industry\\_support/weather-nsw](http://www.awri.com.au/industry_support/weather-nsw)). Whilst there is some variability with the data there is a definite trend, with Hanwood being the most humid site and Nericon the least humid. Although the differences are small (4–9%) they are significant as the readings are the average for a whole month. The differences may be related to the siting of the weather station, eg. a grassed area as compared to bare ground. This needs verification as the higher humidity at Hanwood may indicate a greater susceptibility to *Botrytis* under some conditions.

Figure 2 shows comparison of average monthly leaf wetness data from the NSW DPI network at Griffith. The Yenda data shows significantly higher leaf wetness than the other sites. This may be related to a number of causes and needs careful verification as what factors are making the leaf wetness readings higher at this site. Issues that may cause such a significant difference, as compared to other sites, include the density of the canopy at the point where the leaf wetness sensor is placed. Alternatively it may be that the vineyard is watered by overhead irrigation, increasing the relative humidity in the canopy and

maintaining higher levels of leaf wetness. Examination of the data for October at Yenda, suggest this is the case with several periods during the month where there was no rainfall but the leaf wetness sensor recorded high levels of leaf wetness. Regardless this is important information for interpreting weather station data as compared to your own vineyard siting. This is particularly important when checking whether there has been a downy mildew infection period.

Figure 3 shows data from the Yenda site during a rainfall event of 11.2 mm. This figure helps determine whether or not there was a downy mildew infection event during this period. For a downy mildew primary infection to occur there is a requirement for '10:10:24' conditions to be met. This means that to have an active primary infection, temperatures must be greater than 10°C with rainfall over 10 mm and a 24 hour period of 100% leaf wetness. Figure 3 plots this data from 14:00 on 12 October, 2014 until 14:00 the next day. During this period there was 11.2 mm of rain but there were extended periods when leaf wetness was 0% as the rainfall occurred in two main periods. The nine hours of leaf wetness at 0% clearly indicates that this was not a downy mildew primary infection period at Yenda.

### Weather forecast services

There are many weather websites that provide forecast information across Australia. Provided your vineyard is close to a major town, forecasts are available with a forecast period of up to seven days. To determine which forecast best matches your vineyard site it is worthwhile choosing a couple of sites and then evaluating them for their accuracy in relation to your vineyard. The data sets available to meteorologists allow the majority of these forecasts to be reasonably accurate for up to four days and providing forewarning of changes in conditions over seven days.

The recent introduction of MetEye, on the Bureau of Meteorology website (see Figure 4), has taken this a step further by providing data from existing automated weather stations which is integrated with local forecasts [www.bom.gov.au/australia/meteye](http://www.bom.gov.au/australia/meteye).

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MetEye data is then interpolated to provide a seven-day forecast for your current location (see Figure 5 for Mudgee data for 19 May 2015).

The data for this service is stored in the Australian Digital Forecast Database (ADFD) with a 6 km<sup>2</sup> grid from which maps are generated and forecasts overlaid. This means that each forecast is fine tuned to a 6 km<sup>2</sup> area and takes into account factors including height above seas level and the surrounding topography. Comparison of your own station's data with that from Bureau of Meteorology sites and live MetEye data will help calibration of your station against future forecasts.

For example, with frost forecasting, the elevation of your vineyard and its surrounding topography will influence the behaviour of pools of cold air. Once you have determined whether your site is equivalent, cooler or warmer than the Bureau of Meteorology forecasts this calibration will aid decision making in response to frost warnings.

### Comparison of rainfall data at Mudgee (Bureau of Meteorology) 2014 – 15

Table 1: Comparison of rainfall data at Mudgee; the Bureau of Meteorology station at Mudgee airport, green highlighted data) is compared with the five weather stations installed by the New South Wales Department of Primary Industries (NSW DPI) in July 2014.

	Goree Park	Logan	Stein	Woodbrook	Yeates	Mudgee Airport
September	18.8	22.6	26.4	33.2	24.2	26.8
October	19.8	24.2	25.0	20.2	21.8	22.6
November	36.4	43.2	47.8	30.2	32.8	14.6
December	97.0	97.2	105.8	104.8	113.8	60.4
January	96.0	122.0	71.4	81.4	75.6	74.6
February	41.2	14.0	57.2	36.2	30.0	23.4
March	17.8	14.8	27.2	25.2	31.0	13.6
April	98.2	91.4	52.6	114.0	93.4	93.6

The five new stations – rainfall in each month

- lowest
- highest
- Mudgee Airport data rainfalls that fall outside the range of the five new stations

### Griffith average humidity

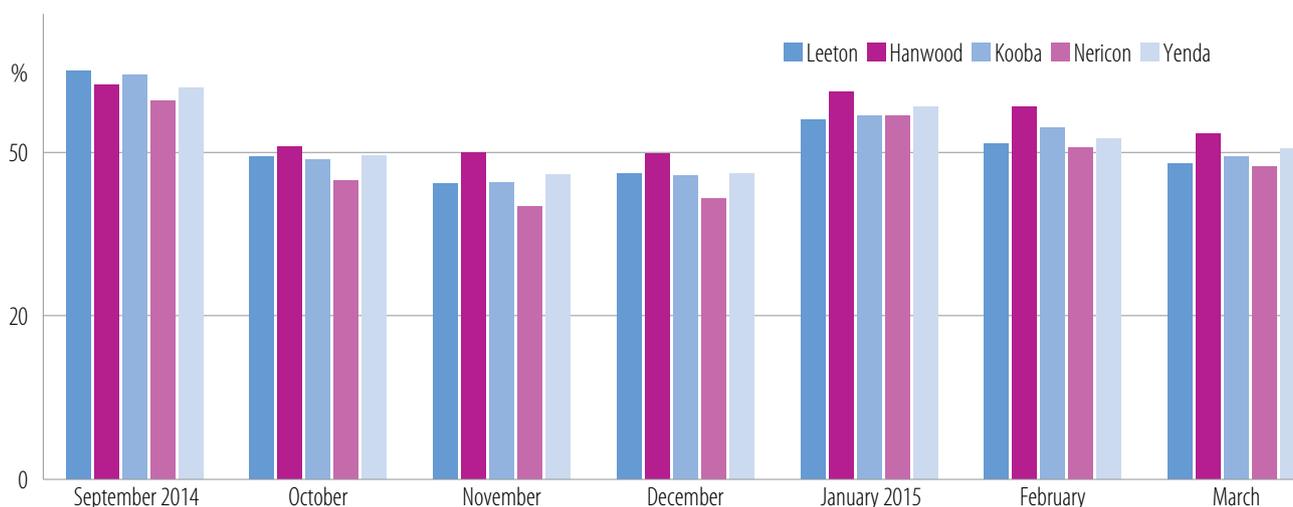


Figure 1: Comparison of monthly average humidity figures at Griffith. The data is from the NSW DPI network and may be accessed at [www.awri.com.au/industry\\_support/weather-nsw](http://www.awri.com.au/industry_support/weather-nsw)

### Griffith average leaf wetness

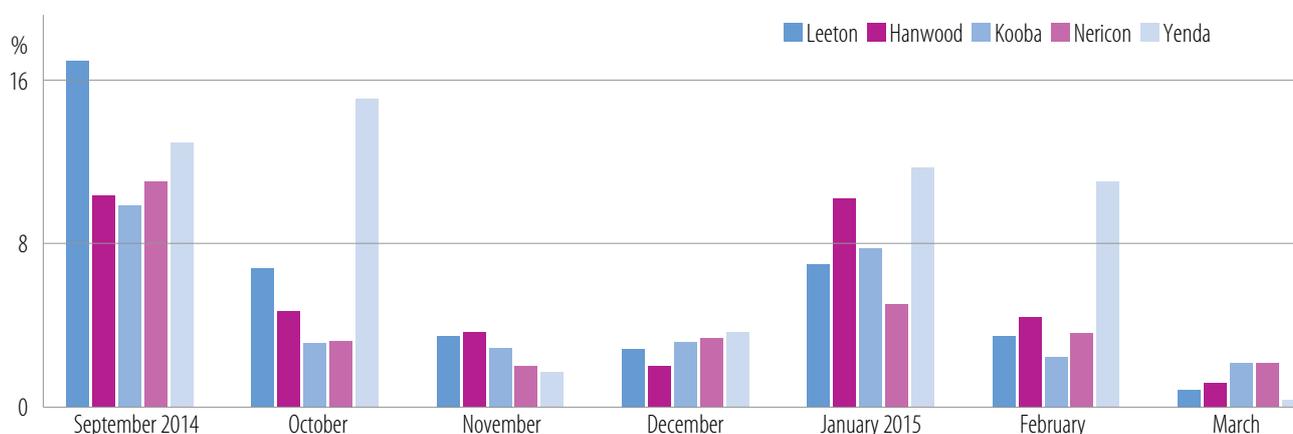


Figure 2: Comparison of monthly average leaf wetness figures from the Griffith weather stations. The data is from the NSW DPI network and may be accessed at [www.awri.com.au/industry\\_support/weather-nsw](http://www.awri.com.au/industry_support/weather-nsw)

### Yenda 24 hour rainfall (x50) and humidity

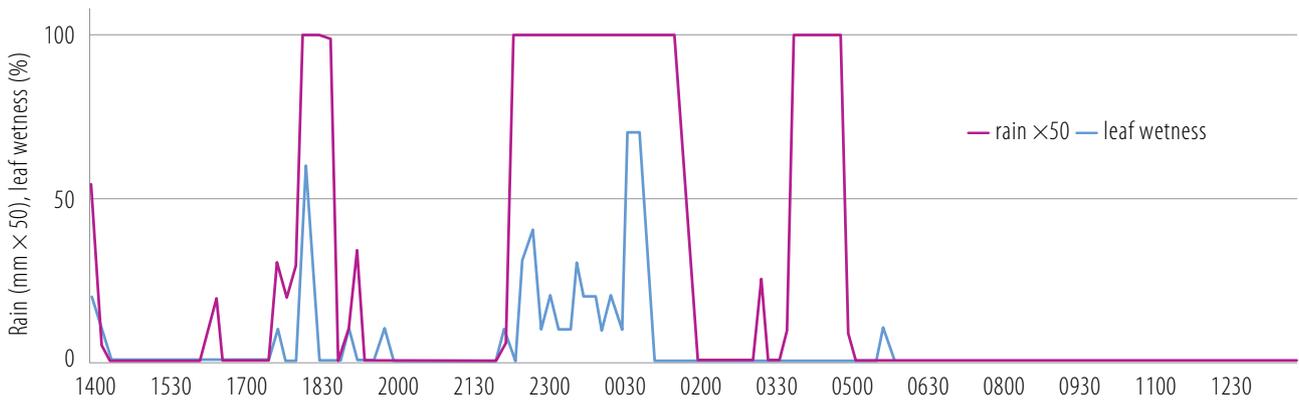


Figure 3: Rainfall and leaf wetness recorded at Yenda from 1400 on 12 October until 1400 the next day. Rainfall data in mm is multiplied by 50 and leaf wetness as % leaf wetness.

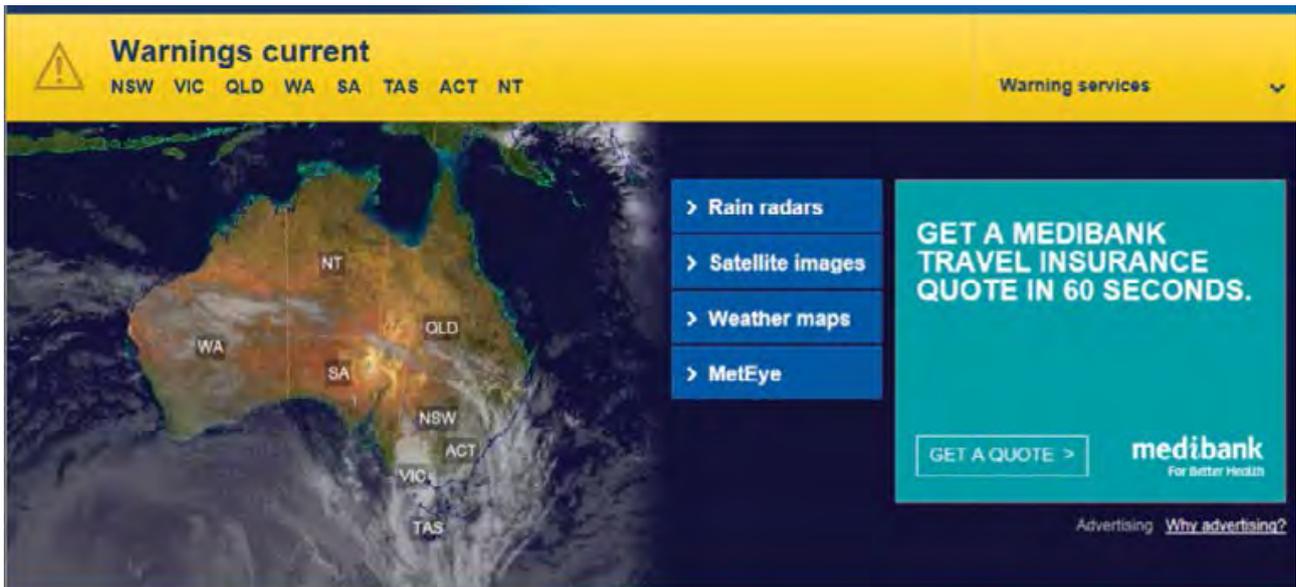


Figure 4: The location of the MetEye tab on the Bureau of Meteorology website [www.bom.gov.au](http://www.bom.gov.au)



Figure 5: A snapshot of the details of MetEye data, from the Bureau of Meteorology website, for forecasts for Mudgee from 19–26 May 2015. Clicking on the detail tab (22 May) brought up 3 hourly forecasts for temperature, wind direction and wind speed.

# Case study: Automated weather station – Robert Stein Wines

## Tell us about Robert Stein Wines:

### Jacob Stein

Winemaker, Robert Stein Wines

The vineyard was established in 1976 by myself, with the help of my wife Lorna and son Andrew. The vineyard started to produce fruit in 1980 and the first wine was made on site in 1982. Our cellar door was opened in 1988.

There is currently 17.5 hectares under vine on two sites, with eight varieties. In order of Hectares is Shiraz, Cabernet Sauvignon, Riesling, Merlot, Semillon, Chardonnay, Gewurztraminer and Black Muscat. From these grape varieties we have 24 different wine styles including blends and different quality levels of each variety.

Riesling is the variety we do very well with, and on which we focus a lot of attention. Third generation winemaker Jacob Stein took over winemaking duties in 2009, and now runs the vineyard, winery and farming operations. Jacob completed degrees in viticulture and winemaking in 2006, however his experience overseas instilled a wealth of knowledge and experience, evident in the rapid increase in quality, demand and volume of the Robert Stein Wines.

The winery also produces wines for many other local vineyards and cellar doors by contract winemaking. A recent upgrade to the winery now allows for small batch winemaking, bringing the total capacity of the winery to 350 tonnes per annum. The quality of Jacob's wines and the winery was honoured with Jacob winning the Gourmet Traveller wine magazines Young Winemaker of the Year in 2012. The vineyard, winery and cellar door employs six full time staff, and three casual staff members.

This is very much a family run business with Gina Stein, Jacob's wife, running the office, accounts, wine club and some marketing events. A recent addition to the estate was the opening of the Pipeclay Pumphouse Restaurant, owned by Lara and Andrew Crestani. Lara, Jacob's sister, focusses on marketing and Andy is the chef and operator. The restaurant and winery work well together growing on farm produce, including pork and lamb. This is certainly one of Mudgee's serious producers, a great place to visit, with a bright outlook for future generations.

## Location and site specifics

The winery and cellar door is located nine kilometres north of Mudgee on the Ulan Cassillis Road. The cellar door and restaurant offer panoramic views of the Mudgee Valley and sits at 600 m altitude. The main Robert Stein vineyard site sits just below the cellar door, and ranges from 570–590 m altitude, with over 13 individual vineyard blocks offering a variation of styles and soil types. In the higher blocks, where the Riesling and some Shiraz are planted, there is quite deep gravel and is a mix of shale, quartz and lighter soils.

The vineyard rows run east-west, and are on a south-west slope. VSP trellising with spur pruning is employed, with numerous foliage wires to manipulate canopies to suit weather conditions. At the bottom of the vineyard, the soil differs to be light loam and with a deep clay base. Drainage is excellent, and water runs off into the grazing and farming paddocks below. Harvest normally starts with Gewurztraminer in the second week of February, then with earlier picked Chardonnay, Semillon and then Riesling. Merlot and Shiraz are normally harvested in March, and Cabernet Sauvignon in late March or early April.



Jacob Stein in vineyard

## How has the Weather Station Network assisted your business and the region?

Unfortunately the local Bureau of Meteorology weather station is not always consistent, and has recorded incorrect weather recordings in the last few years. The regional weather station network has allowed a constant supply of accurate weather recording in its first five months of operation. I believe the weather station, in conjunction with the VineWatch program, to be one of the greatest advances in our vineyard operations of the last few years.

A great advantage of the business is that whether I am on or off site, when rain events occur, I get ten minute intervals of rain and daily measurements, and I know it is accurate. This has helped me in my planning, timing and type of foliar sprays and strengths of applications as well. Irrigation scheduling and cancelling of shifts has been another great advantage.

Regionally it has been very beneficial and interesting watching the records throughout the growing season. We now can see the cooler and warmer areas of Mudgee and what areas received the most rainfall, as opposed to the drier areas. Admittedly, this was possibly known or assumed before, but this is now backed up with quantitative results.

I believe the weather station network in conjunction with the VineWatch Bulletin greatly benefits our business. It has made me more aware of certain pest outbreaks, particularly vine moth caterpillars, and

ensured I kept up to date with my spray program before any large outbreaks occurred. For example, we applied Dipel® at normal rates once a month during the growing season to ensure we kept on top of vine moths, whereas normally I would only monitor and spray accordingly and sometimes would miss their outbreaks and have to spray more expensive and harsher chemicals to combat the larger caterpillars.

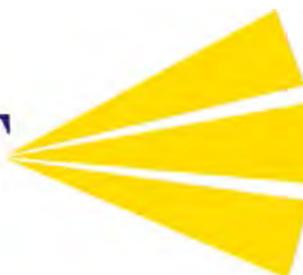
Regionally I believe the response and result has been excellent. Mudgee has removed nearly 40% of our vineyard area, however most of those vineyards removed were large commercial operations which were contracted to large wineries. What remains in Mudgee are vineyards that focus on single vineyard wines, have a cellar door and are family run operations.

VineWatch Bulletins deliver simple but effective information to the grower, so they can be reminded of important stages across the growing season.

It was also one of our earliest and best growing seasons on record, but the short growing season made vineyard operators' decisions and timing of operations (such as bunch closure sprays) most important.

In smaller companies like ours where I am overseeing the winery plus vineyard, such a program is priceless because it is a constant reminder and backup of what to monitor in the vineyard. I also found that this year's VineWatch Bulletins were very professional, and accurately related to my vineyard, and other sites in the region.

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# Overview – automatic weather stations

## David Pickering

David began working with automatic weather stations in the early 1980s, starting with the monitoring of intensive livestock housing for NSW DPI and then branching into monitoring agricultural and horticultural trials. He has extensive experience with a variety of equipment and sensors together with the quality control aspects of the equipment and data. Since retiring from NSW DPI in 2013 he is working with the Bureau of Meteorology evaluating an automated evaporation measurement system to complement their automatic weather stations.

Automatic weather stations (AWSs) can be very simple or very sophisticated. The nature of the AWS system that you choose for your viticulture application will depend on:

- » the aspects of the vineyard climate/ microclimate that you want to monitor
- » how many sites you want to monitor
- » how you want to get the data back to your office
- » whether you want to be notified of particular events occurring
- » the budget available.

The basics of an AWS system are a controller (a datalogger or 'black box'), an array of sensors to measure various climatic parameters, a power source (e.g. mains, or solar and battery) and a communication component (commonly known as 'comms').



MEA junior weather station



MET200 meteorological system

Entry level equipment which is available via the internet or through assorted retail shops generally have a range of sensors to cover air temperature, humidity, rainfall, and some aspects of wind. They usually have the facility to monitor outside conditions and use wireless to send the information (data) a limited distance back to a house/office.

The controller and the sensors of the more sophisticated equipment generally provide more versatility in the measurement of climate parameters both in number, variety, and in the accuracy of the data collected. Commonly they also are able to provide 'virtual' data in the form of calculations relating to single sensors e.g. temperature, or to multiple sensors e.g. disease warnings relating to wetness duration together with temperature, or humidity and temperature etc. Entry level equipment is usually not able to do this, although, if the appropriate sensors are available, such calculations can be done manually in a spreadsheet.

Where the sophisticated equipment really comes into its own however is in the area of comms. These systems can be fitted with a modem or router (which operates in conjunction with a SIM) and data can be downloaded from the AWS system remotely. In addition the system can itself send an SMS or email to a designated recipient either on a regular basis or when conditions leading to a disease or other alert are met. This provides a warning to the user that particular conditions have been met. The other possibilities – extra possibilities – are for the AWS equipment supplier to provide services in

the form of data hosting so that your information is available via password from their website or another option is to have them create a website for you.

A word at this point about the rationale of monitoring. If the area of the vineyard is only small it would normally only require one AWS system. However if the area to be monitored is large, elongated, undulating etc. then consideration should be given to monitoring at multiple sites. It is normally considered that a better picture of the prevailing climate comes from measuring at a number of sites. Accuracy of measurement is all very well but if the conditions vary across the vineyard (e.g. rain showers and therefore leaf wetness can vary widely) then it is best to be aware of, understand and respond to that variation. Likewise variation is particularly relevant with frost susceptibility on undulating sites.

The following listing of available equipment does not cover the simpler retail or internet sources of AWS equipment. That can be found using normal internet searching.

The more sophisticated AWSs are generally put together by the manufacturers/suppliers in accordance with your needs. For fairness, they have been arranged in alphabetical order rather than price or sophistication order. Each of those listed has sensors available to measure both normal climate parameters and less common parameters. Suppliers will provide software and usually program the system in accordance with your needs. With some experience of the system and programming you will be able to modify the program and add sensors.

The list does not claim to cover all the available suppliers. Similarly no attempt has been made to cost the systems because of the wide choice of controllers and sensors that can be used.

**Campbell Scientific**, based in Townsville, Qld  
[www.campbellsci.com.au](http://www.campbellsci.com.au) p: 07 4401 7700

Campbell can provide a complete package in accordance with requirements.

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**DataTaker/Thermofisher**, based in Melbourne, Vic  
[www.datataker.com](http://www.datataker.com) p: 03 9757 4477

DataTaker manufactures the datalogger/controller but complete system packages are available through a number of distributors

[www.datataker.com/distributors.php#ausnz](http://www.datataker.com/distributors.php#ausnz)

We supply to a broad range of customers across many industries including environmental, industrial, construction, manufacturing, process management, scientific, laboratory and education. Our data loggers are designed to be compatible with almost all types

of sensors, with a strong focus on communications to make your data easily accessible. If you have any trouble finding exactly what you need on this website please feel free to contact us we would be pleased to assist!

**Environdata**, based in Warwick, Qld  
[www.environdata.com.au](http://www.environdata.com.au) p: 07 4661 4699

Complete packages with particular emphasis on simplifying access to your data via 'WeatherMation'

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**Measurement Engineering Australia**, based in Magill, SA  
[www.me.com.au](http://www.me.com.au) p: 08 8332 9044

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We design and manufacture environmental monitoring systems. And we turn data into information – information that you can use to minimise cost and time spent on guesswork or re-work. Our objective is to deploy systems that maximise your efficiency, crop yields and profit.

And finally some words for when you're thinking beyond the initial purchase.

**Support:** Is the product readily supported?

**Maintenance:** Irrespective of whether you are thinking about the entry level equipment or the higher quality equipment discussed in more detail in this article, all will require maintenance to continue to give accurate and realistic data. This includes your own time in keeping the various components clean and 'unobstructed'.

**Accuracy:** There is no point in having a highly accurate sensor if tendrils, spider webs, dust, ants or other gremlins start interfering with its performance. Rain gauges can be blocked giving the impression that there has been no rain! Consideration should be given to re-calibration at recommended intervals since even the best sensors and equipment are subject to drift over time.

# Managing downy mildew in NSW vineyards

## Peter A Magarey

Magarey Plant Pathology, Loxton SA 5333  
[pmagarey@riverland.net.au](mailto:pmagarey@riverland.net.au)

Photos in this section: P A Magarey

Downy mildew is 'driven' by warm, wet weather. In consequence, it occurs with different severity in different regions. For instance, in the Hunter Valley, warm, wet weather occurs often and regional crop loss from downy mildew is high. In dry, inland regions there are many seasons when the disease causes no damage at all.

No matter what region you are in, the best way to control downy mildew is to spray effectively when the risk is high and to withhold sprays when you are confident the risk is low. In wet seasons, this means many sprays may be needed but in dry seasons, no matter what region you are in, spraying for downy mildew is often not needed!

## What does downy mildew look like?

Downy mildew is seen on younger leaves as typical, yellow oilspots. If the conditions have been suitable, white down then forms on the undersides of these spots (Figure 1). On older leaves, the symptoms are very different: a tapestry pattern develops when the smallest veinlets become resistant to infection producing small, angular patches of diseased cells. Young bunches are highly susceptible and when infected, turn brown and die quickly (Figure 2). Berries become resistant to infection 3–4 weeks after fruit set as the berries are reaching pea-size (E-L 31), but the berry stems remain susceptible.

Downy mildew is a 'green' disease: like powdery, it only infects green parts of the vine. Older tissue that has changed colour is no longer susceptible. So, for instance, green shoots can be infected whereas browned canes cannot.

Distinguish the two mildews on leaves by the distinctive circular oilspots of downy mildew and the fresh white down that forms in warm humid conditions on the underside of the spots. Contrast this with the more irregular-shaped yellow blotches of young powdery mildew on leaves and its grey-white fungal growth on both sides of the leaves, the foliage and fruit.

## What 'drives' downy mildew?

Downy mildew is not actually a fungus. It is an algae. And, like most algae, it must have free water to infect the foliage. (In this case, free-water usually means enough rainfall to wet the leaves.)

To the contrary, **powdery mildew** mostly can grow without free water. While it does better at high rather than low humidity, in the main, it doesn't need rainfall. A helpful hint is to think of powdery as 'powdery-dry mildew' because it still grows in dry weather and, because water runs downhill, to think of downy mildew as 'down-hill mildew' – it needs water (rainfall with or without irrigation) to spread.

Downy mildew grows best at 20°C to 24°C but it can grow at other temperatures too. For example, if it rains with temperatures as low as 8 to 10°C, its spores in the soil can begin to germinate while, for the spores to form on leaves, warmer weather ie. a minimum temperature of 13°C, is needed.

The level of downy mildew that develops in your vineyard is the result of the complex interactions of temperature, rainfall, relative humidity and leafwetness with the downy mildew organism and how these factors vary over time. Various time intervals are needed for different aspects of downy's life cycle.



Figure 1: Typical symptoms of downy mildew on leaves. Left: Grape leaf showing oil spots caused by downy mildew. Right: Grape leaf showing sporulation on the underside of the oil spot in the morning. [© Western Australian Agricultural Authority].



Figure 2: Downy mildew rapidly kills highly susceptible young bunches (left), but berries are immune well before pea-size (E-L 31). Downy mildew is best controlled at or before primary infection because in suitably warm humid weather, the disease spreads rapidly in secondary infection.

### Downy mildew life cycle

Downy mildew begins (or spreads) from two sources of inoculum (sources of disease). **The first:** downy mildew survives in the soil as resistant structures called *oospores*. Oospore inoculum leads to primary infection. Primary infection, the soil to foliage movement of the disease, leads to oilspots. The oilspots show up in the vineyard after a period of incubation: 4–6 days in warm conditions and up to 10–14 days in cool weather.

**The second:** downy mildew spreads from **oilspots**. Oilspots produce spores called sporangia. The sporangia lead to secondary infection, the leaf-to-leaf and leaf-to-bunch movement of the disease. Primary infection, of itself, does not cause crop loss but it produces a few oilspots that can trigger secondary infection. Secondary infection can lead to an explosive increase in disease producing many 1000s of new generation oilspots overnight. In early-season when bunches are very susceptible, secondary infection can be highly destructive.

Note: Pre-infection fungicides such as copper based products are cheaper than post-infection products such as Ridomil, but they need excellent spray coverage of the undersides of leaves to prevent infection by downy mildew.

### Conditions for primary infection

The disease progresses if (and only if) the conditions are favourable. Those needed for primary and secondary infection differ. In former days, the rule of thumb 10:10:24 was used to summarise the conditions needed for primary infection. This referred to:  $\geq 10$  mm rain to wet the soil sufficiently to germinate the oospores and foster infection;  $\geq 10^\circ\text{C}$  for sufficient warmth for this process to occur; and for at most 24 hours in which the processes needed to be completed.

This rule was better than a guess but it was only a guide. It did not describe the detailed interactions between the vineyard factors that combine to trigger an infection event. If the conditions are warm enough, wet enough for long enough oospores in soil leaf litter germinate to produce a second spore-type called macro-sporangia. These release another spore called zoospores which must be splashed into air currents to reach the foliage. To complete primary infection, the leaves need to be wet and warm enough for long enough. Zoospores, if carried to the undersides of the leaves, will germinate and infect through the stomates (breathing pores in green tissue) if the foliage remains wet for  $\geq 45$  degree-hours ( $0^\circ\text{C-hrs}$ ).

To calculate degree-hours, multiply temperature ( $0^\circ\text{C}$ ) by time (hrs) [ $0^\circ\text{C} \times \text{hrs} = 0^\circ\text{C-hrs}$ ]. For example, if the temperature averages  $23^\circ\text{C}$  for 2 hrs, the degree-hours accumulated is  $23^\circ\text{C} \times 2 \text{ hrs} = 46^\circ\text{C-hrs}$ . This is  $\geq 45^\circ\text{C-hrs}$  and is sufficient for infection.

Figure 3 illustrates some of the more detailed requirements for primary infection.

### 10:10:24 in detail

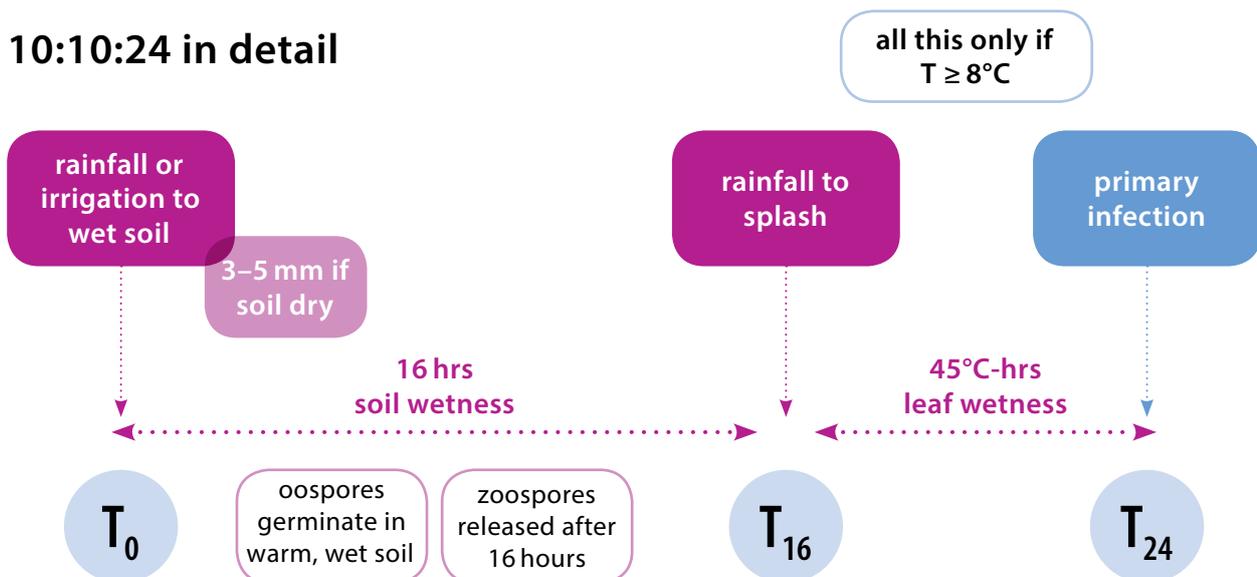


Figure 3: A very specific set of conditions is needed by downy mildew before primary infection will occur in your vineyard. Monitor weather events to determine the timing of disease events. From this, you can work out the best times to spray (or to confidently withhold sprays when not needed).

## Conditions for secondary infection

To begin a secondary infection, an oilspot is needed and this needs primary infection. If primary infection has not occurred, secondary infection cannot occur. Secondary infection also needs warm, humid conditions at night. Humidity of  $\geq 98\%$  is needed while temperatures are  $\geq 13^\circ\text{C}$  for at least 4 hours at night. White down (sporangia) then develops on the undersides of the oilspots and the new spores (zoospores) will lead to secondary infection if the leaves are wet for  $\geq 45^\circ\text{C}\text{-hrs}$  (the same as for primary infection) – that is 2 to 3 hours with temperatures around  $20^\circ\text{C}$ , or for longer if it is colder.

## Managing downy mildew

It is critical to know when primary infection is likely. If you can prevent primary infection you prevent oilspots and if there are no oilspots in your vineyard you cannot have the dangerous secondary infection events. For best control, spray effectively when the risk of infection is high.

Determine the risk of infection by observing the weather. Check the forecasts to know when best to apply a pre-infection (preventative/ protectant) spray – that is to know if a primary (or a secondary) infection event might occur. A pre-infection fungicide is best applied as close as possible **before** the infection event. Monitor the resultant weather events as they pass over your vineyard to determine if the conditions favoured an infection. If your vines were unprotected against downy mildew at a critical time of the season, apply a post-infection (eradicant) fungicide as soon as possible **after** the infection event **and before** the new oilspots appear.

To best determine the risk of an infection event, seek assistance from regional disease alert services. These operate from a network of automatic weather station (AWS, Figure 4) that monitor temperature, rainfall, relative humidity, leaf wetness and daylight and dark at 10 (or 15) minute intervals.

Some systems such as **GrowCare**<sup>®</sup>, use DModel, an Australian computerised, simulation model of downy mildew, to process vineyard weather data and provide an assessment of the risk of downy mildew. This allows specific advice on the optimum timing of sprays against primary and secondary infection events – critical to best control of disease with a minimum of sprays at minimum cost with maximum effectiveness.

Alternatively, you can use the following **GrowCare**<sup>®</sup> checklists in your vineyard as a guide to assess recent (or forecast) weather for risk of downy mildew infection events. Periods of high risk can be determined by monitoring the vineyard rainfall, relative humidity (RH) and leaf wetness and then using the relevant **GrowCare**<sup>®</sup> checklist as a guide to determine the optimum timing of sprays. In this way you can spray at the best time for maximum control or, you can confidently withhold sprays when they are not needed.



Figure 4: Automatic weather stations (AWS) monitor the vine canopy for leafwetness, rainfall, relative humidity (RH) and temperature. These are critical to the life cycle of downy mildew. An AWS, like this Australian designed and built Model T MetStation<sup>®</sup>, is also a disease predictor. It processes the weather data it records and signals infection events by a series of red lights if infection is active. This provides a disease risk statement on-site in the vineyard or it can be relayed directly to your home computer. This information is often critical to refining optimum spray timing in your vineyard.

Note: Good timing of spray applications in relation to infection events, especially primary infection, is a major factor in effective spraying for downy mildew. Young bunches are highly susceptible so good control of primary infection will prevent the risk of secondary infection and reduce the need for more sprays.

## GrowCare<sup>®</sup> check list for downy mildew primary infection

Only tick boxes if answer is 'Yes'.

### Primary infection

- It has rained and your vines were not protected, i.e. they were not sprayed recently with a pre-infection fungicide. This time will vary depending on the stage of season you are in, e.g. for 5–7 days when vine growth is rapid and at flowering; or for 7–10 days until berries are pea-size.
- Rainfall was more than 3 mm if soil was wet before the rain, *or* at least 5 mm if soil was dry.
- Temperature was above  $10^\circ\text{C}$ .

*If Yes, oospore germination has begun.*

Soil was continuously wet to at least 2 cm depth for at least 16 hrs. This means the palm of your hand is wetted when placed on the soil surface.

- Soil did not dry for more than three consecutive hours.
- Temperature remained above  $8^\circ\text{C}$ .

*If Yes, oospores have germinated.*

- Some rain fell after the sixteenth hour and leaves were wetted.

Zoospores have splashed and drifted to the foliage.

- The leaves *then* remained wet for 45 °C-hrs. i.e. for at least 2 hrs 15 mins at 20 °C, or 3 hrs at 15 °C, or 4.5 hrs at 10 °C
- Are all boxes ticked Yes?

If Yes, then primary infection is likely (See note <sup>1</sup> below).

Expect primary oilspots to appear in the next 5–7 days if the weather is warm (20 °C to 25 °C) or in 10–14 days if the weather is cooler or hotter.

- Is it at or near flowering and are berries less than pea-size?

If Yes, apply a post-infection fungicide (e.g. Ridomil) before the new oilspots appear.

These oilspots will be one or two every 50 m or so along the vineyard row – not easy to locate.

If you find any, tag the location to monitor this site for new events.

### Secondary infection

Only tick boxes if answer is Yes.

- Active oilspots are present in my vineyard.
- The vines were unprotected i.e. not sprayed with a pre-infection fungicide in recent days.

This time will vary depending on the stage of season you are in: e.g. 5–7 days when growth is rapid and at flowering or 7–10 days until berries are pea-size.

- The conditions were warm and humid overnight and the leaves were wet in the morning.
- Temperature was above 13 °C and humidity was above 98% for at least four hours overnight.

Fresh white down will have appeared underneath active oilspots.

Check any oilspots present for fresh, white down. The spores drift in the wind to other places in the foliage.

- The leaves *then* remained wet for 45 °C-hrs, i.e. for at least 2 hr 15 min at 20 °C, or 3 hrs at 15 °C, or 4.5 hrs at 10 °C.
- Are all boxes ticked?

If Yes, then secondary infection is likely. (See note <sup>1</sup> below).

Expect primary oilspots to appear in the next 5–7 days if the weather is warm (20 °C to 25 °C) or in 10–14 days if the weather is cooler or hotter.

- Is it at or near flowering and are berries less than pea-size?

If Yes, apply a post-infection fungicide (e.g. Ridomil) before the new oilspots appear. These oilspots will usually be several to many per leaf on many leaves often in clusters on either side of the vine row. If you find any oilspots, tag the location to monitor this site for new events.

<sup>1</sup> Please note: This checklist provides only a guide as to whether infection has occurred or not. It should not be relied upon when determining vineyard

management actions. If needed seek expert advice on the complex interactions between the vine, the weather, the downy mildew organism and any previous spray cover you may have applied. All these factors determine if infection actually occurred or not.

### Further information

Nicholas, P.R., Magarey, P.A. and Wachtel, M.F. (Eds). (1994) *Diseases and Pests*, Vol. I. Grape Production Series, Winetitles, Adelaide, South Australia, 106 pp. See Downy mildew. Ch. 5, pp 5–11. ISBN 1-875130-15-2. This is an easy-read manual on vineyard diseases and pests and their control.

Magarey, P.A. et al. (1999) *The Australian and New Zealand Field Guide to Diseases, Pests and Disorders of Grapes*. This is a companion to *Diseases and Pests*, Grape Production Series No.1., Winetitles, Adelaide, South Australia. 108 pp. ISBN 1 875130 33 0. (634.82), to help you correctly diagnose the symptoms of disease.

Magarey, P.A. (March 2010) *Managing Downy Mildew, (Winning the war!)*. GWRDC Innovators Network Module INO904. Fact Sheet. 6 pp. [www.gwrdc.com.au](http://www.gwrdc.com.au)

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- » the latest seven-day weather forecast from MetEye at the Bureau of Meteorology for your location of interest
- » a check list for you to use as a guide to downy mildew primary and secondary infection events depending on the weather near your vineyard.

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## Alternative bunch rot control - Experimental trial

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### Introduction

Botrytis and non-botrytis bunch rots are weather-driven diseases known to cause significant loss of grape yield and wine quality. Temperature and the duration of surface wetness are key environmental factors that promote bunch rot development.

The factsheet "[Botrytis Management](#)" provides more information on integrated measures for control of botrytis bunch rot.

The factsheet "[Non-Botrytis bunch rots: Questions and Answers](#)" provides more information on integrated measures for control of non-botrytis bunch rot.

In the Hunter Valley, weather-driven disease events are common across vintages. Anecdotal reports indicate naturally isolated *Trichoderma* species used on Chardonnay grapes in the Hunter Valley have been effective in the control of botrytis. However, statistically analysed trials on the efficacy of *Trichoderma* products in the Hunter Valley have been hampered in the past by dry seasonal conditions. Therefore, evidence to support the use of bio-fungicides to manage botrytis and non-botrytis in warm humid regions is required.

Two commercially available products supplied by Organic Crop Protectants <http://ocp.com.au/> were used in this trial; Colonizer® *T. koningii* (Td67) and Antagoniser® *T. harzianum* (Td81b). These were compared with current grower's practice, leaf removal and control treatments without botrytis fungicide application.

### Key Messages

- Adopt holistic approaches to botrytis and non-botrytis bunch rot control as numerous management options may be required within the one season.
- Ensure product compatibility when selecting and using biological inputs.
- Coverage is paramount, ensure all spray equipment is set up correctly to cover entire flower and bunch structures.
- Leaf removal of the bunch zone offers potential to assist in drying bunches from surface wetness. This measure also allows for greater spray coverage of flowers and bunches.
- *Trichoderma* strains are many and varied and have different capabilities. Selection of the right one is critical to disease suppression within different vineyards and climates.

Table 1: Treatments, chemicals and dates applied in Hunter Valley.

Treatment	Product/Actives	Date Applied
Control	Water	3/11/14, 24/11/14, 7/1/15 & 20/1/15
Control + leaf removal *	Water	3/11/14, 24/11/14*, 7/1/15 & 20/1/15
Current Practice	Teldor® Fenhexamid 500 g/L	3/11/14
	Switch® Cyprodinil 375g/Kg Fludioxonil 250g/Kg	24/11/14
	Chief® Iprodione 500 g/L	7/1/15 & 20/1/15
Biological	Colonizer® <i>T. koningii</i> (Td67) 1011 cfu/gram	3/11/14 & 24/11/14
	Antagoniser® <i>T. harzianum</i> (Td81b) 1011 cfu/gram	7/1/15 & 20/1/15

Growth Stages: 3/11/14 – 30% Flowering (EL21), 24/11/14 – 80% Capfall (EL25), 7/1/15 – Veraison (EL35), 20/1/15 – Mid veraison (EL37), \*Leaf Removal conducted @ (EL25) 80% bunch closure.

# Alternative bunch rot control

## Application Strategy

In 2014-15 an experimental trial was conducted across two separate vineyards located at Pokolbin and Broke in the Lower Hunter Valley on own-rooted Shiraz vines to assess 4 treatments (Table 1.) which were replicated 5 times each across blocks of 9 vines in the vineyard. The treatments were arranged in a randomised complete block design.

Timing of spray applications followed current farmer's practice occurring between 20 - 80% capfall. This timing was also consistent with the manufacturer's recommendation for the

application of biological products, with all products assessed as compatible according to the manufacturer. Leaf removal was carried out at 80% capfall (EL 25) with water applied to this and control treatments at the same time as other treatments, to ensure all treatments received the same amount of applied water. Applications of products to all treatments were carried out across both sites on the same day, using individual 5L calibrated knapsack spray equipment for each separate product. All products were applied at manufacturer's application and water rates per hectare.

No other spraying was conducted across the trial sites except for routine copper and sulphur sprays conducted by landholders.

## Outcomes

Rainfall across the Hunter Valley throughout the 2015 vintage posed a significant risk for botrytis and non-botrytis bunch rots, with the majority of the rainfall across the vintage period occurring between Dec and Jan with 191.6mm and 227.8mm (BOM 61298), respectively recorded at Pokolbin, and 277mm and 158mm (BOM 61422) recorded at Broke. The rainfall received equates to twice the annual average for both months at both recording sites. Hail damage resulted from storms which impacted the Broke site on 7<sup>th</sup> December causing minor damage to berries.

Just prior to commercial harvest (February 10, 2015) the level of incidence and severity of botrytis infection on bunches was estimated from 20 randomly selected bunches per replicate. The botrytis assessment was conducted with the aid of a standard area diagram (Evans et al. 2012). Non-botrytis rots were evident across the trial however data is for the severity and incidence is not included in the results.

Looking at results from the Pokolbin site (Figure 1), botrytis was present in all treatments with botrytis incidence significantly higher in the biological and control treatments compared to the leaf removal and current practice treatment which resulted in the lowest incidence levels. The severity of botrytis was significantly lower in the current practice and leaf removal treatments compared to the control and biological treatments.

At the Broke site (Figure 2), botrytis was present in all treatments with botrytis incidence significantly higher in the control, biological and leaf removal treatment than current practice. The severity of botrytis was also significantly lower for the current practice than the control, biological and leaf removal treatments.

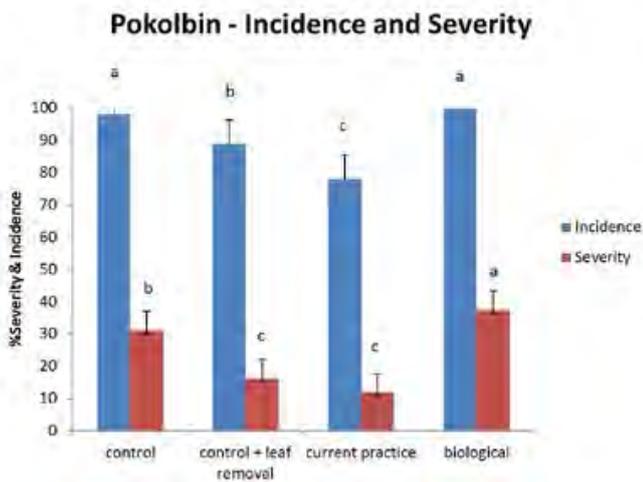


Figure 1. Incidence and Severity of Botrytis on February 10, 2015 in an experimental site at Pokolbin. Different letters indicate significantly different values at P<0.01

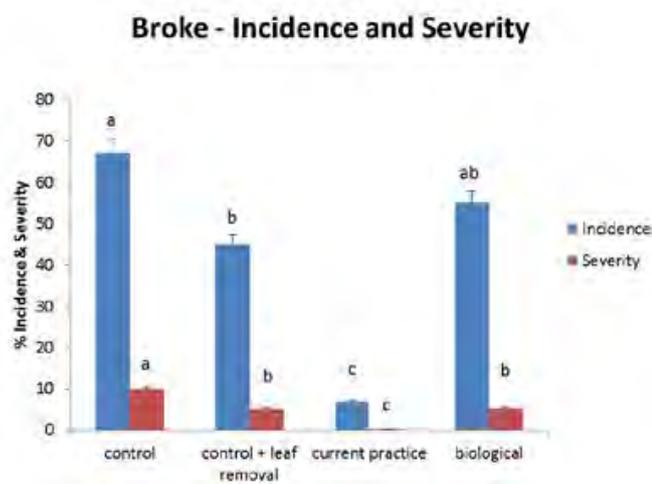


Figure 2. Incidence and Severity of Botrytis on February 10, 2015 in an experimental site at Broke. Different letters indicate significantly different values at P<0.01

# Alternative bunch rot control

## Discussion

The conditions experienced across Pokolbin and Broke trial sites were ideal for the development of botrytis and non-botrytis bunch rots in all treatments.



Picture 1. An unaffected shiraz bunch (left) and a bunch heavily affected by botrytis (right)

The high incidence and severity of botrytis in the biological treatment at both sites was unexpected given anecdotal evidence to support its efficacy. The outcomes resulting from this trial may be related to the low performance of the Trichoderma products Coloniser® and Antagoniser® under warm humid conditions as it was isolated from grapes grown in the cool climate of Tasmania. In support of the suitability of the commercial Trichoderma products Coloniser® and Antagoniser®, replicated trials conducted in the cool climate NSW region of Orange demonstrated that these products significantly lowered severity equal to that of the current practice treatments. Therefore, the isolation of naturally occurring Trichoderma species from warm humid regions should be investigated.

Leaf removal to open up the bunch zone demonstrated a limited potential at reducing incidence across both sites with further investigation warranted, perhaps in-conjunction with the application of commercially available sunscreen products, as it is likely that exposing bunches with leaf removal, berries may become more susceptible to heat and/or sun damage.

The reduction in botrytis under current practice treatments resulted in significantly lower incidence and severity across both trial sites in a high pressure year.



Picture 2. A vigorous Shiraz grapevine resulting in excessive fruit shading and little air penetration



Picture 3. Shiraz grapevine after leaf removal to encourage light and air penetration

## Acknowledgements

This work was funded through Wine Australia's Regional Program. The following people contributed to the project: Mardi Longbottom (AWRI) and Melanie Weckert (NSW DPI & NWGIC). Thanks to Ken Bray (Braemore) and Bob Kennedy (Beyond Broke), for providing vineyard sites and assistance in the trial. James Gardner (Organic Crop Protectants) is acknowledged for supplying products used in this demonstration.

## Alternative bunch rot control



**Picture 4.** Targeted leaf removal around the bunch zone has increased light and air penetration into the canopy, reducing botrytis infection risk.



**Picture 5.** A Shiraz bunch at harvest with no signs of bunch rot.



**Picture 6.** A Shiraz bunch severely affected by bunch rot.

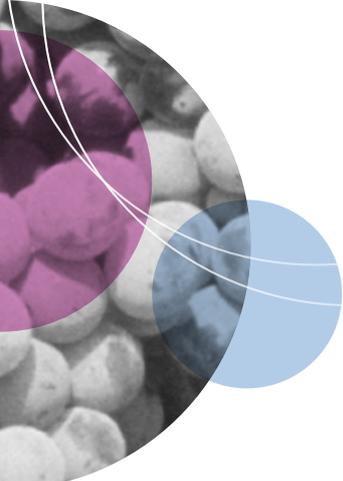


**Picture 7.** A close up of berries affected by bunch rot showing the hyphae of the fungus.

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# Seasonal factors affecting *Botrytis* risk

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Development of a severe late-season *Botrytis* epidemic occurs when substantial rainfall occurs during the last two to three weeks of ripening. If there is no wet weather, it will be a *Botrytis*-free vintage. The potential for late-season *Botrytis* damage is established early in the season, via both the senescent tissue and the latent infection pathways. The more often wet and rainy weather occurs between flowering and veraison, the greater the *Botrytis* activity.

Risk factors that increase early-season *Botrytis* risk, between flowering and veraison, include:

- » severe *Botrytis* in previous season, allowing abundant carry-over of *Botrytis cinerea* in vineyard debris
- » wet weather events that allow *B. cinerea* to colonise senescing flower parts and to establish latent infections
- » high leaf canopy density that prolongs wetness, allowing more fungal growth and higher rates of latent infection.

Risk factors that increase late-season *Botrytis* risk, between veraison and harvest, include:

- » any factor that delays maturity, e.g. high crop load, a cool season, high soil fertility or excessive irrigation
- » wet weather during the two to three weeks before harvest.

## What can be done to reduce *Botrytis* risk?

Several vineyard management actions can decrease early-season *Botrytis* risk. These include:

- » **fungicide applications between flowering and veraison.** The effectiveness of a fungicide application depends on the choice of product and its timing. Fungicide applied just before bunch closure is particularly effective because it can reach colonised flower parts within the bunch and protect the innermost berries from infection. Some fungicides used for control of other grape diseases have very low activity against *Botrytis*.
- » **applications of biological control products.** Biological controls are more variable in their effectiveness than fungicides and cannot be used simply as substitutes for fungicide applications. They need to be used within an integrated strategy that includes other approaches, including vine canopy management and bunch trash removal.
- » **vine leaf canopy management.** Open vine canopies have much lower risk of *Botrytis*. Actions that reduce leaf density and vine vigour, including winter pruning, leaf plucking, vine trimming, soil fertility management and irrigation management, can all decrease *Botrytis* risk. However, canopy management to reduce *Botrytis* risk must be harmonised with the canopy management that is required to achieve optimum fruit quality.



» **bunch trash removal.** The disturbance from mechanical leaf plucking and vine trimming machines, as well as the air stream from an airblast sprayer that is not spraying, will reduce the amount of trash lodged within bunches and reduce *Botrytis* risk.

» **late-season.** there are fewer actions that can be taken to decrease *Botrytis* risk.

Those that are available include:

- » vine leaf canopy management (as for the early season)
- » removal of infected bunches to reduce rot levels in the crop and to reduce the risk of re-infection
- » harvesting earlier at lower sugar content to minimise crop loss when *Botrytis* is increasing rapidly
- » application of benign control products, e.g. biological controls or calcium sprays.

Some late-season disease control options may have little or no demonstrable efficacy in reducing *Botrytis*.

## **Botrytis risk factors that promote Botrytis bunch rot**

### **Pathogen factors**

- » High incidence of berries with latent infection.
- » *Botrytis* visible on any tissues in the grape bunch before veraison.

### **Crop factors**

- » Thin-skinned varieties.
- » Compact, tight bunches.
- » Dense canopy with restricted air movement in the fruiting zone.
- » Excessive soil moisture, pools of water.
- » Berry splits.
- » Berries pushed off the rachis and leaking juice.
- » Damage from light brown apple moth, powdery mildew or other causes.

### **Weather factors**

- » Rainfall, fog, mist or dew that leads to long periods of fruit surface moisture (including intermittent rain).
- » Rapid infection when temperatures are 18°C to 21°C (day or night) and surface moisture is present.
- » Calm, cloudy days with high humidity.



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# Managing powdery mildew in NSW vineyards

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Photos in this section: P A Magarey

Like elsewhere in Australia, powdery mildew progresses in NSW vineyards more or less independent of the weather. Though in some regions, temperature and humidity may at times be limiting the disease, it is, in the main, driven by the amount of inoculum (spores) inherited from last season.

It is a 'two-season' disease and although the disease is common across NSW, by applying knowledge of disease epidemiology (i.e. how and when the disease spreads) and of the need for well-timed sprays applied with effective spray coverage, good control of this persistent disease can be achieved.

## What does powdery mildew look like?

Powdery mildew begins as flagshoots (Figure 1). These are shoots that grow from buds infected last season. Flagshoots are stunted and bear up-curved leaves often with the white powdery growth visible on the leaves. Powdery mildew shows on younger leaves as irregular yellow blotches best seen on the upper surfaces and, on varieties like Chardonnay, with associated browning of the smallest (tertiary) veinlets on the under sides (Figure 2). The blotches soon show the typical white mildew as spots expand and merge across both surfaces of leaves. Eventually the whole surface is covered (Figure 1).

To see young mildew spots clearly, angle the leaf into the light; this makes the fungal sporulation more visible.

Powdery mildew is a 'green' disease: like downy mildew, it only infects green parts of the vine. Older tissue that has changed colour is no longer susceptible. So, for instance, green shoots can be infected whereas browned canes cannot.

Distinguish the two mildews on leaves by the more irregular-shaped yellow blotches of young powdery mildew on leaves and its grey-white fungal growth on both sides of the leaves, the foliage and fruit. Contrast this with the distinctive circular oilspots of downy mildew and the fresh white down that forms in warm humid conditions only on the underside of the spots.

## Powdery mildew life cycle

Only spores from grapevines infect vines. Spores from mildew on roses, cucumbers, melons etc do not infect grapevines. Also, in early-season, this inoculum moves usually much less than 200–300 m which means that the spores that most influence your vineyard in early-season, come from *your* vineyard – and **you** can control this source.

Powdery mildew develops from two sources of inoculum. **First: infected buds** – these carry the disease from last season (Season 1) when they were infected in the first 2–3 weeks of their exposure on last season's shoots. This season (Season 2), the mature buds emerge, producing diseased shoots called 'flag shoots' (Figure 1). The fungus on these produce spores (conidia) that spread disease to adjacent foliage.

**Second: cleistothecia** – these form late last season as fruiting bodies of the fungus (Figure 3). If the conditions are right, these release another spore-type called ascospores. If, this season,  $\geq 2.5$  mm precipitation occurs while the temperature is  $> 10^{\circ}\text{C}$ , the ascospores will be released. If unprotected green tissue is present nearby at that time, the ascospores will help spread the disease. Infection from either spore-types lead to new leaf spots on foliage and bunches every 7–10 days after infection.



Figure 1: Powdery mildew shows as grey-white 'mildew' on any green tissue. Left: A flagshoot with stunted growth and up-curved leaves covered in part with mildew. Right: Severely infected Chardonnay leaf showing ash-grey growth on the surface [© Western Australian Agricultural Authority].

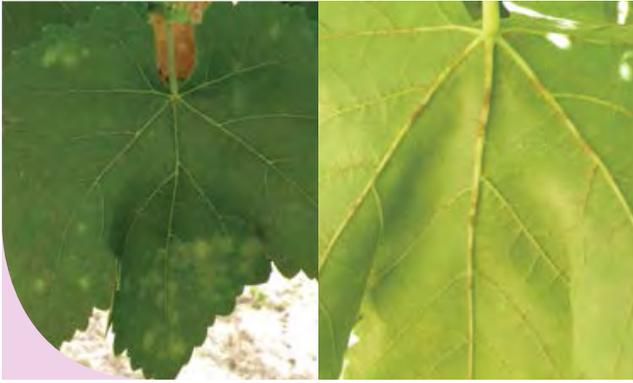


Figure 2: Powdery mildew infection. Left: Yellow-green blotches where early powdery mildew infection has occurred. Right: Veins on the underside of the leaf can turn brown when infected. [© Western Australian Agricultural Authority].



Figure 3: Left: Bunch of grapes with severe infection of powdery mildew. Right: Scarring of berries where growth of powdery mildew has occurred on the skin surface. [© Western Australian Agricultural Authority].

Note: In the main, powdery mildew spreads from diseased buds that were allowed to be infected in your vines last season. This leads to infection of the leaves this season and the spores from these leaf infections are the ones that infect your berries this season

## The disease cycle

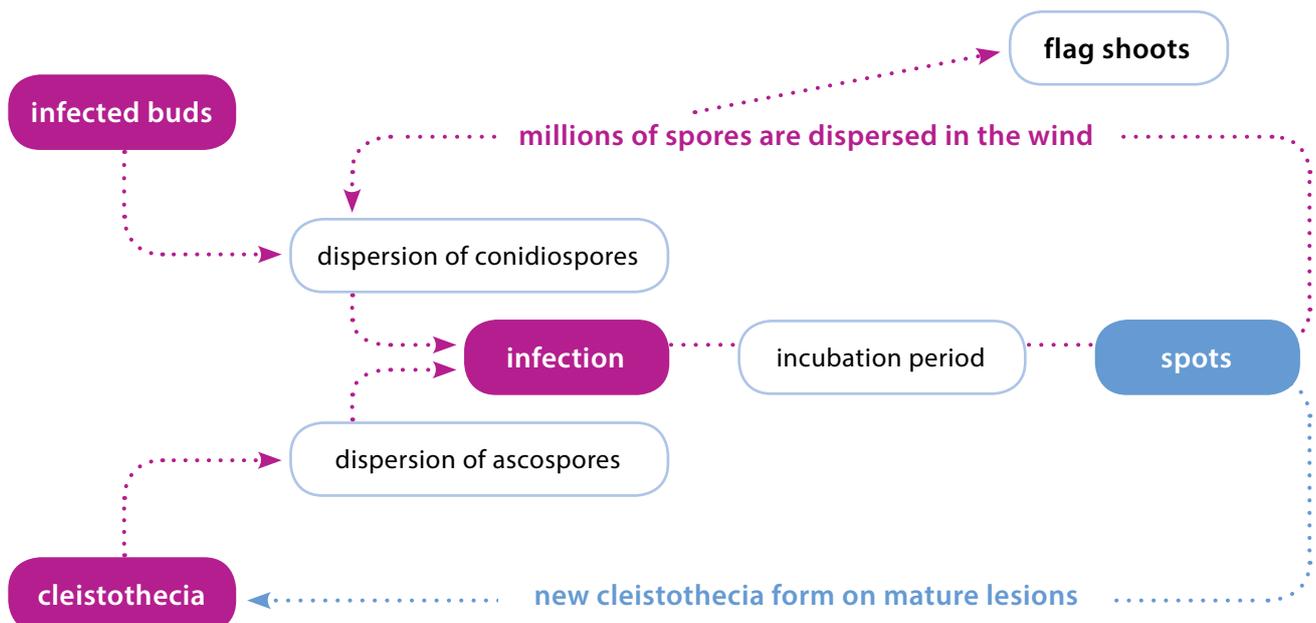


Figure 4. In Australian viticulture, powdery mildew develops from infected buds and sometimes, also from cleistothecia. Both lead to the production of new infection sites in the canopy from where the disease spreads steadily.

## What 'drives' powdery mildew?

Although powdery mildew has considerable capacity to multiply, it only spreads slowly and steadily. It increases in incidence and severity even in dry conditions, often growing unnoticed in shaded parts of the canopy. Optimum temperature for growth is 20°C to 28°C. While powdery mildew is thought to be retarded by temperatures > 40°C, in practice, it thrives in the optimum night temperatures that follow hot days. This is because of the longer duration of favourable rather than unfavourable temperature.

Powdery mildew produces about twice as many spores at relative humidity (RH) > 40% than at lesser RH and is killed by exposure UV light. Canopies open to airflow and UV light therefore have less risk of disease while dense, shaded canopies provide a favourable microclimate.

A simple sequence of events occurs in unsprayed vineyards: fruit infection for this season (Season 2) comes from leaf inoculum this season. Leaf inoculum (conidia) this season comes mostly from flag shoots and flag shoot inoculum comes from bud infection last season (Season 1). These buds are infected by the disease not controlled in your vineyard last season. So, if you control bud infection and cleistothecia from Season 1, you reduce the potential for leaf and fruit infection in Season 2.

## Epi-seasons

As discussed, powdery mildew is a 'two-season' disease. Infected buds and cleistothecia develop in Season 1 producing the inoculum which 'drives' the disease epidemic in Season 2. These two growing

seasons constitute the 'season of the epidemic', that is, the 'epi-season' of powdery mildew. Because most the inoculum does not carry into Season 3, the powdery mildew epi-season covers a rolling window of two growing seasons (Figure 6).

## Legacy/inheritance

As a result, the powdery mildew inoculum produced in Season 1 that survives over winter becomes a legacy you inherited in your vineyard from Season 1. It is this inoculum that triggers infection in Season 2. The 'legacy/inheritance' factor from within your vineyard is the main factor that influences initial levels of powdery mildew disease and in turn, the level of difficulty you face to achieve good control of powdery mildew each season. Thus, the level of powdery mildew that you inherit in Season 2 depends on how much disease you allowed to develop in Season 1.

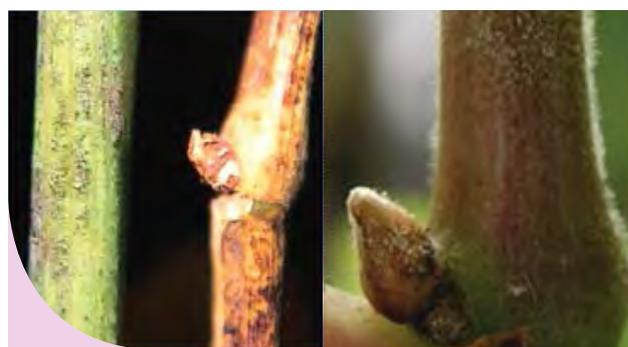


Figure 5. Buds are infected when young and show the white mildew growth (right). This develops greasy blotches on shoots, and reddish blotches on canes (left). Some of these mature buds carry powdery mildew on the inside. As these buds burst (forming flagshoots in spring), the new epidemic begins.

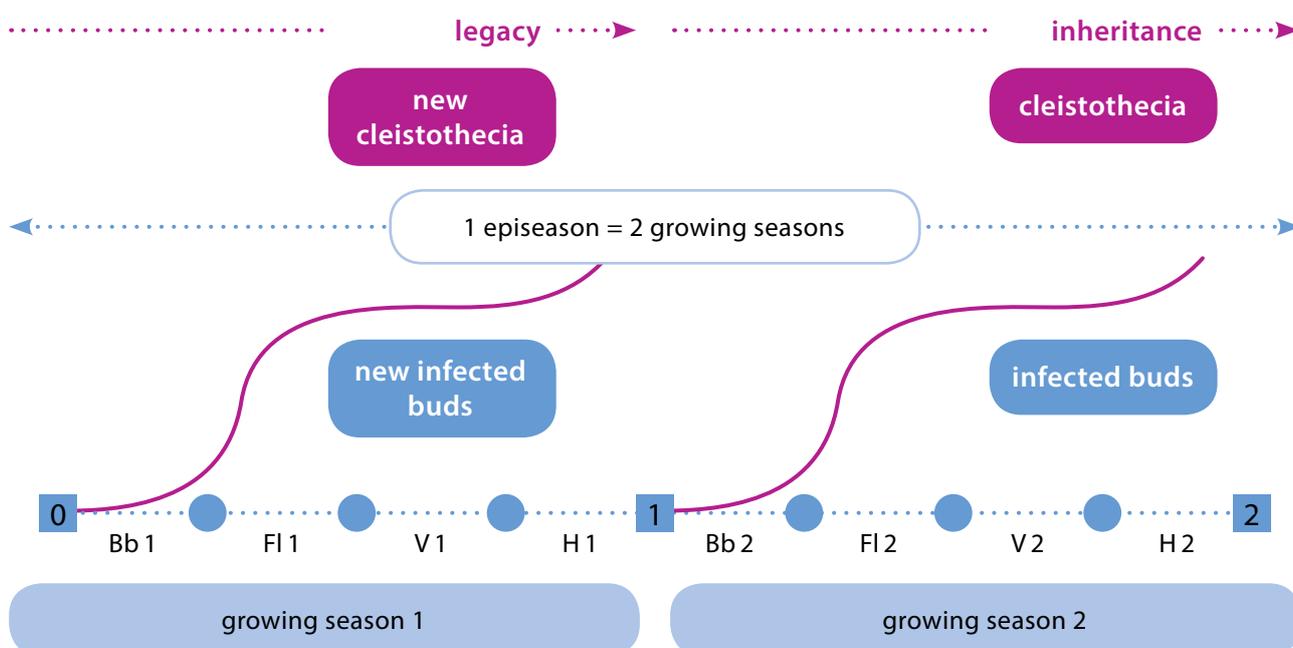


Figure 6: The factors that influence the development within powdery mildew's 'season of epidemic' (an epi-season). This period encompasses two growing seasons (Bb1 – Lf2) where Bb – budburst, Fl – flowering, V – veraison, H – harvest and Lf – leaf fall, in Seasons 1 and 2 respectively. The white graph lines for each season are simplistic disease progress curves for an unsprayed vineyard. The 'legacy/inheritance factor' for over-wintering inoculum 'drives' the powdery mildew epidemic and determines initial levels of disease each season. In consequence, it determines the difficulty to control powdery mildew in the second growing season.

## Managing powdery mildew

It is critical for the best control of powdery mildew to apply sprays as soon as the inoculum is active in the vineyard. As discussed, this occurs from bud-burst onward. This is in the early (slower) stages of the disease epidemic (the 'lag phase' of disease development) (Figure 7) – before powdery mildew spores swamp the vineyard. Once disease controls have 'got behind' and the disease has 'got ahead', it is very difficult to 'catch up'!

In former days, recommendations were to 'spray on either side of flowering'. This approach usually starts spraying in earnest at a time too late to control the level of leaf infection and it is too late to reduce the amount of carry-over inoculum for next season.

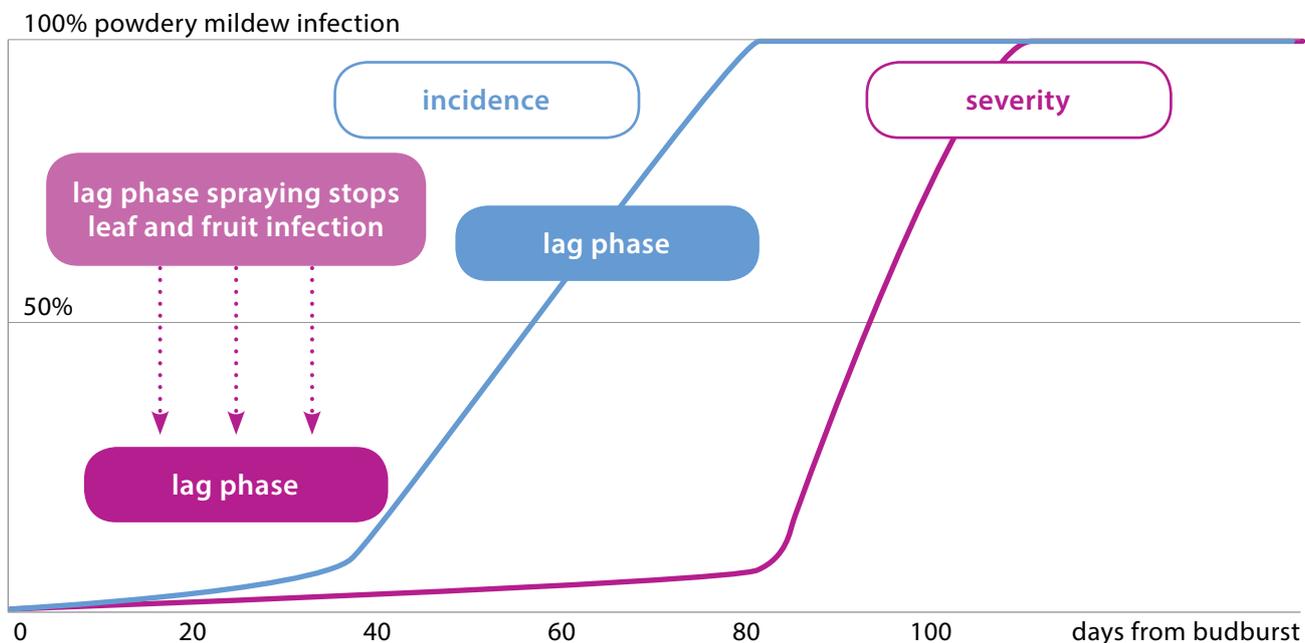


Figure 7: Graph illustrating the increase in incidence and severity of grapevine powdery mildew in a typical unsprayed inland Australian vineyard. Disease incidence increases significantly at around Day 40 from budburst at Day 0, and severity increases at about Day 80. The principle of 'lag phase control' 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 over-wintering inoculum for Season 2.

To control the disease effectively, use:

- » lag phase control, and
- » knowledge of epi-seasons.

### What does this mean for me?

**Spraying in the lag phase** aligns sprays to early season – to a time when spore loads are lowest, when the disease is easiest to control with minimum risk of resistance to fungicides and with maximum reduction of disease carry-over to the next season.

Note: For the most effective control of powdery mildew in your vineyard begin spraying early-season in the first 40 days after budburst – this translates to spraying at weeks 2, 4, and 6 after budburst. For best results, monitor the growth of the foliage and spray accordingly.

Spraying in the light of the **knowledge of the epi-season** for powdery mildew leads to spraying when the mildew fungus is most likely to be active in your vineyard and when it is most active in infecting buds that will carry the fungus over winter and into the next season. Happily, this coincides exactly with lag season spraying!

As a result, the best time to control powdery mildew in your vineyard is to begin just after budburst – when there is sufficient foliage growth (2–3 leaves at EL 7–9). Spray again when the shoots have expanded sufficiently for more new growth to be exposed and again a third time soon after. Continue spraying until you are confident that the disease is under control. Check this by monitoring the canopy closely for early signs of powdery mildew.

**The rule of thumb: the Three T's of good spray application:** Type, Timing and Technique. Like three links in a chain, ensure each factor in spraying is of good quality for quality control. The main cause of failure in vineyards sprayed at optimum spray timing is ineffective spray coverage. Sulphur is an effective fungicide against powdery mildew. If this product is not effective in cooler conditions this indicates signals a less than optimum spray coverage. This is because sulphur works well as a 'contact fungicide' even if its fumigant activity is reduced at temperatures below 17 °C.

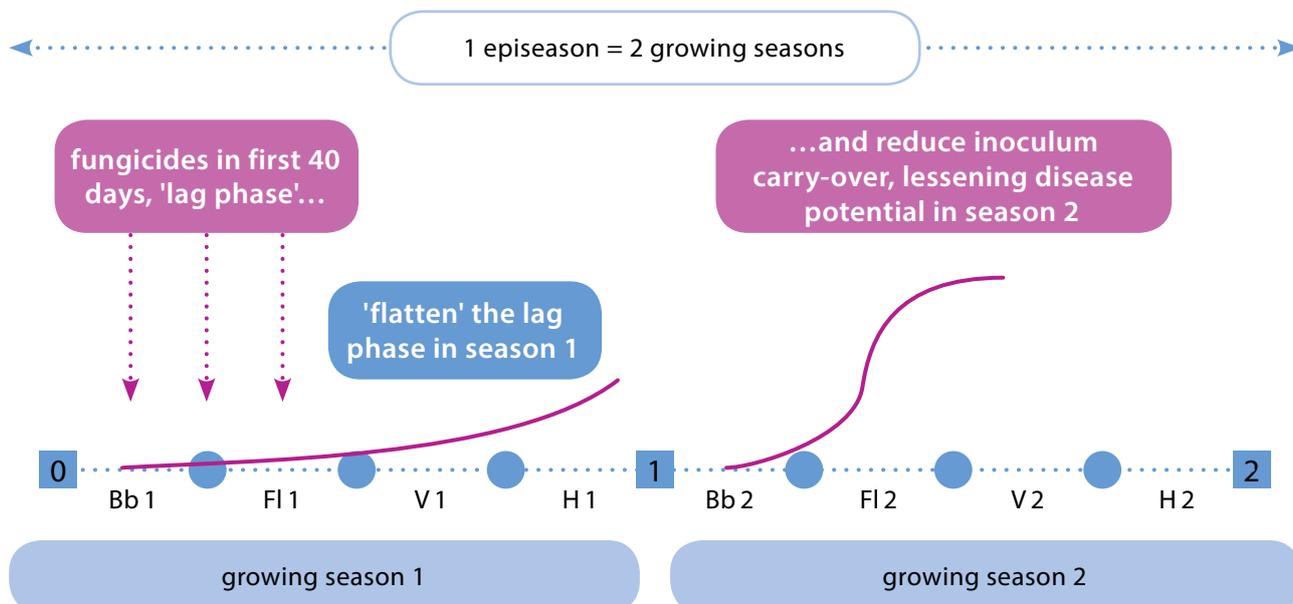


Figure 8: Diagram illustrating that fungicide applications (-----) early in an epi-season (i.e. early in Season 1), have potential to disrupt the progress of the powdery mildew epidemic in that season and to reduce the level of inoculum that carries disease to Season 2. This reduces the disease potential in Season 2, improving control of disease in the long-term with fewer sprays. [Note: Bb – budburst, Fl – flowering, V – veraison, H – harvest and Lf – leaf fall, in Seasons 1 and 2 respectively. The white graph lines for each season are simplistic disease progress curves for that season.]

Note: Most powdery mildew controls fail for want of effective spray coverage. Be sure to check the set up of your sprayer and adjust water rates to changes in canopy volume as the season progresses.

An understanding of the epi-season concept in relation to powdery mildew in your vineyard will lead to the strategy of improving the control of powdery mildew by concerted action to reduce the level of disease this season as a first step to reducing the disease levels next season. By successive seasons of spraying early-season the levels of carry-over inoculum will be reduced and vineyard reservoirs of the disease will be significantly reduced. In this way, instead of spraying 8-10 or more times in a growing season effective control can be achieved by as few as four or less sprays per season!

Nicholas, P.R., Magarey, P.A. and Wachtel, M.F. (Eds). (1994) *Diseases and Pests, Vol. 1. Grape Production Series*, Winetitles, Adelaide, South Australia, 106 pp. See Downy mildew. Ch. 5, pp 5–11. ISBN 1-875130-15-2. This is an easy-read manual on vineyard diseases and pests and their control.

Magarey, P.A. et al. (1999). *The Australian and New Zealand Field Guide to Diseases, Pests and Disorders of Grapes*. This is a companion to *Diseases and Pests, Grape Production Series No.1.*, Winetitles, Adelaide, South Australia. 108 pp. ISBN 1 875130 33 0. (634.82), to help you correctly diagnose the symptoms of disease.

Magarey, P.A. (March 2010). *Managing Powdery Mildew, (Doing it better!)*. GWRDC Innovators Network Module INO906. Fact Sheet. 6 pp. [www.gwrdc.com.au](http://www.gwrdc.com.au)

See [www.growcare.com.au](http://www.growcare.com.au) for access to **GrowCare®** and for **Disease Diagnosis®** – the latter is an online module of the Field Guide (above). It allows you to diagnose vineyard symptoms from the tractor seat!



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# Fungicide Programs for Grapes



# Fungicide Program for Grapevines

## Cool/Wet Climates

Margaret River, Coonawarra, Yarra Valley, Mudgee/Orange, Hunter Valley and Stanthorpe

### Phomopsis, Black Spot, Powdery and Downy Mildew, and Botrytis Rot Control

Dormant		Woolly Bud		Bud Burst		3-4 Leaves Separated		8 Leaves Separated		Flowering Begins		10% Capfall		80% Capfall		Fruit Set		Pre-Bunch Closure		Veraison		Pre-Harvest			
E-L1		E-L3		E-L4		E-L11		E-L15		E-L19		E-L20		E-L25		E-L27		E-L31		E-L35		E-L37			
Shoot and inflorescence development												Berry formation										Berry ripening			
E-L1 to E-L18												E-L19 to E-L26										E-L27 to E-L33		E-L34 to E-L39	
<b>Emblem</b>	Dragon	Solo	Dragon + Solo x2	Captan	Legend <sup>1</sup>	Barrack + Flute	Supernova + Protector 400 + Powdery Mildew Product	Corvette + DMI	Dragon + Viva + Switch	Solo + Liquicop Or Duplex <sup>2</sup> x3	Captan + Protector 400	Corvette	Dragon + Viva + Switch	Solo + Liquicop Or Duplex <sup>2</sup> x3	Captan + Protector 400	Corvette	Solo + Liquicop	Solo + Liquicop							
<b>Phomopsis</b>	Phomopsis Mites	Black spot	Phomopsis	Black spot	Powdery mildew	Downy mildew	Botrytis	Botrytis	Botrytis	Botrytis	Botrytis	Botrytis	Botrytis	Botrytis	Botrytis	Botrytis	Botrytis	Botrytis	Downy mildew	Botrytis	Downy mildew	Powdery mildew	Downy mildew		

**Resistance:**  
All uses comply with CropLife recommendations for fungicide resistance management.

**Suggested total volumes for dilute spraying:**

- Dormant..... 200L/ha
- Woolly bud to early flower..... 500L/ha
- Late flower to pre-bunch closure 750-1,000L/ha
- Bunch closure to vintage..... 1,000-1,500L/ha

**Withholding Periods:**  
All suggestions comply with AWRI recommendations, provided the last Captan spray is at least 30 days before harvest and the last Corvette spray is at least 7 days before harvest.

<sup>1</sup> Information on the IPM compatibility of Legend is not available.  
<sup>2</sup> Use Duplex instead of Liquicop if there has been an infection period for downy mildew and/or downy mildew infection is detected in the vineyard. Do not apply more than two consecutive sprays of Duplex.

PRODUCT TARGET DISEASE

# Fungicide Program for Grapes in Warm/Dry Climates

Barossa, Riverland, Sunraysia, Murrumbidgee Irrigation Area (MIA) and Inland Queensland

## Phomopsis, Black Spot, Powdery and Downy Mildew, and Botrytis Rot Control

Dormant		Woolly Bud	Bud Burst	3-4 Leaves Separated	8 Leaves Separated	Flowering Begins	10% Capfall	80% Capfall	Fruit Set	Pre-Bunch Closure	Veraison	Pre-Harvest
E-L1		E-L3	E-L4	E-L11	E-L15	E-L19	E-L20	E-L25	E-L27	E-L31	E-L35	E-L37
Shoot and inflorescence development						Flowering			Berry formation			Berry ripening
E-L1 to E-L18						E-L19 to E-L26			E-L27 to E-L33			E-L34 to E-L39
<b>Emblem</b>	<b>Dragon</b> + <b>Solo</b> x2	<b>Captan</b> + <b>Legend</b> <sup>1</sup>	<b>Supernova</b> + <b>Corvette</b> + <b>Powdery Mildew Product</b>	<b>Captan</b> + <b>Legend</b> <sup>1</sup>	<b>Captan</b> + <b>Legend</b> <sup>1</sup>	<b>Solo</b> + <b>Liquicop</b> or <b>Duplex</b> <sup>2</sup> x3	<b>Captan</b> + <b>Legend</b> <sup>1</sup>	<b>Captan</b> + <b>Legend</b> <sup>1</sup>	<b>Solo</b> + <b>Liquicop</b> or <b>Duplex</b> <sup>2</sup> x3	<b>Captan</b>	<b>Corvette</b>	<b>Solo</b> + <b>Liquicop</b>
<b>Phomopsis</b>	<b>Phomopsis</b> <b>Mites</b> <b>Black spot</b>	<b>Phomopsis</b> <b>Black spot</b> <b>Powdery mildew</b> <b>Downy mildew</b>	<b>Botrytis</b> <b>Downy mildew</b> <b>Powdery mildew</b>	<b>Botrytis</b> <b>Downy mildew</b> <b>Powdery mildew</b>	<b>Botrytis</b> <b>Downy mildew</b> <b>Powdery mildew</b>	<b>Botrytis</b> <b>Downy mildew</b> <b>Powdery mildew</b>	<b>Botrytis</b> <b>Downy mildew</b> <b>Powdery mildew</b>	<b>Botrytis</b> <b>Downy mildew</b> <b>Powdery mildew</b>	<b>Powdery mildew</b> <b>Downy mildew</b>	<b>Powdery mildew</b> <b>Downy mildew</b>	<b>Botrytis</b>	<b>Downy mildew</b> <b>Powdery mildew</b>

### Resistance:

All uses comply with CropLife recommendations for fungicide resistance management.

### Suggested total volumes for dilute spraying:

- Dormant..... 200L/ha
- Woolly bud to early flower..... 500L/ha
- Late flower to pre-bunch closure 750-1,000L/ha
- Bunch closure to vintage..... 1,000-1,500L/ha

### Withholding Periods:

All suggestions comply with AWRI recommendations, provided the last **Captan** spray is at least 30 days before harvest and the last **Corvette** spray is at least 7 days before harvest.

<sup>1</sup> Information on the IPM compatibility of **Legend** is not available.

<sup>2</sup> Use **Duplex** instead of **Liquicop** if there has been an infection period for downy mildew and/or downy mildew infection is detected in the vineyard. Do not apply more than two consecutive sprays of **Duplex**.

PRODUCT  
TARGET DISEASE

# Fungicide Program for Grapes

## Spray Guidelines

The spray program for warm dry climates is designed to give you the best options for disease control throughout the season in districts such as Barossa, Riverland, Sunraysia, Murrumbidgee Irrigation Area (MIA), Hunter Valley and Inland Queensland grape growing regions.

The spray program for cool wet climates is designed to give you the best options for disease control throughout the season in districts such as Margaret River, Coonawarra, Yarra Valley, Mudgee/Orange and Stanthorpe grape growing regions.

In both situations the number of sprays needed will vary with disease pressure and the diseases present. The programs provided are for conditions of high disease pressure. Important factors considered when preparing these programs are outlined below.

**Strategic Coverage:** The viticulture industry has become more focused on good phomopsis control, thanks to research over recent years, which has identified different strains with different pathogenicity, the importance of pruning methods and effective fungicides. The importance of early season control of this disease is supported by pre-budburst application of Emblem\*. This is followed by applications of Dragon\* and Captan between budburst and pre-flowering. These two fungicides have been shown to be very effective as protectant fungicides against phomopsis.

Another example is the control of Botrytis with a balance between high value systemic products at critical times of the crop/disease life cycle. In this case the highly effective bunch rot fungicides Protector 400\* and Corvette\* are recommended in cool wet climates at the critical stages of 80% capfall, pre-bunch closure and pre harvest. Where Botrytis pressure is much lower or the stage of the crop/disease life cycle is less critical, the protectants Barrack\* and Captan are recommended.

**Mode of Action:** To reduce the chance of fungicide resistance developing, a range of modes of action are recommended for control of diseases. Fungicides are also recommended at times of the disease life cycle where they will be most effective according to their mode of action. For example, for powdery mildew control we recommend the protectant fungicide sulphur (Group M2) for early and late sprays. Before, during and after flowering, which are the critical periods for powdery mildew control, we recommend 1 spray of Flute® (Group U6), 2 sprays of Supernova® (Group 1.1), 1 DMI (Group 3) spray and 1 Legend® (Group 1.3) spray, so that (5) modes of action products are recommended for powdery mildew control.

**Fungicide Resistance Management:** The maximum number of sprays as recommended by CropLife is always adhered to so as to minimise the risk of the development of fungicide resistance. In some cases the number of sprays of a product in the program may be less than the recommended maximum, but never more. Relatively cheap and effective fungicide options such as DMI, copper and sulphur are included. However, reduced effectiveness of some DMIs has been reported and we have therefore restricted the number of DMI sprays to one, depending on climate, and introduced products from different modes of action for powdery mildew control. A maximum of 1 or 2 dicarboximides (depending on the total sprays for this disease) are recommended by CropLife for Botrytis control in vines. Therefore two applications of Corvette\* are recommended in our programs.

**Integrated Pest Management:** The effect of fungicides on biological control agents such as predatory mites is carefully considered. Fungicides which are known to have an adverse affect are generally not included in the spray program unless there is no alternative product with a better IPM profile.

Captan and Dragon control a wide spectrum of diseases (phomopsis cane and leaf blight, downy mildew and black spot) and at the same time have excellent IPM profiles. Some other protectant fungicides such as those based on mancozeb are known to have a damaging affect on a range of predatory mites which assist in the management of bud mite and rust mite in vines. We **do not** recommend them.

**Withholding Period:** Withholding requirements for export wines, as recommended by the Australian Wine Research Institute (AWRI) have been strictly adhered to.

Although Barrack has a 7 day withholding period in Australian grapes, MRLs do not exist in some important overseas wine markets and therefore it is not recommended past 80% capfall as recommended by the AWRI.

**Cost Effectiveness:** Where there are 2 alternative products or product combinations that will fulfil a similar role, the one, which costs less, is recommended. Several products are registered for protective and post infection control of downy mildew, but these are generally more expensive than straight protectants. We only recommend these products (e.g. Crop Care's new Duplex®) where there has been a downy mildew infection and curative activity is required. Otherwise we recommend the protectant copper product Liquicop\*.

**Crop Effects:** Where a large number of sprays of a product may have an adverse affect on vines or the environment, the total sprays are reduced (or sometimes eliminated) and another product with similar activity is recommended.

For example copper products used throughout the season will cause a bronzing of leaves of many varieties and may result in pollen sterility at flowering. We recommend our copper product Liquicop only after flowering and later in the season after earlier sprays of Dragon, Barrack and Captan.

**For more information, please contact your local Technical Sales Representative.**

**Customer Service (Australia-wide):**

**1800 111 454**

**[www.cropcare.com.au](http://www.cropcare.com.au)**

\* Barrack, Dragon, Solo and Supernova are registered trademarks of Crop Care Australasia  
\* Captan, Corvette, Duplex, Emblem, Flute, Legend, Liquicop and Protection 400 are registered trademarks



# Plant Health Diagnostic Service

*Helping to improve the health and profitability of your vineyard*



## ■ DIAGNOSIS ■ IDENTIFICATION ■ SURVEILLANCE

The **Plant Health Diagnostic Service (PHDS)** provides an essential link in protecting the health and improving the profitability of crops, pastures and nursery enterprises. Our laboratories are staffed by specialist pathologists, mycologists and entomologists - experts in a wide range of crop, pasture and horticultural pests and diseases – who can provide plant pathogen and insect identification.

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Our Plant Health Diagnostic Services staff are supported by the Department of Primary Industries advisory service, providing a complete plant health package for your business.

## Diagnostic and Analytical Services

### Elizabeth Macarthur Agricultural Institute (Menangle)

Phone: (02) 4640 6327

Private Bag 4008

NARELLAN NSW 2567

Email: [emai.phds@industry.nsw.gov.au](mailto:emai.phds@industry.nsw.gov.au)

### Available services

Key functions of PHDS include:

- Botrytis monitoring of grape bunches and experience in diagnosing woody trunk diseases;
- diagnosis of winegrape disease and disorders, including bacteria, fungi, and nematodes;
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- active surveillance for emerging and exotic diseases;
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We can assist you to:

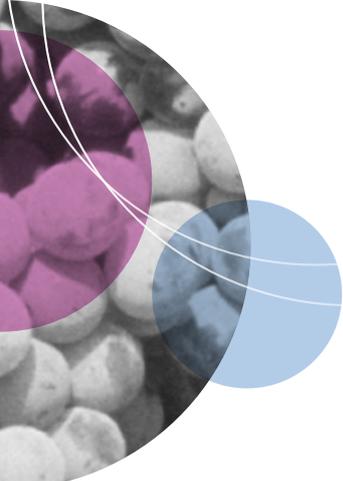
- save expenditure on unnecessary or incorrect chemical usage;
- ensure your produce achieves best quality and, therefore, best market price;
- implement best practice pest and disease control.



For more information, you can contact our Customer Service Unit on 1800 675 623 or visit our website at: [www.dpi.nsw.gov.au/aboutus/services/das](http://www.dpi.nsw.gov.au/aboutus/services/das)



Department of Primary Industries



# Industry projects

## National Wine and Grape Industry Centre – Experimental Winery

The National Wine and Grape Industry Centre (NWGIC) – Experimental Winery is a large, well-equipped facility that has undergone major renovations, improvements and extensions within the last five years. The experimental winery produced 256 individual small-lot wines during the 2015 vintage period. These wines (red and white with volumes of a few litres up to 300 L) were produced for a large range of NWGIC/CSU projects to determine the impact of various viticultural trials, sequential harvest, winemaking procedures and the investigation of wine fault amelioration and chemical reactions such as oxidation or reduction that result in wine spoilage.

### Features/facilities

The experimental winery is managed by a full-time winemaker, Campbell Meeks, a graduate of the Charles Sturt University Wine Science program. Features/facilities of the experimental winery that allow the production of representative, consistent and sound experimental wines include:

### Processing equipment/infrastructure

- » Under-cover fruit receipt/processing area
- » MORI R30B destemmer/crusher with a short hopper
- » 2 × 60 kg metal pneumatic basket presses
- » 8.5 kW refrigeration unit with brine tank for chilling tanks
- » Designated tasting room
- » Four cool rooms with the capacity to heat and cool to -4 °C
- » 7000 bottle temperature-controlled wine cellar VELO 660 L bag press
- » CROWN walking forklift to facilitate gravity racking and VCT movement
- » MORI 4 head benchtop bottle filler
- » Tenco semi automatic capping machine.

### Fermentation facilities

- » 186 × 100 L variable capacity tanks
- » 20 × 100 L fermenters which are individually temperature controlled using brine and electrical heating via computer monitoring

- » 5 × 500 L variable capacity tanks
- » 3 × 345 L variable capacity tanks
- » 270 × 5 to 25 L glass demijohns.

### Analytical equipment

- » FOSS Fiastar for sulphur dioxide measurement
- » Rankine aspiration/oxidation apparatus for sulphur dioxide measurement
- » Arena 20XT Konelab for a full range of enzymatic analyses
- » Anton Paar NIR Alcolyser
- » Anton Paar DMA Density Meters (2)
- » FIBOX oxygen meter
- » Metrohm automated pH/TA analyser
- » Shimadzu scanning spectrophotometer
- » Winery database programme designed by the experimental winemaker Campbell Meeks
- » Digital freezer set to -4 °C for cold stability testing
- » Heated water baths for heat stability testing
- » Turbidity meter
- » Eppendorf refrigerated centrifuge.

### NWGIC/CSU research

There are currently 14 active NWGIC/CSU research projects, of which five use the experimental facilities. These projects are primarily funded by the Australian Grape and Wine Authority (AGWA), and are closely linked to Australian wine industry priorities. The following list is a summary of the major programs which currently utilise the winery facilities as part of the integrated and multidisciplinary approach that is key to all NWGIC projects:

- » Metal ion speciation, understanding its role in wine development and generating a tool to minimise wine spoilage.
- » Optimising harvest date through use of an integrated grape compositional and sensory model.
- » Low alcohol wine and sequential harvest .
- » Improving industry capacity to manage yield and wine quality relationship through understanding the influence of vine carbon balance and berry composition.

- » Determination of thresholds for bunch rot contamination of grapes and techniques to ameliorate associated fungal taints.

In addition, the multinational Lallemand group has contracted the NWGIC/ CSU winery to undertake a diverse range of wine product trials, which has led to further industry engagement and incorporation of current research into CSU wine subjects.

## Teaching

### HDR student support

Research higher degree by research (HDR) students enrolled within the School of Agricultural and Wine Sciences (SAWS) are heavy users of the of the experimental winery infrastructure. Many HDR student research programs are planned with the expectation that the research will involve a considerable component of winemaking in the experimental winery to determine the impact of the specific experimental factors investigated upon grape and resulting wine composition. Currently the following students are enrolled in higher degree studies in which small lot wine making is an integrated component of their research:

- » Navideh Sadoughi – PhD, Vine Pathology
- » Markus Mueller – PhD, Vine Physiology

- » Rocco Longo – PhD, Wine Chemistry and Production
- » Subhashini Abeysinghe – PhD, Vine Physiology
- » Gerhard Rossouw – PhD, Vine Physiology

### Undergraduate

The experimental winery used for wine science residential schools and the students using the facilities to produce wine for subject assessments. For example, the WSC304 Wine Chemistry residential practical assessment is completed wholly within the experimental winery. Students are able to complete a comprehensive range of stabilisation, fining and analytical procedures to investigate the effect of an array of legal processing aids and additives and ensure their wine sample is bottled in the best possible condition. The experimental winery is also able to demonstrate the effects of the various winemaking procedures or processing aids to the wine production and wine engineering subjects. The state-of-art analytical equipment also develops the skills of the WSC101 Wine Science cohort, and enables them to be readily employed within the grape, wine and ancillary industries as they have the necessary skills and knowledge for immediate employment.

Experimental wine maker Campbell Meeks



# Appendix 1: Internet sites for wine and grape industries

Internet services include:

- » Electronic mail (email)
- » World wide web (www)
- » Internet relay chat (IRC) groups.

Listed are some of the web sites accessible to wine and grape industries. To access the sites, enter the address into a browser window, or go to the NSW Department of Primary Industries website, [www.dpi.nsw.gov.au](http://www.dpi.nsw.gov.au) and search for 'grapes'.

## General weather sites

[www.bom.gov.au](http://www.bom.gov.au)

Bureau of Meteorology is the national meteorological authority for Australia, providing meteorological, hydrological and oceanographic services. The web site features education, publications, news, weather forecasts, warnings and observations, other weather services, climate services, and hydrology services.

[www.bom.gov.au/watl](http://www.bom.gov.au/watl)

Water and land information is a service of the Bureau of Meteorology. It provides detailed weather services for agriculture and natural resource managers, including national rain forecast maps and frost potential maps.

[www.longpaddock.qld.gov.au](http://www.longpaddock.qld.gov.au)

Ten-day precipitation outlook for Australia and New Zealand viewed through two 5-day charts and precipitation percentage of normal chart.

<http://wxmaps.org/pix/aus.vv.html>

This site presents Global Forecast System medium-range 7-day forecast maps of vertical velocity and rainfall for Australia and NZ.

## Organic agriculture sites

[www.ofa.org.au](http://www.ofa.org.au)

Organic Federation of Australia is the peak Australian organic producers' industry body. Site includes an organic directory, information forums and events.

[www.ifoam.org](http://www.ifoam.org)

The International Federation of Organic Agriculture Movements is the international umbrella body for national organic producer groups.

## Australian organic certification and grower groups

[www.nasaa.com.au](http://www.nasaa.com.au)

The National Association for Sustainable Agriculture (Australia) provides certification services for Australian producers; these services are also suitable for export markets.

[www.organicgrowers.org.au](http://www.organicgrowers.org.au)

Organic Growers Australia Certified Ltd (OGA) is Australia's first certification service to specifically cater for the needs of the smaller organic producer.

[www.demeter.org.au](http://www.demeter.org.au)

The Biodynamic Research Institute is the grower association and certifier for biodynamic producers in Australia. Certified bio-dynamic producers use the Demeter biodynamic label on produce.

[www.organicfoodchain.com.au](http://www.organicfoodchain.com.au)

Organic Food Chain is a company that certifies producers under its own label, as well as to export standards.

## Wine industry organisations

[www.wineaustralia.com](http://www.wineaustralia.com)

The Australian Wine and Brandy Corporation web site features newsletters, statistics, vintage reports, publications, contacts, exporting, promotion, geographical indications (wine zones and regions) and a register of protected names. The link to [www.wineaustralia.com](http://www.wineaustralia.com) provides statistical information and an interactive wine tasting challenge (BYO bottle).

[www.gwrdc.com.au](http://www.gwrdc.com.au)

The Australian Grape and Wine Authority is the body responsible for investing in grape and wine research and development on behalf of the Australian wine industry and community. The web site features information on grape and wine research, newsletters, research applications, contacts and the National Vine Health Steering Committee.

[www.awri.com.au](http://www.awri.com.au)

The Australian Wine Research Institute provides research, development and extension services. The web site features industry services, links, agrochemicals, information resources, wine exporting, publications, wine and health and research projects.

[www.crcv.com.au](http://www.crcv.com.au)

The Cooperative Research Centre for Viticulture promotes cooperative scientific research and is a joint venture between the viticulture industry and research and education organisations. The web site features information on research programs, education and training, Viticare, AusVit, publications and links.

[www.asvo.com.au](http://www.asvo.com.au)

The Australian Society of Viticulture and Oenology Inc. serves the interests of practising winemakers and viticulturists by encouraging the exchange of technical information. Activities include seminars, a newsletter, and industry awards.

[www.nswwine.com.au](http://www.nswwine.com.au)

The NSW Wine Industry Association Inc. (NSWWIA) represents the wine regions of NSW. Committees formed since the Association began cover Research and Development, Education and Training, Licensing, Tourism and Promotion, and Water and Resources. The web site provides information on activities of the Association, promotion opportunities and events. See the list of regional associations at [www.nswwine.com.au/pages/NSW-Wine-Regions.html](http://www.nswwine.com.au/pages/NSW-Wine-Regions.html)

[www.csu.edu.au/nwgc](http://www.csu.edu.au/nwgc)

The National Wine and Grape Industry Centre was formed by bringing together the resources of the NSW Department of Primary Industries, Charles Sturt University, and the NSW Wine Industry Association. This unique initiative helps the industry to maintain its internationally competitive edge through research, education, training and extension. The web site contents include courses available, a contact page and research topics.

[www.phylloxera.com.au](http://www.phylloxera.com.au)

The Phylloxera and Grape Industry Board of South Australia web site provides information about the Board, phylloxera, research results, rootstocks, other pests, young vine management, news, statistics and links to other web sites.

[www.avia.org.au](http://www.avia.org.au)

The Australian Vine Improvement Association is made up of participating Vine improvement groups throughout Australia.

### Government sites

[www.dpi.nsw.gov.au](http://www.dpi.nsw.gov.au)

NSW Department of Primary Industries is a leading provider of information for profitable, sustainable food and fibre industries. The web site features horticulture, animals, field crops and pasture, pests, diseases and weeds, natural resources and climate, farm business, trade, research, advisory and education services, community services, corporate information, employment, news, media, a bookshop and links.

[www.daff.gov.au](http://www.daff.gov.au)

The Australian Government Agriculture Portal provides all government services and information under the one web site.

[www.agric.wa.gov.au](http://www.agric.wa.gov.au)

Department of Agriculture and Food, Western Australia.

[www.depi.vic.gov.au](http://www.depi.vic.gov.au)

Victorian Department of Environment and Primary Industries.

[www.pir.sa.gov.au](http://www.pir.sa.gov.au)

Department of Primary Industries and Resources South Australia.

[www.daff.qld.gov.au](http://www.daff.qld.gov.au)

Queensland Primary Industries and Fisheries within the Department of Employment, Economic Development and Innovation.

[www.dpipwe.tas.gov.au](http://www.dpipwe.tas.gov.au)

Tasmanian Department of Primary Industries, Parks, Water and Environment.

[www.csiro.au](http://www.csiro.au)

Commonwealth Scientific and Industrial Research Organisation.

[www.workcover.nsw.gov.au](http://www.workcover.nsw.gov.au)

WorkCover Authority of NSW looks at all relevant issues pertaining to safety in your business enterprise.

[www.daff.gov.au/biosecurity](http://www.daff.gov.au/biosecurity)

DAFF Biosecurity manages quarantine controls at our borders to minimise the risk of exotic pests and diseases entering the country. DAFF Biosecurity also provides import and export inspection and certification to help retain Australia's highly favourable animal, plant and human health status and wide access to overseas export markets.

[www.austrade.gov.au](http://www.austrade.gov.au)

Austrade (Australian Trade Commission) provides export and investment services to Australian companies and international buyers and investors in 94 locations worldwide. It is the official trade and investment facilitation agency of the Australian Government. Some of the web site features are trade events, useful links, publications, industry and country information and information on exporting and investment.

[www.abs.gov.au](http://www.abs.gov.au)

Australian Bureau of Statistics is Australia's official statistical organisation. The web site features media releases, news, statistics, education resources, census data, products and services.

[www.daff.gov.au/abares](http://www.daff.gov.au/abares)

Australian Bureau of Agricultural and Resource Economics (ABARE) is a professionally independent applied economic research agency. It provides stakeholders in Australia's rural and resource industries with up-to-date public policy analysis and commodity forecasts. The web site features ABARE data, commodity analyses, agricultural surveys, economics, media releases, conferences, publications, related links and feedback.

[www.customs.gov.au](http://www.customs.gov.au)

Australian Customs and Border Protection Service is a statutory authority that services the government, the business community and the people of Australia. Some features of the web site are: a business guide to customs, media and publications, customs tax reform, customs notices, importing goods into Australia, links to other sites, Minister's Home Page, and customs forms.

[www.efic.gov.au](http://www.efic.gov.au)

The Export Finance and Insurance Corporation helps Australian exports to compete internationally by providing insurance and finance facilities to support their overseas contracts. The web site contains customer service, country information, environment policy, news, publications and market watch.

## Journals

[www.winetitles.com.au](http://www.winetitles.com.au)

Publisher of *Australian Viticulture*.

[www.winebiz.com.au](http://www.winebiz.com.au)

Publisher of *Australian & New Zealand Grapegrower & Winemaker*.

## Pest, disease and pesticide information

[www.awri.com.au/industry\\_support/viticulture/agrochemicals/](http://www.awri.com.au/industry_support/viticulture/agrochemicals/)

A comprehensive list of Agrochemicals registered for use in Australian viticulture. It also lists current MRLs, Fungicides Resistance Management Strategies and off-label grapevine permits.

[www.cropwatch.com.au](http://www.cropwatch.com.au)

CropWatch SA provides grapegrowers in the Riverland, McLaren Vale, Mildura, Swan Hill and Robin Vale areas with timely information on the potential risks of important diseases and pests like downy mildew, powdery mildew, black spot and light brown apple moth. It has an interactive disease diagnosis page based on Ausvit's *The Australian and New Zealand Field Guide to Diseases, Pests and Disorders of Grapes*.

[www.apvma.gov.au](http://www.apvma.gov.au)

The Australian Pesticides and Veterinary Medicines Authority (formerly National Registration Authority) operates the Australian system that evaluates, registers and regulates agricultural and veterinary chemicals. The web site includes a PUBCRIS database, which contains details of registered agricultural and veterinary chemical products.

## Education and training

[www.dpi.nsw.gov.au/education](http://www.dpi.nsw.gov.au/education)

NSW Department of Primary Industries is a provider of short courses and education and training through the Murrumbidgee Rural Studies Centre at Yanco and the CB Alexander Agricultural College at Paterson ('Tocal'). For more details see below, and see the NSW Department of Primary Industries web site for information on short courses.

[www.csu.edu.au/nwgic](http://www.csu.edu.au/nwgic)

National Wine and Grape Industry Centre (NWGIC). Through Charles Sturt University (CSU) the NWGIC provides higher education to the Australian Wine Industry. CSU provides undergraduate and postgraduate programs in Winegrowing, Wine Science, Food Processing and Food Science.

[www.tocal.nsw.edu.au](http://www.tocal.nsw.edu.au)

CB Alexander Agricultural College or 'Tocal' is a part of the NSW Department of Primary Industries. The site contains details of full-time and part-time courses for school leavers who want to pursue careers in agriculture. It also has details of external courses in agriculture and natural resource management, short courses, coming events and education resources for sale.

[www.uws.edu.au](http://www.uws.edu.au)

The University of Western Sydney. Some web site features are: search engine, learning, research, academic publications, Internet support, library, news, colleges and schools.

[www.tafensw.edu.au](http://www.tafensw.edu.au)

NSW Department of Education and Communities, Technical and Further Education (TAFE NSW). Web site features include courses and careers, campuses and institutes, flexible study options, getting started at TAFE and news.

## USA sites

[www.tablegrape.com](http://www.tablegrape.com)

The California Table Grape Commission gives a guide to fresh table grapes, including recipes, cooking tips and nutritional information.

[www.nysaes.cornell.edu](http://www.nysaes.cornell.edu)

New York State Agricultural Experiment Station has researchers and extension educators working to develop good farming, food storage and processing practices. Web site features departments, information, news, press releases.

[www.universityofcalifornia.edu](http://www.universityofcalifornia.edu)

The University of California develops and promotes the use of integrated pest management. The web site features information, education, publications, programs and a directory.

<http://wineserver.ucdavis.edu>

The Department of Viticulture and Oenology, University of California, Davis is a research and educational institution. The web site features wine and grape information, programs, research, newsletters, courses and links.

## New Zealand sites

[www.lincoln.ac.nz](http://www.lincoln.ac.nz)

Lincoln University Centre for Viticulture and Oenology is an internationally renowned university specialising in commerce and management, primary production, natural resources, science, engineering and social science. The web site features departments, information, news and press releases.

[www.massey.ac.nz](http://www.massey.ac.nz)

Massey University Laboratory for Wine Microbiology is a leader in the fields of sciences, design, social sciences, education and business. The web site features research and library information, business and community information, and links.

### French sites

[www.montpellier.inra.fr](http://www.montpellier.inra.fr)

The Montpellier INRA Centre is a leader in wine research and a major teaching site for southern France.

### German sites

[www.campus-geisenheim.de](http://www.campus-geisenheim.de)

The Geisenheim Research Centre is one of the oldest research institutions in the areas of viticulture, oenology, wine technology and beverage research, horticulture and landscape architecture in Germany.

[www.genres.de](http://www.genres.de)

The Grape and Vine Variety Catalogue web site features an online search, a database and links. Links to an English language page of the German site.

### Other overseas sites

[www.arc.agric.za](http://www.arc.agric.za)

The South African Institute for Research in Viticulture and Oenology (Agricultural Research Council) promotes the agricultural and related sectors through research, technological development and transfer. Web site features are strategic plan, events, products, opportunities and links.

[www.brocku.ca/ccovi/](http://www.brocku.ca/ccovi/)

Brock University's Cool Climate Oenology and Viticulture Institute. This Canadian web site features research, academic programs, background and links.



## Pathways to a wine science or viticulture degree

Have you completed a TAFE course or studied at university?

Ask about credit towards your wine science and viticulture degree at Charles Sturt University.

For more information  
**1800 334 733**  
[www.csu.edu.au/wine](http://www.csu.edu.au/wine)



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# Appendix 2: Where to buy your planting material

## Approved sources for purchasing cuttings in NSW, Victoria and South Australia

### Vine improvement organisation

#### MIA Vine Improvement Society

Leo De Paoli  
PO Box 486 YENDA NSW 2681  
m: 0412 699 476 p: 02 6968 1202  
miavis@bigpond.com

#### Victorian and Murray Valley Vine Improvement Association

Gary Thomas  
PO Box 5051 MILDURA VIC 3502  
m: 0418 997 730 p: 03 5022 8499, 03 5021 4833  
vamvvia@bigpond.com  
Orders accepted at any time  
[www.vamvvia.org.au](http://www.vamvvia.org.au)

#### Riverland Vine Improvement Committee\*

David Nitschke  
PO Box 292 MONASH SA 5342  
m: 0407 974 149 p: 08 8583 5366, 08 8583 5504  
info@rvic.org.au  
Preference given to orders received by 31 May  
[www.rvic.org.au](http://www.rvic.org.au)

#### Australian Vine Improvement Association Inc.

Gary Thomas  
PO Box 5051 MILDURA VIC 3502  
m: 0418 997 730 p: 03 5022 8499, 03 5021 4833  
[www.avia.org.au](http://www.avia.org.au)

## Nurseries supplying rootlings from approved sources

The nurseries listed are recognised for using material sourced from vine improvement organisations. However, they may use material obtained from other sources. This information is provided to inform the Australian grape and wine sector of nursery supplier information, and it should not be interpreted as an endorsement. Buyers should check the source of the material they intend to purchase to ensure it meets their needs.

### New South Wales

#### Adro Grafted Vines\*

PO Box 539 GRIFFITH 2680  
m: 0428 447 246 p: 02 6964 4288, 02 6964 4288  
adrografted@bigpond.com

#### Binjara Vine Nursery Pty Ltd\*

PO Box 75 EUSTON 2737  
m: 0417 148 429 p: 03 5026 1661, 03 5026 1050  
justin@binjara.com.au  
[www.binjara.com.au](http://www.binjara.com.au)

#### Hanwood Grafted Vines

PO Box 55 HANWOOD 2680  
m: 0412 699 476 p: 02 6963 0247, 02 6963 0247  
[Indepoli@dragnet.com](mailto:Indepoli@dragnet.com)

#### Mallee Point Nursery\*

PO Box 438 YENDA 2681  
m: 0428 690 208 p: 02 6968 1086, 02 6968 1786  
[malleepoint@bigpond.com](mailto:malleepoint@bigpond.com)

#### Sunraysia Nurseries\*

PO Box 45 GOL GOL 2738  
p: 03 5024 8502, 03 5024 8551  
sales@sunraysianurseries.com.au  
[www.sunraysianurseries.com.au](http://www.sunraysianurseries.com.au)

### Victoria

#### Ausvine Nursery

PO Box 243, MILDURA 3502  
m: 0429 950 031 p: 03 5021 0068 (03) 5021 0068  
niutta1@bigpond.com.au

#### Boulevard Nurseries

PO Box 816 IRYMPLE 3498  
p: 03 5024 9000, 03 5024 6692  
info@boulevard.com.au  
[www.boulevard.com.au](http://www.boulevard.com.au)

#### Binjara Vine Nursery Pty Ltd\*

See NSW details

#### Freck's Vine Nursery

PO Box 1161, RED CLIFFS 3496  
m: 0412 947 426 p: 03 5024 2885, 03 5024 2885  
freck94@bigpond.com

#### KC Vines & Rootstocks\*

PO Box 1054, MILDURA 3502  
m: 0407 309 961 p: 03 5024 8812, 03 5024 8834  
info@kcvines.com.au  
[www.kcvines.com.au](http://www.kcvines.com.au)

### **Fussy Britches Nursery**

PO Box 5033, MILDURA 3502  
m: 0428 502 588 p: 03 5023 4370  
ICA-37 accredited  
fussbrit@iinet.net.au  
john@fussybritches.net.au

### **Revs Nursery Pty Ltd**

PO Box 498 IRYMPLE 3498  
m: 0429 873 114 p: 03 5024 5986, 03 5024 6596  
revsnursery@bigpond.com

### **Sunraysia Nurseries\***

See NSW details

\* Vine Improvement Nursery Association Accredited.

## **South Australia**

### **Adelaide Hills Vine Improvement Inc\***

C/- Box 38 Kangarilla 5157  
m: 0422 644 825 p: 08 8383 7532  
davidc@adelaidehillsvineimprovement.org  
[www.adelaidehillsvineimprovement.org](http://www.adelaidehillsvineimprovement.org)

### **Barossa Vine Improvement\***

PO Box 293 Nuriootpa 5355  
p: 08 8562 2011, 08 8562 4410

### **Fleurieu Vine Nursery**

3 Clemens Road, Langhorne Creek 5255  
m: 0429 676 014 p: 08 8537 3286  
gd.warren@bigpond.com

### **Glenavon Nurseries Pty Ltd\***

101 South Bremer Rd, Langhorne Creek 5255  
m: 0417 883 826 p: 08 8537 3207, 08 8537 3250  
[www.glenavon.com.au](http://www.glenavon.com.au)

### **Golding Vine Nursery**

C/- Box 700, Lobethal 5241  
m: 0413 942 272 p: 08 8389 5120, 08 8389 5290  
darren@goldingwines.com.au

### **Langhorne Creek Vine Improvement\***

C/- PO Langhorne Creek 5255  
m: 0439 373 450 (08) 8537 3450 (08) 8537 3450

### **Orchard Fruits Nursery**

PO Box 1716 LOXTON 5333  
m: 0418 815 655 (08) 8584 5544 (08) 8584 5544  
[www.pippos.com](http://www.pippos.com)

### **RVIC Nursery**

PO 292 MONASH 5345  
m: 0407 974 149 (08) 8583 5366 (08) 8583 5504  
[www.rvic.org.au](http://www.rvic.org.au)

### **Ramco Wine Group**

Box 889 NURIOOTPA 5355  
0400 742 603 (08) 8541 9013  
s.curtis@ramcowinegroup.com

### **River Murray Nursery**

PO Box 995 LOXTON 5333  
m: 0428 819 540  
rivermurraynursery@yahoo.com.au

### **Yalumba Nursery\***

PO Box 10 ANGASTON 5353  
m: 0411 487 495 p: 08 8568 7700, 08 8568 7710  
[www.yalumbanursery.com](http://www.yalumbanursery.com)  
[ndry@yalumba.com](mailto:ndry@yalumba.com)

### **Vinewright\***

PO Box 180 Mount Pleasant 5235  
plwright@vinewright.com.au  
m: 0438 682 345 p: 08 8568 2385, 08 8568 2345  
[www.vinewright.com.au](http://www.vinewright.com.au)

## **Tasmania**

### **Woodlea Nursery\***

49 Whish-Wilson Rd, Scottsdale 7260  
m: 0447016744 p: 03 6352 7262, 03 6352 7252  
info@woodleanursery.com.au  
[www.woodleanursery.com.au](http://www.woodleanursery.com.au)

## **Western Australia**

### **Viticlone Supplies\***

Box 202 Dunsborough 6281  
m: 0418 946 901 p: 08 9755 2030, 08 9755 2030  
viticlone@netserv.net.au  
[www.viticlonesupplies.com](http://www.viticlonesupplies.com)

\* Vine Improvement Nursery Association Accredited

Note: Check with the respective authorities that all certificates are obtained for planting material to enter your state. Written consent is required to introduce grapevine material, regardless of its origin, into the proclaimed phylloxera exclusion area.

Quality planting stock is the best investment a grower can make to establish a long-lived and productive vineyard.

Producers wanting to purchase new vine material should refer to the *Grapevine management guide* 2012–2013 article 'Quality planting stock: it's your business' on pages 27–32, written by Helen Waite.

# Appendix 3: Pesticide record keeping

Adapted from the NSW Environment Protection Authority

[www.epa.nsw.gov.au/pesticides/risintro.htm](http://www.epa.nsw.gov.au/pesticides/risintro.htm)

The EPA's Pesticides Regulation 2009 makes it compulsory for all people who use pesticides for commercial or occupational purposes to make a record of their pesticide use (Spray Diary). Pesticides include herbicides, fungicides, insecticides, fumigants, nematicides, defoliants, desiccants, bactericides and vertebrate pest poisons.

To comply with the record keeping rules set out in the Regulation you must record:

- » Date, start and finish time.
- » The operator details – name, address and contact details\*.
- » The crop you treated e.g. Shiraz grapes. The property address, and a clear delineation of the area where the pesticide was applied – you can mark this on a rough sketch or map of your property if this is easiest for you
- » Type of equipment used to apply the pesticide e.g. knapsack, air blast sprayer, tractor mounted boom-spray etc.
- » The full product name of the pesticide applied (e.g. Bayfidan 250 EC Fungicide® – not just 'Bayfidan'). If you mixed two pesticides together, you can record both on the same form.
- » The total amount of concentrate product used.
- » The total amount of water, oil or other things mixed in the tank with concentrated product.
- » Size of block sprayed.
- » Order blocks were treated.
- » An estimate of the wind speed and direction at the start of spraying. You can use a windmeter or the Beaufort scale to help estimate the wind speed, available from Bureau of Meteorology at [www.bom.gov.au/lam/glossary/beaufort.shtml](http://www.bom.gov.au/lam/glossary/beaufort.shtml)
- » If other weather conditions are specified on the label as relevant to the proper use of that pesticide (such as temperature, humidity, rainfall etc.) you must record a description of these weather conditions at the start of the application.
- » If wind and weather conditions change significantly while you are spraying you need to record these changes.

## Records must be made in English

If the EPA's Pesticides Regulation 2009 requires you to make a record you must do so within 24 hours of applying the pesticide.

If you already keep records for other purposes (e.g. for the winery you are supplying), you can simply add to that record any of the requirements listed above that are not already in that record.

If under EPA's Pesticides Regulation 2009 you are required to make a record, you must keep that record for three years. If you are the owner or the person who has the management or control of the property on which you or your employees applied the pesticide, you are responsible for keeping the record.

\* If you applied the pesticide yourself, then it is your responsibility to make the record. You can get someone else to write it down for you but it is up to you to make sure the record is made and that it is accurate. If you employed someone to apply the pesticide then that person must record their name as well as your name, address and contact details as their employer. If the pesticide was applied by a contractor, the contractor must record their own name, address and contact details, the name, address and contact details of the owner or the person who has the management or control of the land where the pesticide was applied. You only have to record this additional information if the person who owns or manages the property and the person who applied the pesticide are different. See EPA's example record keeping form (Spray Diary) opposite.

# Pesticides: Example record keeping form

**Note:** It is not compulsory to use this format. If you use a short name for something in filling out this form, you must write the full name somewhere else such as a book or farm diary.

Pesticides application record sheet. Record the name, address and contact details of the owner or occupier of the land where the pesticide was applied:										
Date, start and finish time	Operator details	Crop or place where pesticide was applied	Type of equipment used	Name of pesticide used	Amount of concentrated product used	Total quantity applied	Size of block sprayed	Order blocks were treated	Estimated wind speed and direction	Other weather details
		 Also record spray spraying of fallow land and any pesticides used in and around crops*		 Record all the pesticides you used.	 If you mixed two pesticides together, you can record both on the same form.	 Total amount of water, oil or other things mixed with concentrated product.	 Refer to your farm map**	 Write which block was sprayed first, second, third, etc.	 If these conditions change significantly during spraying then also record the changes.	 Only if they are specified on the label or APVMA permit
									Speed	Direction

\* It is not compulsory to record the pest or disease but it is recommended as part of good operating practices.

\*\* A farm map is recommended because it would make recording this information easier.

**(Records must be in English)**

**Table 1. Post-emergent herbicides registered in NSW for use in vineyards. Read the product label before use.**

Chemical (Poisons Schedule)	Trade names	Herbicide Group	WHP Days	Rates	Weeds controlled	Comments
Amitrole 250 g/L (S5)	SabakelM, Imtrade Nufarm Amitrole T Farmalinx Amitaz, Aw Aggrav8	Q	56	4–12L/ha	Broadleaf weeds and grasses	<ul style="list-style-type: none"> <li>» Apply when weeds are small and making active growth.</li> <li>» Repeat application may be necessary in 6–8 weeks.</li> <li>» Apply as directed spray to weeds only. Use higher rates for larger or more tolerant weeds.</li> <li>» For improved control of tillered annual grasses.</li> <li>» DO NOT apply as a spray near trees or vines less than 3 years old, unless they are effectively shielded from spray and spray drift.</li> <li>» DO NOT allow spray or drift to contact green bark or stems, canes, laterals, suckers, fresh wounds, foliage or fruit.</li> </ul>
Amitrole + Paraquat (S7)	Alliance – 250g/L Amitrol + 125g/L Paraquat	Q + L	Not req when used as directed	3–4L/ha or 400mL per 100L as a spot spray	Young seedling plants only of: Annual ryegrass (including glyphosate resistant biotypes), Brome grass, Barley grass, Capeweed, Indian hedge mustard, Turnip weed, Volunteer cereals – barley, oats, triticale, wheat, Wild oats, Wild radish. Plus: Barnyard grass (max early tillering), Bladder ketmia, Cowvine, Grapesbill, Dove's foot, Dwarf amaranth, Fleabane (max 6 leaf) Field peas, Goosefoot, Marshmallow Medics, Mignonette, Paterson's curse, Soursob, Speedwell (not ivy-leaf), Stonecrop, Storksills, Sub-clover Thistles – artichoke, milk/sow, spear, stemless, variegated, Three cornered Jack, Volunteer cotton, Volunteer canola (including Roundup Ready® varieties), Wireweed, Wild lettuce	<ul style="list-style-type: none"> <li>» Spray young weeds during late winter to spring–summer as required.</li> <li>» Use higher rate for spring application. Can be combined with residual herbicides for longer term control.</li> <li>» Does not require additional wetter unless spraying at high volume.</li> <li>» Where Amitrole + Paraquat is mixed with water at less than 400 mL/100 L of water, add 100 mL Shinwet® 600 or 60 mL BS1000 per 100 L of spray.</li> <li>» Spot spray rate assumes a total volume of 1000 L/ha. For lower water volumes increase dilution rate as below: water volume 250L/ha: use 1.6 L/100L watervolume 500L/ha: use 800mL/100L water volume 750 L/ha: use 530 mL/100 L.</li> </ul>
Carfentrazone-ethyl 240 g/L + (unscheduled)	Para-Trooper, Paraaglide ≠ 10g/L Amitrol + 250g/L Paraquat Spotlight Plus, Carfentrazone 240 EC, Elevate, Hammer 400 EC, Nail 240 EC, Spotlight Plus	G		1.7 L/sprayed ha 25– 75 mL/ha plus recommended label rates of knock-down herbicides Spot spray 10 mL/100 L plus recommended label spot spray rates of knockdown herbicides	Australian crassula/Stonecrop, Capeweed, Chickweed, Common storksbill (max 4 leaves), Doublegee / Spiny emex / Three cornered Jack, Marshmallow, Paterson's curse, Sub. Clover, Wild radish	<ul style="list-style-type: none"> <li>» If Fat Hen or <i>Portulaca</i> spp. are present and Imtrade Para-Trooper Herbicide rate is less than the ratio 800 mL/100 L Imtrade Penetrate Wetter per 100 L spray mix.</li> <li>» Apply as a tank mix with glyphosate paraquat.</li> <li>» Addition of Spotlight Plus to knockdown herbicides will increase the speed at which treated broadleaf weeds in general develop visible symptoms (compared with results achieved with knockdown herbicides applied alone) and may improve final control of broadleaf weeds, including certain hard-to-kill weeds (marshmallow in particular).</li> <li>» The use of higher rates and full soil disturbance may improve control of marshmallow in particular. Use the lower rates on younger plants or plants growing under good conditions and the higher rates on older plants or plants growing under less optimum conditions.</li> <li>» The lower rate may only provide suppression of Capeweed, Wild radish, Common storksbill and Doublegee under poor growing conditions.</li> <li>» Application to hardened weeds or drought stressed weeds especially under summer conditions may cause only localised injury to weed foliage which may not enhance final weed control.</li> </ul>
Diflufenican 25 g/L Bromoxynil 250 g/L (S5)	Bentley, Colt, Cougar, Difluken B, Jaguar	C + F	Not req when used as directed	500 mL–1 L	Certain broadleaf weeds in cover crops	<ul style="list-style-type: none"> <li>» Apply during vine dormancy only. Avoid contact with vines.</li> <li>» Particular care should be taken if applied in late autumn or early spring, when vines may not be fully dormant. Apply from early post-emergence and when weeds are actively growing.</li> </ul>
Diquat 200 g/L (S6)	Regione, Diquat 200, Desiquat, Dia-Kill 200, Ozcrop diquat 200	L		1.5L + 1.4L Agralin 700L water/ha plus 1.6L/ha Paraquat 250 (S7)	Capeweed	<ul style="list-style-type: none"> <li>» Apply as a directed spray under trees or vines.</li> <li>» Under most conditions Gramoxone 250 at 1.6 to 3.2 L/ha or Spray Seed 250 at 2.4 to 3.2 L/ha will give effective control of grasses and broadleaf weeds in orchards, but where heavy infestations of capeweed occur Diquat 200 should be added to Gramoxone 250 at the rate of 1.5 L/ha.</li> <li>» For inter-row or around butts use high-volume applications. Gramoxone 250, Spray Seed 250 and Diquat 200 have no effect on brown bark, but care should be taken when spraying around trees to avoid spray contacting green bark or plant material.</li> </ul>

Chemical (Poisons Schedule)	Trade names	Herbicide Group	WHP Days	Rates	Weeds controlled	Comments
Diquat + Paraquat (S7)	agVantage Di-Par 250, Agmate Paraquat & Diquat 250 SL, Spalding Exocet 250, Spray, Seed 250	L	7	Boom: 2.4 to 3.2 L/ha Spot spray 240 to 320 m	Most Annual Grasses and Broadleaved Weeds	<ul style="list-style-type: none"> <li>For spot spraying and when volume of water applied exceeds 200 L/ha add a wetter at 120 mL/100 L of additional water.</li> <li>Thoroughly wet plant foliage. Use the high rate for dense more established weed growth. Repeat treatment on regenerated green perennial weeds (such as Paspalum and Docks) while plants are weakened from previous treatment.</li> <li>Addition of at Oxyfluorfen 240 ml/ha will improve control of Small Flowered Mallow, Evening Primrose and other weeds sensitive to Oxyfluorfen. Refer to the Oxyfluorfen product label.</li> <li>Vines must be at least 4 years old. DO NOT exceed 10 kg/ha per year</li> <li>Apply as a direct spray into vine rows.</li> <li>Half rate at 10 to 14 day intervals.</li> </ul>
2,2-DPA-sodium 740 g/kg	Ag spray Ahtapon Dalapon 740 SP, Propon	J	7	Boom: 10 kg per sprayed hectare	Couch, Kikuyu, Johnsons grass	<ul style="list-style-type: none"> <li>Apply in not less than 200 L/ha. Direct the spray to the base of the vine.</li> <li>Withholding period: 4 weeks.</li> <li>Young growth is most susceptible at 5 leaves to early tillering when actively growing. Higher rates may be required for more advanced plants. Suppression is only beyond the 5-leaf stage.</li> <li>Use the higher rate for well-established infestations or where greater control is required in one season.</li> <li>Or consider a double knock of Spray/Seed followed by Fluazifop-P when fresh growth has emerged – may be necessary for couch control.</li> <li>Note: Tank mixes of Fluazifop-P are not recommended, and there should be a minimum of 3 days before any other herbicide is applied.</li> <li>Fluazifop-P does not control winter grass or silver grass.</li> </ul>
Fluazifop-P 128 g/L (S6)	Fusilade Fort, Fuzilier, Rootout 212	A	28	1.65 L/ha 2.5 L/ha 3.3 or 6.6 L/h	Growing actively at 5-leaf to early tillering: Annual (Wimmera) ryegrass, Barley grass, Barnyard grass, Brome grasses, Crowsfoot grass, Johnson grass, Liverseed grass, Prairie grass, Summer grass (Crabgrass), Wild oats Growing actively at 5-leaf to early tillering: Innocent weed and Stinkgrass Growing actively at 3- to 5-leaf stage: Foxtail (TAS) seedlings (Setaria spp.), Pigeon grass Young vegetative growth (3–6 leaves per shoot) when actively growing. Established plants of couch grass, English couch (rope twitch), Water couch, Johnson grass, Paspalum, Bent grass and Kikuyu grass.	<ul style="list-style-type: none"> <li>Apply as a directed or shielded spray. Refer to the label section Application for specific information on application methods.</li> <li>Warnings: <ul style="list-style-type: none"> <li>Do not allow spray or spray drift to contact desirable foliage or green (uncalcoused) bark. To avoid potential crop damage, refer to the label sections on Application and protection of crops, native and other non-target plants.</li> <li>Glufosinate-ammonium may be used around trees/vines less than two years old provided they are effectively shielded from spray and spray drift</li> </ul> </li> <li>Weed species</li> <li>Apply the appropriate rate to control the least susceptible weed present as per the lists of weeds controlled in the labels tables.</li> <li>Weed stage of growth</li> <li>Use the lower rate when weeds are young and succulent (grasses: pre-tillering; broadleaves: cotyledons to 4-leaf) or the population is very sparse.</li> <li>A median rate should be used for medium sized plants (grasses: tillering; broadleaves: 4 leaf to advanced vegetative) and the high rate should be used when weeds are mature (grasses: nodding to flowering; broadleaves: budding to flowering).</li> <li>Climatic conditions</li> <li>Best results are achieved when applied under warm humid conditions (temperatures below 33°C with a relative humidity above 50%). Control will be reduced and/or slower under cold conditions. Good results will be achieved under most other conditions, however poor results may occur under hot, dry conditions.</li> <li>Weeds that have been hardened or stunted in growth due to stressed conditions should be treated at the maximum rate.</li> <li>For Weed Density, Coverage and Perennial Weeds see label.</li> </ul>
Glufosinate-ammonium (S5)	Basta, Biffo, Cease, Exile, Exonerate, Exonerate 200 SL, Fascinate 200 SL, Fester-TG 200, Fiestar, Glufosinate 200, Glufosinate-Ammonium 200, Muster, Kelpie	N	21	1 – 5 L/ha The recommended rate of use is determined by the following criteria: Weed species Weed stage of growth Weed density Climatic conditions	<p><i>Amaranthus</i> spp., Apple of Peru, Argentine peppergrass, Avnless barnyard grass, Barley grass, Barnyard grass, Billy goat weed, Bitter cross, Black bindweed (buckwheat), (refer Note 2), Bladder kerria, Bordered panic, Brome grasses (refer Note 1), Calopo, Caltrop burr, Cape weed, Clover (subterranean), Cobbler's peg, Common storksbill, Crowsfoot grass, Dead nettle, Dwarf crumbweed, Fat hen, Flax-leaf fleabane, Fumitory, Green crumbweed, Lesser canary grass, Liverseed grass, Medics (annual), Milk thistle, Mint weed, New Zealand spinach, Patterson's curse, Peanuts, Pigweed, Pinkburr, Potato weed, Prairie grass, Prickly lettuce, Red natal grass, Ryegrass (annual), Saffron thistle, St. Barnaby's thistle, Sago weed, Scarlet pimpernel, Setaria, Sheep thistle, Silver grass, Sorghum/sudax, Square weed, Stagger weed, Star of Bethlehem, Summer grass, Thickhead, Three cornered jack, Tomato, Townsville stylo, Turnip weed, Variegated thistle, Wheat, Wild carrot</p>	<ul style="list-style-type: none"> <li>Apply as a directed or shielded spray. Refer to the label section Application for specific information on application methods.</li> <li>Warnings: <ul style="list-style-type: none"> <li>Do not allow spray or spray drift to contact desirable foliage or green (uncalcoused) bark. To avoid potential crop damage, refer to the label sections on Application and protection of crops, native and other non-target plants.</li> <li>Glufosinate-ammonium may be used around trees/vines less than two years old provided they are effectively shielded from spray and spray drift</li> </ul> </li> <li>Weed species</li> <li>Apply the appropriate rate to control the least susceptible weed present as per the lists of weeds controlled in the labels tables.</li> <li>Weed stage of growth</li> <li>Use the lower rate when weeds are young and succulent (grasses: pre-tillering; broadleaves: cotyledons to 4-leaf) or the population is very sparse.</li> <li>A median rate should be used for medium sized plants (grasses: tillering; broadleaves: 4 leaf to advanced vegetative) and the high rate should be used when weeds are mature (grasses: nodding to flowering; broadleaves: budding to flowering).</li> <li>Climatic conditions</li> <li>Best results are achieved when applied under warm humid conditions (temperatures below 33°C with a relative humidity above 50%). Control will be reduced and/or slower under cold conditions. Good results will be achieved under most other conditions, however poor results may occur under hot, dry conditions.</li> <li>Weeds that have been hardened or stunted in growth due to stressed conditions should be treated at the maximum rate.</li> <li>For Weed Density, Coverage and Perennial Weeds see label.</li> </ul>

Table 1. Post-emergent herbicides registered in NSW for use in vineyards.

Chemical (Poisons Schedule)	Trade names	Herbicide Group	WHP Days	Rates	Weeds controlled	Comments
Glyphosate 360 g/L present as ipa and/or mono-ammonium salts (S5)	Acencis 360, Banish 360, BioChoice 360, Country Glyphosate 360, Glyphosate 360 SL, Gladiator, Glistar 360, Glyphosate 360, Aquatic 360, Pestmaster Aqua-Tech 360, Roundup Blactive, Santos 360, SquareDown 360, Weedmaster Duo, Wipe-Out 360, Wipe-Out Bio	M	Not req when used as directed	Annual weeds: Boom: 2–3 L per sprayed hectare Perennial weeds: Boom: 3–9 L per sprayed ha Weed-wiping equipment: 1 L mix: 2 L water	Broad spectrum. Hard-to-kill perennials (Couch, Paspalum, etc.) require higher rates. Use low rates where weeds are less than 15 cm high	<ul style="list-style-type: none"> <li>» Apply as a directed or shielded spray or using wiper equipment.</li> <li>» Do NOT apply as a spray near or vines less than 3 years old unless they are effectively shielded from spray and spray drift.</li> <li>» Do NOT allow wiper surface to contact any part of the vine.</li> <li>» Do NOT allow spray or spray drift to contact green bark or stems, canes, laterals, suckers, fresh wounds, foliage or fruit.</li> <li>» Do NOT allow wiper equipment to contact vines.</li> </ul>
Glyphosate– ipa/mas 450 g/L (S5)	AllOut 450, ClearUp 450, Eradicator 450, Glistar 450, Glymont 450, Glyphos classic 450, Glyphosate 450 Glyphosate 450 CT, Glyphosate 450 SL	M	Not req when used as directed	Annual weeds: Boom: 1.6–2.4 L per sprayed hectare Perennial weeds: Boom: 2.43–4.8 L per sprayed ha		
Glyphosate ipa/mas 540 g/L (S5)	Credit, Sickle 540	M	Not req when used as directed	Annual weeds: Boom: 1.35–2 L per sprayed hectare Perennial weeds: Boom: 2–4 L per sprayed ha		
Glyphosate- ipa 432g/L + carfentrazone-ethyl 7. g/L (S5)	Broadway	M + G	Not req when used as directed	850 mL – 2.5 L/ha	Australian Grassula/Stonecrop, Capeweed, Chickweed, Common storkbill (max. 4 leaves) Doublegee / Spiny emex / Three cornered jack, Marshmallow, Paterson's curse, Sub. clover, Wild radish	<ul style="list-style-type: none"> <li>» The use of higher rates and full soil disturbance may improve control of small, flowered mallow in particular.</li> <li>» Use the lower rates on younger plants or, plants growing under good conditions and the higher rates on older plants or plants growing under less optimum conditions.</li> <li>» When using Broadway Herbicide as a spot-spray, apply in sufficient water (minimum, 500 L/ha) to thoroughly wet all weed foliage to the point of run-off.</li> <li>» Addition of standard rates of a non-ionic surfactant may improve weed control.</li> <li>» DO NOT allow spray or spray drift to contact green bark or stems, canes, laterals, suckers, fresh wounds, foliage or fruit.</li> </ul>
Haloxypop-R-methyl 520 g/L (S6)	Verdict, Haloxypop, Jasper, V Agro-Essence, Convict, Evert, Firepower, Haloxypop, Haloxyken, Hermes, Recon	A	Not req when used as directed	Annual grasses: 200 mL/ha Perennial grasses: Couch, Rhodes, slender rats tail 400–800 mL/ha <i>Paspalum</i> spp., kikuyu, buffel grass, Johnson, <i>Serripa</i> spp 200–400 mL/ha	Perennial grasses: Couch Rhodes grass, Slender rats tail grass, Buffel grass, Green panic, Johnson grass, Kikuyu, <i>Paspalum</i> spp., <i>Serripa</i> spp Annual grasses: Annual ryegrass, Bairy grass, Barnyard grass, Brome grass, Crowsfoot grass, Lesser canary grass, Liverseed grass, Mossman river grass, Paradoxa grass, Summer grass, Volunteer cereals, Wild oats	<ul style="list-style-type: none"> <li>» Spray should be directed to base of vine. Avoid contact with fruit and foliage.</li> <li>» When using perennial rates, annual grasses are also controlled.</li> <li>» Spot spray: Use 25 mL to 50 mL/100 L of water. Use higher rate on late tillering mature grasses.</li> </ul>
Haloxypop-R-methyl 130 g/L (S6)	Asset, Gallant, Judgement,	A	Not req when used as directed	Annual grasses: 800 mL/ha Perennial grasses: Couch: 1.6–3.2 L/ha Paspalum, Johnson grass: 0.8–1.6 L/ha		

Chemical (Poisons Schedule)	Trade names	Herbicide Group	WHP Days	Rates	Weeds controlled	Comments
Oxyfluorfen, 240 g/L	Goal, Point Herbicide, Striker	G+M	Not req when used as directed	75 mL/ha plus a glyphosate product at its recommended label rate	Refer to label of the glyphosate product (such as Ripper™, 480, Roundup®, Roundup C®, PowerMax®, Touchdown® or Touchdown HiTech®)	<ul style="list-style-type: none"> <li>» Addition of Oxyfluorfen to glyphosate products will improve knockdown and increase the speed at which treated weeds develop visible symptoms of phytotoxicity (compared to results achieved with glyphosate applied alone) and give control of annual nettles, (<i>Urtica</i> spp.), barley grass, Paterson's curse, small-flowered mallow and storkbill.</li> <li>» For rates of glyphosate, refer to the appropriate label. Read and follow all label directions.</li> <li>» DO NOT apply the tank mix of glyphosate and Oxyfluorfen near trees or vines less than 3 years old unless they are effectively shielded from spray and spray drift.</li> </ul>
Paraquat 135 g/L + Diquat 115 g/L (S7)	Spray Seed 250 Blowout, Brown Out 250, Combik 250, Di-Par 250, EOS, Kwicknock 250, Paraquat/Diquat, Paraquat + Diquat 250, Pre-Seed 250, Revolver, Scorch 250, Speedy 250, Spray & Sow, Spray Out 2500	L	Not req when used as directed	250 mL/ha plus a paraquat or diquat/paraquat product at its recommended label rate  Spot spraying: 240–320 mL/100 L. Add 170 mL Agral or 100 mL BS1000 per 100 L  Boom: 2.4–3.2 L/ha. If volume of water applied exceeds 200 L/ha, add 200 mL Agral or 120 mL BS1000 per 100 L of additional water.	Refer to label of the paraquat or diquat /paraquat products (such as Spray, Seed® or Tryquat® 200)  Broad spectrum: For rapid kill of a wide range of annual grasses and broadleaf weeds see label.	<ul style="list-style-type: none"> <li>» Addition of Oxyfluorfen in a tank mix with a paraquat or diquat/paraquat product will improve control of small flowered mallow, evening primrose and other weeds sensitive to Oxyfluorfen. For the rate of the paraquat or diquat/paraquat product, refer to the appropriate label. Read and follow all label directions.</li> <li>» Thoroughly wet plant foliage. Use the high rate for dense, more established weed growth. Repeat treatment on regenerated green perennial weeds (such as paspalum and docks) while plants are weakened from previous treatment.</li> <li>» Addition of Spak at 250 mL/ha will improve control of small-flowered mallow, evening primrose and other weeds sensitive to Spak. Refer to the Spak label.</li> <li>» Note: Spot spray rate assumes 1000 L water/ha. For lower water volumes increase dilution rate as below: water volume 250 L/ha: use 960 to 1280 mL/100 L water volume 500 L/ha: use 480 to 640 mL/100 L water volume 750 L/ha: use 320 to 430 mL/100 L</li> <li>» OR Measure how much spray is required to cover an area of 100 m<sup>2</sup> using your normal application volume.</li> <li>» Your dilution rate is 24 to 32 mL of Paraquat+Diquat 250 in this volume.</li> </ul>
Paraquat (S7)	Gramoxone 250, Nuqua 250t Explode 250, Nuquat 250, Paradox 250, Para-Ken 250, Para-Ken 334, Paraquat 250, Paraquat 250 SL, Shirquat 250, Sinnosa 250, Sprayquat 250, Spraytop 250SL, Uniquat 250	L	Not req when used as directed	Knapsack: 50 mL Paraquat plus 30 mL non-ionic wetter/15 L (add 30 mL diquat if capeweed is present)  Boom: 1.7 L/ha  Add diquat if capeweed is present. See label for rates.	Broad-spectrum annual weed control. Most active against grasses. See label for rates at increased wetting agent where Fat hen and <i>Pottuliza</i> spp. are present.	<ul style="list-style-type: none"> <li>» Spray as necessary for control of annual weeds.</li> <li>» Avoid contacting crop foliage.</li> <li>» Apply soon after weed emergence and before weeds reach 15 cm in height.</li> <li>» Use spraying pressure less than 240 kPa.</li> <li>» Repeat sprays as required. Paraquat 250 will not harm vines with mature brown bark.</li> <li>» Use the higher rate for dense weed growth.</li> <li>» If product rate is less than 400 mL/100 L, add 100 mL Agral or 60 mL BS1000/100 L of spray mix.</li> </ul>
Pine oil (S6)	BioWeed	unspecified	0	1/4 L water	Broad-spectrum nonselective weed control.  Claims to act as a pre-emergent and weed seed killer (not on label)	<ul style="list-style-type: none"> <li>» This product does not work in the same manner as a petiochemical herbicide and failure to change your approach to application may lead to disappointing results.</li> <li>» Ensure that all weed foliage is totally covered with spray as Pine oil is a contact spray only. Partial coverage will only give partial control.</li> <li>» Use a foaming nozzle or spraying tips which apply 2 L per minute.</li> <li>» A water volume of 600L/ha is recommended or 1litre BioWeed™ to 4 litres water.</li> </ul>
Quizalofop-P-ethyl 100, 200, 250 & 480g/L (S6)	Atomic Selective Herbicide, Eiantra, Eiantra Xtreme, Leopard, Leopard 200 EC, Quinella 100 EC, Quinella Upgrade, Quiz, Quizalofop-P-ethyl 200 EC, Sextant, Tiger, Tiger Gold 250, Triflen 480	A	Not req when used as directed	See label for directions	Selected post-emergent systemic grass control. For details on control of <i>Awnless Barnyard</i> , <i>Crowsfoot</i> , <i>Paspalum</i> , <i>Johnson Grass</i> and <i>Kikuyu</i> , see label	<ul style="list-style-type: none"> <li>» Apply when weeds are actively growing.</li> <li>» Use a minimum of 800L of prepared spray/ha.</li> <li>» Thoroughly wet target weeds (especially well established clumps) without causing run off.</li> <li>» Repeated sprays may be necessary for perennial grass species.</li> <li>» Always add a surfactant/wetting agent at the recommended rate – see label on 'Use of Surfactant/Wetting agent' for details.</li> </ul>

Table 1. Post-emergent herbicides registered in NSW for use in vineyards.

Chemical (Poisons Schedule)	Trade names	Herbicide Group	WHP Days	Rates	Weeds controlled	Comments
Quizalofop-P-ethyl 120 g/L (S6)	Pantera	A	Not req when used as directed	125–250 mL/100L	Amless Barnyard Grass, Crowfoot Grass, Kikuyu, Paspalum, Johnson Grass	<ul style="list-style-type: none"> <li>» Apply when weeds are actively growing.</li> <li>» Use minimum of 800L of prepared spray/ha.</li> <li>» Thoroughly wet target weeds (especially well established clumps) without causing run off.</li> <li>» Repeated spraying may be necessary for perennial grass species.</li> <li>» Always add a surfactant/wetting agent at the recommended rate — see section on 'Use of Surfactant/Wetting agent' for details</li> </ul>

**Table 2. Residual herbicides registered in NSW for use in vineyards: Long-term pre-emergent control of a range of weeds depending on rate, soil and moisture. Read label before use**

Chemical	Trade names	Herbicide Group	WHP Days	Rates	Weeds controlled	Comments
Dichlobenil 67.5g/kg (S6)	Casoron G	0	Not req when used as directed	60–90 kg/ha (treated hectare (2 m × 5 km)	Annual grasses and broadleaf weeds	<ul style="list-style-type: none"> <li>» For bearing and non-bearing vines.</li> <li>» Spread granules evenly over the soil of the area to be treated.</li> <li>» Remove existing weeds by hand, desiccation or cultivation.</li> <li>» Use higher rate on heavier soils.</li> </ul>
Isoxaben 750 g/kg (S5)	Gallery 750	0	Not req when used as directed	375–750 g/ha	Amaranth, Bittercress, Black nightshade, Capeweed, Clover, Fat Hen, Flatweed, Hedge mustard, Malow, Milk thistle, Paterson's curse, Plantain, Scarlet pimpernel, Wild radish, Wireweed Isoxaben has negligible activity on grasses	<ul style="list-style-type: none"> <li>» Apply to weed-free, even soil surface.</li> <li>» Needs moisture via rainfall or irrigation within 21 days of application to be activated.</li> <li>» Mix with pendimethalin or oxyzin to provide additional grass weed control.</li> </ul>
Napropamide 500 g/kg (Unscheduled)	Devimol WG	K	Not req when used as directed	4.5 kg/ha – light to medium soils 6.7 kg/ha – heavy clay soils apply in 500–1000L of water/ha as a band spray	Annual ryegrass, Barnyard grass, Crowsfoot grass, Innocent weed, Liverseedgrass, Pigweed, Potato weed, Redshank, Sowthistle, Stinkgrass, Summer grass, Winter grass	<ul style="list-style-type: none"> <li>» Soil must be free of weeds and trash and must have a fine tith</li> <li>» Apply in 500–1000 L of water/ha</li> <li>» Apply as a directed band spray, avoiding contact with fruit or foliage.</li> <li>» In irrigated areas apply in early spring and follow with sprinkler irrigation to 5 cm soil depth within 10 days of application.</li> <li>» In non-irrigated winter rainfall areas apply late autumn/winter and mechanically incorporate, within 10 days. If rainfall exceeds 20 mm during this 10-day period, mechanical incorporation will be unnecessary.</li> </ul>
Norfurazon 800 g/L (Unscheduled)	Zolar 800 DF, Zolar DF	F	Not req when used as directed	2.5 kg/ha	Annual Ryegrass, Bailey Grass, Blackberry Nightshade, Brochiana Galtrop, Capeweed, Chickweed, Common Sowthistle, Dandelion seedlings, Curled Dock seedlings, False Caper seedlings, Fat Hen, Indian Hedge Mustard, Spiny Burgrass, Medic, Hedge Mustards, Paspalum, Paterson's curse, Plantain seedlings, Portulaca, Prairie Grass, Prickly Lettuce, Great Brome, Scarlet Pimpernel, Shepherd's Purse, Silver Grass, Skeleton Weed seedlings, Sorrel seedlings, Soursob, Stinkgrass, Stinking Roger, Subterranean Clover, Summer Grass, Three-cornered Jack Yategated Clover, Wild Oats, Wild Radish, Wild Turnip, Winter Grass, Wireweed, Witch Grass, Yellow Weed, Yorkshire Fog Grass Couch Grass+, Dandelion, Curled Dock, False Caper, Johnson Grass+, Skeleton Weed, Sorrel, Soursob Pigweed (Portulaca)	<ul style="list-style-type: none"> <li>» Apply using a boom spray to bare ground before weed emergence. Apply as a directed spray in 300 to 500 L water/ha</li> <li>» Avoid contact with foliage or fruit.</li> <li>» An application in early autumn will give winter weed control, or in early to midspring will give full summer weed control.</li> <li>» Not recommended for grapes grown in sand or loamy sand soils with less than 1% organic matter and pH greater than 7.5, as vernal chlorosis may occur.</li> <li>» Do not apply to nursery stock.</li> <li>» Do not use more than 5 kg/ha each year</li> <li>» When specific weeds are present as a major pest they will be more effectively controlled by tank mixes of ZOLIAR 800 plus Simazine.</li> </ul>
				5.0 kg/ha		
				1.25 kg/ha ZOLIAR plus 2.0 L/ha Simazine 500 g/L		
				1.9 kg/ha ZOLIAR + 2.0 L/ha Simazine 500 g/L		
					Barnyard Grass, Clammy Goosefoot, Cobbler's Pegs, Green Pigeon Grass, Redroot Amaranth, Summer Grass, Wireweed	

Chemical	Trade names	Herbicide Group	WHP Days	Rates	Weeds controlled	Comments
Oryzalin 500 g/L (Unscheduled)	Surflan 500, Flowable Oryzalin, Stonevall, Accensi Oryzalin, Ospray Oryzalin, Agricrop Prolan, Sharp Shooter, Rygel Oryzalin, Genfarm Oryzalin	D	Not req when used as directed	4.5 L/ha – up to 4 months' weed control 6.8 L/ha – 6–8 months' weed control Use 200–450 L water/ha	Grasses: Barnyard Grass, Guinea Grass, Love Grass, Paradoxo Grass, Pigeon Grass, Spiny Burr (Gentle Annie/ Innocent Weed), Summer Grass, Crabgrass Broadleaf Weeds: Deadnettle, Fathen, Fumitory, Portulaca (Pigweed) Sowthistle, Wireweed (Hogweed) Brassica spp. Blackberry Nighthshade, Caltrop, Paddy melon, Silver Leaf Nighthshade Controls Many Annual Grasses And Broadleaf Weeds <b>Before germination:</b> Amisnickia, Barley grass, Barnyard grass, Blackberry nighthshade, Bladder kermia, Burrgrass, Caltrop, Capeweed, Chickweed, Crowfoot grass, Deadnettle, Fat hen, Giant pigweed, Liverseed grass, Lovegrass, Pigeon grass, Pigweed, Prickly lettuce, Red Natal grass, Redshank, Ryegrass, Sesbania pea, Shepherd's purse, Small flowered mallow, Soursob, Sow thistle, Starburr, Stinkgrass, Summer grass, Thornapple, White eye, Wild mustard, Wild radish, Wireweed <b>Seedlings:</b> Amisnickia, Bellvine, Capeweed Common, cotula, Crowfoot grass Deadnettle, Groundsel, Liverseed grass, Pigweed, Potato weed, Redshank, Shepherd's purse, Sow thistle, Stinging nettle, Stinkgrass, Wild radish.	<ul style="list-style-type: none"> <li>» Suitable for nurseries and newly planted and established vineyards.</li> <li>» For best results, if irrigation or rain is not expected within 21 days after application, then mechanically incorporate into the top 2.5 cm of soil.</li> <li>» Soil must be free of weeds, of good tilth, and firm.</li> </ul>
Oxyfluorfen 240 g/L (S5)	Goal, Point Herbicide, Spark, Striker	G	Not req when used as directed	Weed-free soil: 3–4 L/ha  Emerged weeds present (4–6 leaf stage)	<ul style="list-style-type: none"> <li>» Weed-free soil: apply to freshly worked weed-free soil. Use the higher rate when longer residual control is required (up to 4 months).</li> <li>» Where grass weeds are expected to be a major problem, or when control of a wider weed spectrum is required, mix the lower rate with 4.5 L Oryzalin 500 per treated hectare.</li> <li>» Use the higher rate when longer residual activity (up to 4 months) is required. When young seedling grasses and/or broadleaf weeds are present, apply as a tank mix with certain post-emergent herbicides to produce both knockdown and residual control.</li> <li>» A non-ionic surfactant should be used in the spray mixture at 100 mL/100 L.</li> <li>» Mature established weeds must be eliminated by mechanical or chemical means before application. See label for more details.</li> </ul>	
Pendimethalin (S5)	Argo 440EC, Cronos 440EC, Cyclone 330 EC, Fiat 330, Panida Grande, Pendimethalin 330, Pendimethalin 330EC, Rifle 330, Rifle 440, Romper 440 EC, Stomp 440	D	Not req when used as directed	See label for directions	<ul style="list-style-type: none"> <li>» Annual Ryegrass, Asthma Plant, Barnyard Grass, Chickweed, Caltrop, Cobbler's Pegs, Crowfoot grass, Deadnettle, Dwarf Amaranth, Fat Hen, Deadnettle, Green Amaranth, Pigeon Grass, Pigweed, Prickly Lettuce, Sowthistle, Spotted Medic, Stinking Roger, Summer Grass, Winter Grass, Wireweed</li> </ul>	<ul style="list-style-type: none"> <li>» Do not apply oxyfluorfen once bud swell has occurred.</li> <li>» Use the higher rate when longer residual control is required (up to 4 months).</li> <li>» When young seedling grasses and/or broadleaf weeds are present, apply as a tank mix with glyphosate or paraquat or diquat/paraquat to obtain both knockdown and residual control.</li> <li>» A non-ionic surfactant such as BS-1000 should be used at 0.1% v/v.</li> <li>» Read and follow all label directions.</li> <li>» Where weed growth is large and dense, weeds must be eliminated prior to application of Oxyfluorfen, using chemical or mechanical means</li> </ul>
					<ul style="list-style-type: none"> <li>» Do not apply pendimethalin to grapevines after bud swell.</li> <li>» Precaution: pendimethalin or pendimethalin plus simazine are likely to affect the emergence and growth of green manure crops if they are sown into the treated band within 12 months of application.</li> <li>» Use the higher rate on medium to heavy textured soils and the lower rate on light textured soils.</li> <li>» Use a directed spray avoiding spray contact with green bark, fruit and foliage. If applied to freshly transplanted trees or vines, soils should be compacted prior to application of pendimethalin to avoid contact with roots.</li> <li>» Pendimethalin must be incorporated by a minimum of 5 mm of rainfall or spray irrigation as soon as possible but no later than 10 days after application or weed control may be reduced.</li> <li>» For best results, soil surface should be free of weeds, surface litter and clods at the time of application.</li> <li>» If small weeds are present at the time of application Pendimethalin should be tank mixed with a knockdown herbicide at the recommended rate.</li> <li>» Crop damage and/or reduced weed control may result if pendimethalin is not incorporated successfully. If insufficient rainfall follows within 10 days after application the product must be incorporated over the whole surface area treated through the use of overhead sprinklers or by mechanical means, using appropriate equipment to avoid root damage.</li> </ul>	

Table 2. Residual herbicides registered in NSW for use in vineyards.

Chemical	Trade names	Herbicide Group	WHP Days	Rates	Weeds controlled	Comments
Simazine 500 g/L (Unscheduled)	Simazine 500, Simazine 500 Flowable, Simazine 500 SC, Gesatop 500 SC	C	Not req when used as directed	<b>Boom</b> 2.3–4.5 L/ha. Use 2.3 L/ha on sandy alkaline soils and 4.5 L/ha on heavy soils. In first year of use split applications are preferred.	Annual Weeds and Grasses. Annual Ryegrass, Annual Thistles, Barley Grass, Biny-Eye, Brome Grass, Capeweed, Chickweed, Common Sowthistle, Creeping Oxalis, Fat Hen, Geranium, Ivy-Leaf Speedwell, Nettles, Potato Weed, Powell's Amaranth, Redroot Amaranth, Redshank, Shepherd's Purse, Slim Amaranth, Wild Mustard, Wild Oats, Winter Grass, Wireweed, (Not TAs) and suppression of Soursob	<ul style="list-style-type: none"> <li>» NOTE most of the 500 and 600 g/L products labels state 'grapevines must be established for 3 years' but please check the label.</li> <li>» In the first year a split application is preferred.</li> <li>» Normally apply to bare, moist soil before weed emergence.</li> <li>» Damage may result from using high rates on sandy soils low in organic matter.</li> <li>» Mechanical incorporation is not necessary, but for best results 13 mm rain or sprinkler irrigation is required within 2 weeks of application to give herbicide activity in soil.</li> </ul>
Simazine 600 g/L (Unscheduled)	Gesatop 600 SC	C	Not req when used as directed	<b>Boom:</b> 1.9 to 3.8 L/ha <b>Use</b> 1.9 L/ha on sandy alkaline soils and 3.8 L/ha on heavy soils. In first year of use, split applications are preferred.		As for above BUT <ul style="list-style-type: none"> <li>» NOTE most of the 900 g/L products labels state 'for vines established more than 12 months of age' or similar, but please check the label.</li> <li>» In the first year split applications are preferred, e.g. use 2.2 kg/ha in July or August and 2.2 kg/ha in October.</li> <li>» Warning: do not use on excessively sandy soils, as crop damage may occur.</li> </ul>
Simazine 900 g/kg (Unscheduled)	Simazine 900 WDG, Simazine 900 WG, Simazine 900DF, Simanex 900 WG, SimaPhos 900, Simaquest 900 WG	C	Not req when used as directed	1.25 kg/ha – light soil 2.5 kg/ha – heavy soil		<ul style="list-style-type: none"> <li>» Mechanically incorporate into soil.</li> <li>» New plantings: apply during pre-plant cultivation.</li> <li>» Apply to established crops in spring after weeds and green manure crop has been ploughed into ground. Refer incorporation label for suitable method of incorporation.</li> </ul>
Trifluralin 480 g/L (S5)		D	Not req when used as directed	1.2 L/ha – light soils 1.7 L/ha – medium soils 2.3 L/ha – heavy soils	Annual ryegrass, Barley grass, Canary grass, Caltrop, Crab grass, Spiny burr grass, Pigweed, Redroot, Redshank, Summer grass, soil surface Wild oats, Winter grass, Wireweed. From seed only: Columbus grass, Guinea grass, Johnson grass, Liverseed grass	<ul style="list-style-type: none"> <li>» Mechanically incorporate into soil.</li> <li>» New plantings: apply during pre-plant cultivation.</li> <li>» Apply to established crops in spring after weeds and green manure crop has been ploughed into ground. Refer incorporation label for suitable method of incorporation.</li> </ul>

**Table 3: Chemical desuckering: Non-selective post-emergent 'knockdown' herbicides registered in NSW for use in vineyards. Read the product label before use.**

Chemical	Trade names	Rates	Weeds controlled	Comments
carfentrazone-ethyl 240 g/L (Unscheduled)	Spotlight Plus	300 mL/100L sprayed to point of run-off. A minimum volume of 50L of spray solution per kilometre of vine row (both sides sprayed) is recommended.	Control of unwanted suckers (water shoots) arising from the main stem or trunk.	<ul style="list-style-type: none"> <li>» Application of Spotlight Plus to suckers (water shoots) arising from the main stem will result in rapid burn down and extended control of regrowth. Any regrowth may be less vigorous but may need a repeat application for season long control. Suckers arising from pruned stubs or roots may be less well controlled. More vigorous varieties and grafted vines on vigorous rootstocks may need several applications depending on the growth conditions.</li> <li>» Preferably apply with a fully-shrouded sprayer designed for the purpose and targeting the basal 60 cm of the trunk. Air-induction, off-centre nozzles such as AirMix OC or similar are preferred to minimise the production of fine, driftable droplets. The optimum nozzle configuration is to have nozzles pointing forwards and backwards to ensure all surfaces of the shoots are sprayed. Use sufficient spray volume to ensure that the spray solution thoroughly wets the foliage and stems of unwanted suckers to the point of run-off.</li> </ul>

# Appendix 4: 'Off label' grapevine permits

All agricultural and veterinary products sold in Australia must be registered for use by the Australian Pesticides and Veterinary Medicines Authority (APVMA). Therefore, in most States, registered products must only be used for those approved purposes that are stated on the label. However, situations do arise whereby chemicals are needed for a use not specified on the label.

In such instances an 'off-label' permit may be obtained through the APVMA Permits Scheme. Such permits allow the use of chemicals legally in ways that are different to the uses specified on the product label and/or allow limited use of an unregistered chemical.

The following table lists the current off-label permits issued for grapevines in various situations. It is essential that you read the conditions attached to the permit prior to use. For example, the permit may have a restriction on permitted uses and States in which it is current. It is advised that you contact your winery or grape purchaser prior to the application of any chemical covered by an off-label permit.

Permits can be downloaded from the APVMA website by clicking on the link or visiting [www.apvma.gov.au](http://www.apvma.gov.au)

Permits can be downloaded from the APVMA website by clicking on the link or visiting [www.apvma.gov.au](http://www.apvma.gov.au)

Permit No.	Permit No.	Expiry date	Condition of use and restriction on use for export wine grapes*
PER14556	Fipronil* meat bait European wasp	31 Mar 2019	Tasmania only – baits to be prepared under direction of Wine Industry Tasmania at specific locations.
PER 14868	Chlorpyrifos* bait European earwig	3 Sep 2019	SA 1 application on the ground (August to October).
PER13859	Dimethoate* – 400 g/L Fruit fly – all species	31 Jul 2024	All states. DO NOT apply more than 2 applications per host crop following harvest. Apply as a foliar and/or ground cover spray to both fallen and retained fruit.
PER13841	Lebaycid Insecticide Spray (fenthion*) Fruit fly – all species	29 Oct 2015	NT, Qld Use no later than 80% capfall.
PER13840	Leybacid Insecticide Spray (fenthion*) Mediterranean fruit fly	29 Oct 2015	WA Use no later than 80% capfall.
PER12770	Glyphosate / Grapevine removal/destruction / Phylloxera	31 Dec 2016	QLD Apply to cut stumps only.

\*Contact your winery/grape purchaser prior to the application of any 1A, 1B, 2B or 3A insecticide.



Flowering in Chardonnay

# Agrochemical update September 2015

The AWRI publication Agrochemicals registered for use in Australian viticulture 2015/2016 ('Dog book') is now available. This agrochemical update summarises the major changes in the 2015/2016 'Dog book' compared with the previous version.

## Timing chemical application to growth stage

The following statement was emphasised on page 3 in the 2014/15 edition to better meet target withholding periods and satisfy export market maximum residue limits (MRL).

**Grapevine growth-stage can be variable across a block. When assessing grapevine phenology for the purpose of applying agrochemicals, base the assessment on the most advanced vines in the block to minimise the possibility of residues at harvest.**

To reiterate this, the following was added on page 12 in the section: Growth stage description.

**Growth stage assessments are not an average across the vineyard.**

**Base all growth stage assessments on the most advanced vines in the block.**

## Registered products list

The list of registered products (pages 15–21) is now printed in black and white to distinguish it from the recommendations section. The purpose of the recommendations section is to provide withholding period advice for export markets.

## Footnotes

A new footnote about the application rates of products containing pyrimethanil states: Apply no more than 800 g active per hectare (maximum 2L of 400SC and 1.33L of 600SC formulations).

Pyrimethanil products include Predict 600 SC, Protector 400SC, Pyrus 400 SC and Scala 400 SC.

## New active constituent for sap sucking pests

### Spirotetramat APVMA 61864

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has approved the active constituent spirotetramat for use on wine-grapes. Movento 240 SC (APVMA 61864) is registered for control of longtailed mealybug (*Pseudococcus longispinus*) and tuber mealybug (*Pseudococcus virburni*) and for suppression of grapevine scale (*Parthenolecanium persicae*), plague thrips (*Thrips imuginis*) and northern plague thrips (*Thrips safrus*).

Movento 240 SC is a Bayer CropScience Pty Ltd product. The label withholding period (WHP) is four weeks before harvest.

Recommended restriction on use for grapes destined for export wine: Use no later than E-L 18, 14 leaves separated, flower caps still in place, but cap colour fading from green.

## Active constituents and targets

### Fluazinam APVMA 65082

**Emblem** has been granted registration by the Australian Pesticides and Veterinary Medicines Authority (APVMA) for control of Eutypa in grapevines.

**Emblem** is a Crop Care Australia Pty Ltd product. It contains the active constituent fluazinam. It should be applied as a dormant treatment within 24 hours of pruning. Application should be made as a directed spray in a water volume that ensures thorough coverage of the pruning cuts.

**Restriction on use for export grapes:**

Not required when used as directed.

## New restrictions on use in Dog book 'Recommendations'

### Captan 13 August 2015

The European Union have notified of a change to the maximum residue level (MRL) and residue definition for captan. The MRL for captan has changed from 0.02 mg/kg (limit of quantification) to 0.03 mg/kg (limit of quantification), and the residue definition is now the *sum of captan and THPI (expressed as captan)*. THPI (tetrahydrophthalimide) is the main metabolite when captan breaks down. The change is expected to enter into force in early January 2016. To comply with the new residue regulations, **captan is not recommended for use on grapes destined for export wines.**

The AWRI is supporting Wine Australia and Winemakers' Federation Australia who are working through the Federal Department of Agriculture to resolve this trade issue.

Alternative chemical options for control of black spot, *Botrytis* bunch rot, downy mildew and phomopsis cane and leaf spot are listed in the 'Dog book'. The AWRI recommends growers consult with their winery and follow their winery guidelines for agrochemical sprays.

### **Azoxystrobin and Tebuconazole**

The WHP for active constituents azoxystrobin and tebuconazole has changed to 'Use no later than E-L 29, berries peppercorn size (4 mm diameter)'. This recommendation is for grapes destined for export wine and applies to all products containing these actives, either alone or in combination.

### **Chlorothalonil**

Chlorothalonil is an activity group M5 fungicide registered for control of black spot, *Botrytis* bunch rot, and downy mildew. The restriction on use for registered products containing chlorothalonil is now: Use no later than E-L 29, berries peppercorn size (4 mm diameter).

### **Myclobutanil**

Myclobutanil is an activity group 3 fungicide registered for control of powdery mildew. The restriction on use for registered products containing myclobutanil is now: Use no later than 30 days before harvest.

The changes to the 'Dog book' can be viewed in the online pdf or mobile app. For more information, please contact Marcel Essling on 08 8313 6600 or email [helpdesk@awri.com.au](mailto:helpdesk@awri.com.au)

This information is provided to inform the Australian grape and wine sector of agrochemical information, and should not be interpreted as an endorsement.

# Agrochemicals registered for use in Australian viticulture

# 15/16

A must for grapegrowers and winemakers exporting wine



Compiled by Marcel Essling and Anne Lord  
Updated 3 September 2015

## **Disclaimer**

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## Growing grapes for export wine?... choose the right chemical

Governments around the world set limits for the amount of residue of a fungicide, insecticide or herbicide that is legally allowed in a food, such as grapes or wine. These limits for agrochemicals are commonly referred to as MRLs (maximum residue limits), and for Australia they are listed in the Australian New Zealand Food Standards Code.

Over the past year, Australian wineries have exported wine worth more than \$1.82 billion, mostly to countries that have MRLs vastly different to, and sometimes lower than, those set by our own government. In fact, some chemicals commonly used by Australian grapegrowers do not have MRLs in some of our major export markets. Often this is because grapes are not grown commercially in these countries and, therefore, there is no need to register products for use on grapes. As a result no MRL is set, which means that the importing country will either not allow any detectable residue of the agrochemical in wine, or only permit 'safe' amounts of it.

To ensure that wine meets these requirements, it is necessary to restrict the application of certain chemicals or to avoid their use altogether. Since 1991, some wineries have provided their grapegrowers with a list of recommended fungicides and insecticides and the associated 'export harvest interval' (the minimum number of days before the last application and harvest). The export harvest interval is sometimes much longer than the withholding period stated on the chemical label, and it has been calculated to minimise the likelihood of residues affecting fermentation, affecting sales of the wine and to reduce the exposure of the public to pesticides.

The following tables list the preferred agrochemicals for use in the production of grapes for export wine, and any restriction on their use, for the 2015/2016 season. Some biological control agents are also listed. The recommendations have been developed to satisfy the lowest MRL for any of Australia's major wine markets after considering available data on the persistence of the chemical, both on grapes and through winemaking. Many of these data were gathered as a result of a large, multi-agency research effort, funded by the Grape and Wine Research and Development Corporation and the Dried Fruits Research and Development Council. A list of current MRLs and supporting information can be obtained by visiting the AWRI's website: [www.awri.com.au](http://www.awri.com.au), or by contacting Marcel Essling on telephone (08) 8313 6600.

If you are a member of the Australian wine industry and would like to receive email notices from the AWRI on technical issues, including agrochemicals, please visit the AWRI website [www.awri.com.au](http://www.awri.com.au) to subscribe to eBulletins.

## AWRI Agrochemical search app and online search facility

The AWRI agrochemicals online search facility and agrochemical search app allows the user to rapidly access information contained in the current *'Agrochemicals registered for use in Australian viticulture'* booklet (often called the Dog Book). These tools also contain additional information derived from the AWRI database i.e. they allow the user to search for products registered for use on targets that are not listed in the Agrochemical booklet. Visit [www.awri.com.au/agrochemicals/](http://www.awri.com.au/agrochemicals/) or scan the QR code below to download the app.

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## Frequently asked questions

### ***Why does The Australian Wine Research Institute recommend that the application of some products (for example Scala) be restricted to before 80% capfall?***

The recommendations in the tables have been developed to satisfy the lowest maximum residue limit (MRL) for *any* of Australia's major wine markets after considering available data on the persistence of the agrochemical, both on grapes and through winemaking.

In the case of *Scala* (pyrimethanil), it is known that if it is sprayed onto grapes after 80% capfall, residues might be detectable in the resultant wine. Some of the markets to which Australia exports wine have a very low MRL for pyrimethanil, or alternatively, have not announced their position on the course of action they would take if pyrimethanil was detected in wine. To ensure that Australian wine meets MRLs set by all of these markets, the 80% capfall restriction is suggested.

### ***Are there exceptions to these restrictions?***

Yes. Products may be used closer to harvest than the suggested restriction period in consultation with the winery/grape purchaser.

A winery may choose to ignore the restriction if the wine made from the grapes will be sold in Australia alone, or to an export market that has an MRL greater than the expected residue or if the market otherwise permits residues of the agrochemical. In this case, the label withholding period is the minimum delay that should be observed between spraying the grapes and harvest.

### ***Can I use a product that is not listed?***

Yes. Provided that it is in consultation with your winery and used according to the label specifications.

## Important points

- **GRAPEVINE GROWTH-STAGE CAN BE VARIABLE ACROSS A BLOCK. WHEN ASSESSING GRAPEVINE PHENOLOGY FOR THE PURPOSE OF APPLYING AGROCHEMICALS, BASE THE ASSESSMENT ON THE MOST ADVANCED VINES IN THE BLOCK TO MINIMISE THE POSSIBILITY OF RESIDUES AT HARVEST.**
- To accurately identify the grapevine growth stage, use the chart on page 13. For more information consult Coombe, B (1995) Adoption of a system for identifying grapevine growth stages. Aust. J. Grape and Wine Res. 1:104-110. The chart can also be downloaded from the AWRI website [www.awri.com.au/agrochemicals/](http://www.awri.com.au/agrochemicals/).
- Ask your winery if they have specific chemical recommendations. These might differ from the recommendations suggested below.
- When spraying, ensure that the amount of chemical applied never exceeds the rate specified on the manufacturer's label (unless otherwise specified).
- If you are unable to keep to these recommendations, or if you need to spray closer than 30 days before harvest, contact your winery or The Australian Wine Research Institute for advice.
- Avoid spraying some types of foliar fertilisers closer than 60 days before harvest, as wine quality might be affected.
- Always read the label on the chemical container. The products mentioned in the table might not necessarily be registered for use in your State.
- Keep a record of agrochemical applications. Some wineries might not accept delivery of grapes without receipt of a signed spray diary from the producer. An industry accepted spray diary template can be downloaded from the AWRI agrochemical website [www.awri.com.au/agrochemicals/](http://www.awri.com.au/agrochemicals/)
- These recommendations have been developed as a general guide and assume that the wine will be sent to a range of overseas markets, each with differing MRLs. If you only sell wine in Australia, or to only a few countries, contact The Australian Wine Research Institute to discuss how the recommendations might differ. We can also provide advice regarding the persistence of a chemical on grapes or through winemaking, and MRLs for most major export destinations.

## How to use the following table

Active Constituent	Activity group	Some registered products	Restriction on Use
Grouped alphabetically within each restriction on use for every target	Australian agrochemical codes. Note; International codes for fungicides were introduced in 2009	List of some chemical products available	The recommended withholding period for export grapes

## Recommendations

Active Constituent	Activity group	Some registered products	Restriction on Use
<b>BLACK SPOT</b>			
captan	M4	Captan, Captan 800 WG, Captan 900 WG, Captan WG	Not recommended for use on grapes destined for export wines.
captan + metalaxyl	M4 + 4	Duplex WG	
benalaxyl + mancozeb	4 + M3	Galben M	Use no later than 80% capfall.
metiram	M3	Polyram DF	
thiram	M3	Thiragranz, Thiram 800 WG	
ziram	M3	Ziragranz, Ziram DG, Ziram Granuflo	
chlorothalonil	M5	Applonil 720, Barrack 720, Barrack Betterstick, Bravo 720, Bravo Weather Stik, Cavalry Weatherguard, Cheers 720, Cheers 720 Weathershield, Chemtura Chlorothalonil, Chlornil 720 SC, Chloro 720, Chloronil Pro, Chlorothalonil 720, Chlorothalonil 900 WG, Conan Sticks 720SC, Echo 720, Echo 900 WDG, Elect 500, Fung-o-nil 500, Unite 720, Whack 720, Whack 900 WG	Use no later than E-L 29, berries pepper-corn size (4 mm diameter).
copper hydroxide + mancozeb	M1 + M3	ManKocide DF	Use no later than 30 days before harvest.
copper oxychloride	M1	Copper Oxychloride WP, Oxydul DF	
dithianon	M9	Delan 700 WG, Dragon 700 WG	
mancozeb	M3	Choice Mancozeb 750 WG, Dithane Rainshield Neo Tec, innova Mancozeb 750, Kencozeb 750DF, Mancoflo, Mancozeb 750 DF, Mancozeb 750 WG, Mancozeb DF, Manfil, Manzate DF, Manzeb, Penncozeb 750DF, Sinozeb Xtend 750 DF, UniZeb 750 DF	
<b>BOTRYTIS BUNCH ROT*</b>			
boscalid <sup>1</sup>	7	Filan	Not recommended for use on grapes destined for export wines.
captan	M4	Captan, Captan 800 WG, Captan 900 WG, Captan WG	
captan + metalaxyl	M4 + 4	Duplex WG	
fenhexamid	17	Teldor 500 SC	Use no later than 80% capfall.
pyrimethanil <sup>2</sup>	9	Predict 600SC, Protector 400SC, Pyrus 400 SC, Scala 400 SC	
azoxystrobin	11	Affix 250SC, Amistar 250 SC, Avior 800 WG, Azaka, Azoxystrobin 250, Azoxystrobin 250 SC, Azoxystrobin 500 WG, Connect 800 WG, Mirador 250 SC, Spartacus 250 SC, Supernova 250SC	Use no later than E-L 29, berries pepper-corn size (4 mm diameter).
tebuconazole + azoxystrobin	3 + 11	Custodia	

\* Review resistance management strategies on page 22 and follow the directions on page 24.

1. Contact your winery or grape purchaser prior to the application of any boscalid spray.
2. Apply no more than 800g active per hectare. (maximum 2L of 400 SC and 1.33L of 600SC formulations).

Active Constituent	Activity group	Some registered products	Restriction on Use
<b>BOTRYTIS BUNCH ROT* (CONT.)</b>			
chlorothalonil	M5	Applonil 720, Barrack 720, Barrack Betterstick, Bravo 720, Bravo Weather Stik, Cavalry Weatherguard, Cheers 720, Cheers 720 Weathershield, Chemtura Chlorothalonil, Chlornil 720 SC, Chloro 720, Chloronil Pro, Chlorothalonil 720, Chlorothalonil 900 WG, Conan Sticks 720SC, Echo 500SC, Echo 720, Echo 900 WDG, Elect 500, Fung-o-nil 500, Unite 720, Whack 720, Whack 900 WG	Use no later than E-L 29, berries peppercorn size (4 mm diameter).
cyprodinil <sup>3</sup>	9	Solaris 300 EC	Use no later than E-L 29, berries peppercorn size (4 mm diameter). Do not use within 60 days of harvest.
cyprodinil + fludioxonil <sup>3</sup>	9 + 12	Switch	
potassium salts of fatty acids	U1	Ecoprotector	Use no later than 14 days before harvest.
hydrogen peroxide + peroxyacetic acid (suppression only)	M + M	Peracetic Acid, Peratec, Peratec PLUS, Peroxy Treat	Use no later than 7 days before harvest.
iprodione	2	Aquaflow 500 SC, Chief 250 Liquid, Chief Aquaflo, Corvette Flowable, Corvette Liquid, Ippon 500 Aquaflo, Ipral 250, Iprine 250, Iprine 500, Iprodex 250, Iprodione 250, Iprodione Aquaflow 500, Iprodione Liquid 250, Rovral Aquaflo, Rovral Liquid, Shelby 250, Sindon 500 SC, Sinpro 500 SC, Subscribe, Transact	Use no later than 7 days before harvest. Consult your winery/ grape purchaser before spraying within 30 days of harvest.
<b>DOWNY MILDEW*</b>			
captan	M4	Captan, Captan 800 WG, Captan 900 WG, Captan WG	Not recommended for use on grapes destined for export wines.
captan + metalaxyl	M4 + 4	Duplex WG	
phosphorous acid <sup>4</sup>	33	Agri-Fos 600, ChemPhos 400, Country Phospot 400, Country Phospot 400 pH 7.2, Country Phospot 600, Dominator 600, Fungacid 600, Fungi-Fos 400, Fungi-Fos 400 pH 7.2, Grow-Phos 600, Phos Phyt 400, Sprayphos 400, Sprayphos 600, Sprayphos 620, Throw Down, Throw Down 600	
ametoctradin + dimethomorph	45 + 40	Zampro	Use no later than 80% capfall.
benalaxyl + mancozeb	4 + M3	Galben M	
dimethomorph	40	Acrobat SC, Downright, Sphinx	
metiram	M3	Polyram DF	
oxadixyl + propineb	4 + M3	Rebound WP	
zineb	M3	Zineb	

\* Review resistance management strategies on page 22 and follow the directions on page 24.

3. Do not apply Solaris 300 EC or Switch at both flowering and growth stage E-L 29.

4. Contact your winery or grape purchaser prior to the application of any phosphorous acid spray.

Active Constituent	Activity group	Some registered products	Restriction on Use
<b>DOWNY MILDEW* (CONT.)</b>			
mandipropamid	40	Revus	Use no later than E-L 26 (capfall complete)
azoxystrobin	11	Affix 250SC, Amistar 250 SC, Avior 800 WG, Azaka, Azoxystrobin 250, Azoxystrobin 250 SC, Azoxystrobin 500 WG, Connect 800 WG, Mirador 250 SC, Spartacus 250 SC, Supernova 250SC	Use no later than E-L 29, berries pepper-corn size (4 mm diameter).
chlorothalonil	M5	Applonil 720, Barrack 720, Barrack Betterstick, Bravo 720, Bravo Weather Stik, Cavalry Weatherguard, Cheers 720, Cheers 720 Weathershield, Chemtura Chlorothalonil, Chlornil 720 SC, Chloro 720, Chloronil Pro, Chlorothalonil 720, Chlorothalonil 900 WG, Conan Sticks 720SC, Echo 500SC, Echo 720, Echo 900 WDG, Elect 500, Fung-o-nil 500, Unite 720, Whack 720, Whack 900 WG	
tebuconazole + azoxystrobin	3 + 11	Custodia	
trifloxystrobin	11	Flint 500 WG (suppression only)	Use no later than E-L 31, berries pea-size (7 mm diameter).
pyraclostrobin	11	Cabrio, Cabrio WG	Use no later than E-L 31, berries pea-size (7 mm diameter). Do not use within 63 days of harvest.
copper ammonium acetate	M1	Cop-IT	Use no later than 30 days before harvest.
copper ammonium complex	M1	Copperguard, Liquicop	
copper cuprous oxide	M1	Ag Copp 750, Nordox 750 WG, Red Copper WG	
copper hydroxide	M1	Blue Shield DF, Champ Dry Prill WG, Cung Fu 350 SC, Flo-Bordo, Hydrocop, Kocide Blue Xtra, Kocide Opti, Vitra 400 WG	
copper hydroxide + mancozeb	M1 + M3	ManKocide DF	
copper octanoate	M1	Tricop	
copper oxychloride	M1	Copper Oxychloride, Copper Oxychloride 500 WP, Copper Oxychloride WP, Coppox WG, Coppox WP, Neoram 375 WG, Oxydul DF, Uni-Guard 500 WP	
copper sulphate tribasic	M1	Bordeaux WG, Cuprofix Disperss, Tri-Base Blue, Tribasic Liquid	
copper sulphate tribasic + mancozeb	M1 + M3	Copman DF, Novofix Disperss	
dithianon	M9	Delan 700 WG, Dragon 700 WG	

\* Review resistance management strategies on page 22 and follow the directions on page 24.

Active Constituent	Activity group	Some registered products	Restriction on Use
<b>DOWNY MILDEW* (CONT.)</b>			
mancozeb	M3	Choice Mancozeb 750 WG, Dithane Rainshield Neo Tec, innova Mancozeb 750, Kencozeb 750DF, Mancoflo, Mancozeb 750 DF, Mancozeb 750 WG, Mancozeb DF, Manfil, Manzate DF, Manzeb, Penncozeb 420 SC, Penncozeb 750DF, Sinozeb Xtend 750 DF, UniZeb 750 DF	Use no later than 30 days before harvest.
metalaxyl - M + copper hydroxide	4 + M1	Ridomil Gold Plus	
metalaxyl - M + mancozeb	4 + M3	Ridomil Gold MZ WG	
metalaxyl + copper oxychloride	4 + M1	Axiom Plus, Copper Plus, Medley Plus, Metalaxyl + Copper Oxychloride WP, Zeemil Plus	
metalaxyl + mancozeb	4 + M3	Axiom MZ 720, Max MZ, Maxyl, Medley MZ, Metal-Man MZ 720, Zeemil MZB 720 WP	
sulfur + copper oxychloride	M2 + M1	Mildex WG	
hydrogen peroxide + peroxyacetic acid (suppression only)	M + M	Peratec PLUS	Use no later than 7 days before harvest.
<b>EUTYPA DIEBACK</b>			
Cyproconazole + iodocarb	3 + 28	Garrison Rapid	Dormancy spray only.
fluazinam	29	Emblem	
tebuconazole	3	Greenseal	
<i>Trichoderma herzianum</i>	NA	Vinevax Bio-Implants, Vinevax Wound Dressing	
<b>PHOMOPSIS CANE AND LEAF SPOT</b>			
captan	M4	Captan, Captan 800 WG, Captan 900 WG, Captan WG	Not recommended for use on grapes destined for export wines.
captan + metalaxyl	M4 + 4	Duplex WG	
fluazinam	29	Emblem, Gem <sup>5</sup> , Shirlan <sup>5</sup>	Dormancy spray only.
metiram	M3	Polyram DF	Use no later than 80% capfall.
copper sulphate tribasic + mancozeb	M1 + M3	Novofix Disperss	Use no later than 30 days before harvest
dithianon	M9	Delan 700 WG, Dragon 700 WG	
mancozeb	M3	Choice Mancozeb 750 WG, Dithane Rainshield NeoTec, innova Mancozeb 750, Kencozeb 750 DF, Mancoflo, Mancozeb 750 DF, Mancozeb 750 WG, Mancozeb DF, Manfil, Manzate DF, Manzeb, Penncozeb 420 SC, Penncozeb 750DF, Sinozeb Xtend 750 DF, UniZeb 750 DF	

\* Review resistance management strategies on page 22 and follow the directions on page 24.

5. Gem and Shirlan have a 32 day re-entry period.

Active Constituent	Activity group	Some registered products	Restriction on Use
<b>POWDERY MILDEW*</b>			
boscalid <sup>6</sup>	7	Filan	Not recommended for use on grapes destined for export wines.
hexaconazole	3	Viva	Use no later than 80% capfall.
metrafenone	U8	Vivando	
spiroxamine	5	Prosper 500 EC	
sulfur, present as elemental or crystalline sulfur	M2	Dusting Sulphur, Dusting Sulphur 900	Use no later than 12 weeks before harvest.
azoxystrobin	11	Affix 250SC, Amistar 250 SC, Avior 800 WG, Azaka, Azoxystrobin 250, Azoxystrobin 250 SC, Azoxystrobin 500 WG, Connect 800 WG, Mirador 250 SC, Spartacus 250 SC, Supernova 250SC	Use no later than E-L 29, berries pepper-corn size (4 mm diameter).
sulfur + tebuconazole	M2 + 3	Unicorn 745WG	Use no later than E-L 31, berries pea-size (7 mm diameter). Do not use within 63 days of harvest.
tebuconazole	3	Buzz Ultra 750WG, Folicur 430 SC, Laguna Xtreme 800 WG, Launch, Orius 430 SC, Zolo 430 SC	
tebuconazole + azoxystrobin	3 + 11	Custodia	
cyflufenamid	U6	Flute 50 EW	Use no later than E-L 31, berries pea-size (7 mm diameter).
paraffinic oil	n/a	BioPest	
trifloxystrobin	11	Flint 500 WG	
pyraclostrobin	11	Cabrio, Cabrio WG	Use no later than E-L 31, berries pea-size (7 mm diameter). Do not use within 63 days of harvest.
penconazole	3	Azotic, Delos, Ruby 100EC, Topas 100 EC	Use no later than E-L 31, berries pea-size (7 mm diameter). Do not use within 60 days of harvest.
tetraconazole	3	Domark 40ME, Mettle 40ME	
quinoxifen	13	Legend	Use no later than E-L 34, (before commencement of veraison). Do not use within 42 days of harvest.
fenarimol	3	Rubigan SC	Use no later than 35 days before harvest.
triadimefon	3	Slingshot, Triadimefon 125	Use no later than 35 days before harvest.
triadimenol	3	Allitron, Bayfidan 250 EC, Citadel, Triadimenol 250 EC, Tridim 250 EC	

\* Review resistance management strategies on page 22 and follow the directions on page 23.

6. Contact your winery or grape purchaser prior to the application of any boscalid spray.

Active Constituent	Activity group	Some registered products	Restriction on Use
<b>POWDERY MILDEW* (CONT.)</b>			
copper ammonium acetate	M1	Cop-IT	Use no later than 30 days before harvest.
copper ammonium complex	M1	Copperguard, Liquicop	
myclobutanil	3	Mycloss Xtra	
proquinazid	13	Talendo	
sulfur, present as elemental or crystalline sulfur	M2	Chemtura Sulphur WG, Cosamil, Cosavet WG, David Grays Sulphur Spray, Flosul 800, GranuSulf 800 WG, InnoSulph 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Rutec Sulfur, Solo 800WG, Sulfostar DF, Sulfur 800 WG, Sulgran WG, Sulphur 800 WG, Thiovit Jet, Top Wettable Sulphur, Uni-Shield, Wettable Sulphur	
sulfur + copper oxychloride	M2 + M1	Mildex WG	
hydrogen peroxide + peroxyacetic acid (suppression only)	M + M	Peratec PLUS	Use no later than 7 days before harvest.
potassium bicarbonate	M2	Ecocarb	

<b>AUSTRALIAN PLAGUE LOCUST</b>			
<i>Metarhizium anisopliae</i> var. <i>acridum</i>	n/a	Green Guard SC, Green Guard SC Premium	Use no later than 7 days before harvest.
<b>BUD MITE</b>			
sulfur, present as polysulfide	M2	Lime Sulphur	Apply as near as possible to budburst.
sulfur, present as elemental or crystalline sulfur	M2	Chemtura Sulphur WG, Cosamil, Cosavet WG, GranuSulf 800 WG, InnoSulph 800 WG, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Solo 800WG, Sulfostar DF, Sulfur 800 WG, Sulgran WG, Sulphur 800 WG, Thiovit Jet, Top Wettable Sulphur, Uni-Shield, Wettable Sulphur	Use no later than 30 days before harvest.
<b>BUNCH MITE</b>			
sulfur, present as polysulfide	M2	Lime Sulphur	Apply as near as possible to budburst.
sulfur, present as elemental or crystalline sulfur	M2	Chemtura Sulphur WG, Cosamil, Cosavet WG, GranuSulf 800 WG, InnoSulph 800 WG, Microsul WG Elite, Sulfur 800 WG, Sulgran WG, Sulphur 800 WG, Thiovit Jet, Wettable Sulphur	Use no later than 30 days before harvest.

\* Review resistance management strategies on page 22 and follow the directions on page 23.

Active Constituent	Activity group	Some registered products	Restriction on Use
<b>GARDEN WEEVIL</b>			
esfenvalerate	3A	Sumi-Alpha Flex	Foliar spray only. Use no later than 80% capfall.
indoxacarb	22A	Avatar	Use no later than E-L 31, berries pea-size (7 mm diameter). Do not use within 56 days of harvest.
<b>GRAPE LEAF BLISTER MITE</b>			
paraffinic oil	n/a	Heavy Paraffinic Dormant Spray Oil	Dormant spray only.
petroleum oil	n/a	Stifle, Vicol Winter Oil	
sulfur, present as polysulfide	M2	Lime Sulphur	Apply as near as possible to budburst.
sulfur, present as elemental or crystalline sulfur	M2	Chemtura Sulphur WG, Cosamil, Cosavet WG, David Grays Sulphur Spray, Flosul 800, GranuSulf 800 WG, InnoSulph 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Rutec Sulfur, Solo 800WG, Sulfostar DF, Sulfur 800 WG, Sulgran WG, Sulphur 800 WG, Thiovit Jet, Top Wettable Sulphur, Uni-Shield, Wettable Sulphur	Use no later than 30 days before harvest.
<b>GRAPE LEAF RUST MITE</b>			
sulfur, present as polysulfide	M2	Lime Sulphur	Apply as near as possible to budburst.
sulfur, present as elemental or crystalline sulfur	M2	Chemtura Sulphur WG, Cosamil, Cosavet WG, Flosul 800, GranuSulf 800 WG, InnoSulph 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Rutec Sulfur, Solo 800WG, Sulfostar DF, Sulfur 800 WG, Sulgran WG, Sulphur 800 WG, Thiovit Jet, Top Wettable Sulphur, Uni-Shield, Wettable Sulphur	Use no later than 30 days before harvest.
<b>GRAPEVINE MOTH</b>			
chlorantraniliprole	28	Altacor	Use no later than 80% capfall.
spinetoram	5	Delegate	Use no later than E-L 31, berries pea-size (7 mm diameter).
emamectin	6	Proclaim, Warlock	Use no later than E-L 31, berries pea-size (7 mm diameter).
indoxacarb	22A	Avatar	Do not use within 56 days of harvest.
<i>Bacillus thuringiensis</i> subspecies <i>aizawai</i>	11	Bacchus WG	May be used until harvest.
<i>Bacillus thuringiensis</i> subspecies <i>kurstaki</i>	11	Delfin, DiPel DF	

Active Constituent	Activity group	Some registered products	Restriction on Use
<b>GRAPEVINE MOTH (CONT.)</b>			
<i>Trichogrammanza carverae</i>	n/a	Trichogramma parasitic wasp	May be used until harvest.
<b>GRAPEVINE SCALE<sup>7</sup></b>			
paraffinic oil	n/a	Bioclear, BioPest, Heavy Paraffinic Dormant Spray Oil, Trump Spray Oil	Dormant spray only.
petroleum oil	n/a	All Seasons White Oil, D-C-Tron Plus Spray Oil, Socoa Summer Spray Oil, Stifle, Vicol Summer Oil, Vicol Winter Oil	
spirotetramat (suppression only)	23	Movento 240 SC	use no later than E-L 18.
<b>LIGHT BROWN APPLE MOTH</b>			
chlorantraniliprole	28	Altacor	Use no later than 80% capfall.
methoxyfenozide	18	Prodigy	
spinetoram	5	Delegate	Use no later than E-L 31, berries pea-size (7 mm diameter).
emamectin	6	Proclaim, Warlock	Use no later than E-L 31, berries pea-size (7 mm diameter).
indoxacarb	22A	Avatar	Do not use within 56 days of harvest.
<i>Bacillus thuringiensis</i> subspecies <i>aizawai</i>	11	Bacchus WG,	May be used until harvest.
<i>Bacillus thuringiensis</i> subspecies <i>kurstaki</i>	11	Delfin, DiPel DF	
tetradecenyl acetate + tetradecadienyl acetate	n/a	Isomate LBAM Plus Pheromone, MD LBAM Corto, MD LBAM Flex Pheromone, MD LBAM Pheromone	
<i>Trichogrammanza carverae</i>	n/a	Trichogramma parasitic wasp	
<b>MEALYBUG<sup>8</sup></b>			
paraffinic oil	n/a	Bioclear, BioPest, Trump Spray Oil	Dormant spray only.
spirotetramat	23	Movento 240 SC	Use no later than E-L 18.
buprofezin	16	Applaud, Scale & Bug, Strident	Use no later than 80% capfall.
<b>MEDITERRANEAN/QUEENSLAND FRUIT FLY</b>			
A baiting program that does not target fruit or foliage is recommended.			
Control options for fruit fly are subject to APVMA permit conditions.			
Contact your winery or grape purchaser prior to any 1A, 1B, 2B or 3A insecticide.			

7. Some group 1B insecticides are registered for grapevine scale. Contact your winery or grape purchaser prior to any 1B insecticide application.

8. Consult product label, registration may apply to specific mealybug species.

Active Constituent	Activity group	Some registered products	Restriction on Use
<b>SNAIL</b>			
copper complex	n/a	Escar-go	Dormant spray only.
metalddehyde	n/a	Meta (pellets), Metarex Snail and Slug bait, Pestmaster Snail and Slug pellets, Slug Out (bait), Slugger Slug and Snail pellets	Ground application only. Use no later than 7 days before harvest.
iron EDTA complex	n/a	Multiguard Snail and Slug Killer	Ground application only. May be used until harvest.
<b>TWO SPOTTED MITE</b>			
petroleum oil	n/a	Stifle	Dormant spray only.
sulfur, present as polysulfide	M2	Lime Sulphur	Apply as near as possible to budburst.
sulfur, present as elemental or crystalline sulfur	M2	Chemtura Sulphur WG, Cosamil, Cosavet WG, GranuSulf 800 WG, InnoSulph 800 WG, Microsul WG Elite, Sulfur 800 WG, Sulgran WG, Sulphur 800 WG, Thiovit Jet	Use no later than 30 days before harvest.
etoxazole	10B	ParaMite	Use no later than 21 days before harvest
<b>WINGLESS GRASSHOPPER</b>			
indoxacarb	22A	Avatar	Use no later than E-L 31, berries pea-size (7 mm diameter). Do not use within 56 days of harvest.
<i>Metarhizium anisopliae</i> var. <i>acridum</i>	n/a	Green Guard SC, Green Guard SC Premium	Use no later than 7 days before harvest.

## Growth stage description

GROWTH STAGE ASSESSMENTS ARE **NOT** AN AVERAGE ACROSS THE VINEYARD  
BASE ALL GROWTH STAGE ASSESSMENTS ON THE **MOST ADVANCED VINES** IN THE BLOCK

**Budburst:** When the first green tips are visible (E-L 4).

**5% capfall:** E-L stage 19-20; flowers have just begun to open and the first caps have lifted and fallen off. No developing berries present.

**80% capfall:** E-L stage 25; 80% of caps have just lifted and the largest berries are no more than 2 mm in diameter.

**E-L 18:** 14 leaves separated, flower caps still in place, but cap colour fading from green.

**E-L 29:** Just after berry set, berries peppercorn size (4 mm diameter); bunches tending downwards.

**Pre-bunch closure:** E-L stage 31; Berried have reached pea-size (7 mm diameter); bunches hanging down.

**Veraison:** E-L stage 35; When 50% of berries begin to soften and sugar starts increasing.

# Grapevine growth stage table

MAJOR STAGES	E-L number	ALL STAGES	
	1	Winter bud	Shoot and inflorescence development
	2	Bud scales opening	
	3	Wooly bud ± green showing	
4 Budburst	4	Budburst; leaf tips visible	
	7	First leaf separated from shoot tip	
	9	2 to 3 leaves separated; shoots 2-4 cm long	
	11	4 leaves separated	
12 Shoots 10 cm Inflorescence clear, 5 leaves separated	12	5 leaves separated; shoots about 10 cm long; inflorescence clear	
	13	6 leaves separated	
	14	7 leaves separated	
	15	8 leaves separated, shoot elongating rapidly; single flowers in compact groups	
	16	10 leaves separated	
	17	12 leaves separated; inflorescence well developed, single flowers separated	
	18	14 leaves separated; flower caps still in place, but cap colour fading from green	Flowering
19 Flowering begins	19	About 16 leaves separated; beginning of flowering (first flower caps loosening)	
	20	10% caps off	
	21	30% caps off	
23 Flowering 50% caps off	23	17-20 leaves separated; 50% caps off (= flowering)	
	25	80% caps off	
	26	Cap-fall complete	Berry formation
27 Setting Young berries growing Bunch at right angles to stem	27	Setting; young berries enlarging (>2 mm diam.), bunch at right angles to stem	
	29	Berries pepper-corn size (4 mm diam.); bunches tending downwards	
31 Berries pea-size Bunches hanging down	31	Berries pea-size (7 mm diam.)	
	32	Beginning of bunch closure, berries touching (if bunches are tight)	Berry ripening
	33	Berries still hard and green	
	34	Berries begin to soften; Sugar starts increasing	
35 Veraison Berry softening continues Berry colouring begins	35	Berries begin to colour and enlarge	
	36	Berries with intermediate sugar values	Senescence
	37	Berries not quite ripe	
38 Harvest Berries ripe	38	Berries harvest-ripe	
	39	Berries over-ripe	
	41	After harvest; cane maturation complete	
	43	Beginning of leaf fall	
	47	End of leaf fall	

"Grapevine growth stages" Viticulture 1 - Resources. 2nd edition 2004. Eds. Dry, P. and Coombe, B. (Winetitles)

13 AGROCHEMICALS REGISTERED FOR USE IN AUSTRALIAN VITICULTURE

## Agrochemicals registered for use in Australian viticulture

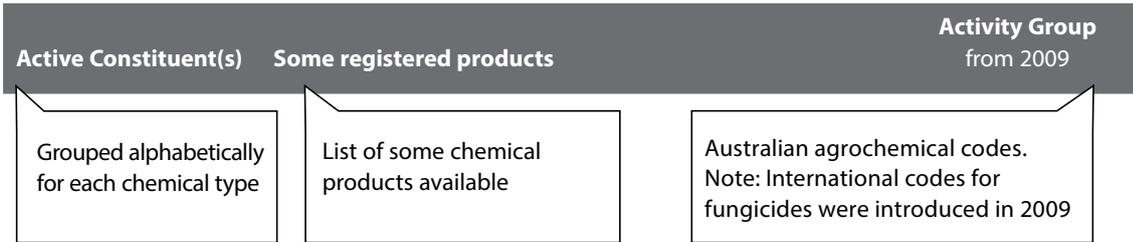
The following products are registered by the Australian Pesticides and Veterinary Medicines Authority for use in wine grape production in Australia. Always read the label on the chemical container as the products listed in the table might not necessarily be registered for use in your State.

To avoid the development of chemical resistance, it is necessary to know how the product works. Most chemicals have been allocated an ‘activity group’ based on their mode of action. The activity group appears on the product label as a number (or letter and number) for fungicides, a letter for herbicides and a number and letter or only a letter in the case of insecticides and miticides. Sometimes the resistance management strategy is also shown on the label. Management strategies to avoid the development of fungicide resistance have been published by CropLife Australia, and are described on page 22. More information regarding activity groups can be found on the CropLife Australia website: [www.croplifeaustralia.org.au](http://www.croplifeaustralia.org.au)

In the past, the export restriction on use for many of the insecticides listed in the table below has not been provided. Due to international pressures, the use of agrochemicals belonging to chemical groups such as the organophosphates and carbamates is not encouraged. The recommended restriction on use for all 1A, 1B, 2B, 4A and 4C insecticides listed in this booklet is ‘Use no later than 80% capfall’. In addition, it is recommended that any 3A insecticides that are not restricted to use during dormancy only (label withholding period), should not be used later than 80% capfall. However, it is essential that you contact your winery/grape purchaser prior to the application of any 1A, 1B, 2B, 3A, 4A or 4C insecticide.

The CropLife resistance management strategies on page 22 are a guide only and do not endorse particular products, groups of products or cultural methods in terms of their performance. Always follow the product label for specific use instructions. While all effort has been taken with the information supplied in this document no responsibility, actual or implied, is taken for the day to day accuracy of product or active constituent specific information. Readers should check with the Australian regulator’s (APVMA) product database for contemporary information on products and actives. The database can be sourced through [www.apvma.gov.au](http://www.apvma.gov.au). The information given in the resistance management strategies is provided in good faith and without any liability for loss or damage suffered as a result of its application and use.

### How to use the following table



Active Constituent(s)	Some registered products	Activity Group from 2009
<b>FUNGICIDE</b>		
ametoctradin + dimethomorph	Zampro	45 + 40
azoxystrobin	Affix 250SC, Amistar 250 SC, Avior 800 WG, Azaka, Azoxystrobin 250, Azoxystrobin 250 SC, Azoxystrobin 500 WG, Connect 800 WG, Mirador 250 SC, Spartacus 250 SC, Supernova 250SC	11
benalaxyl + mancozeb	Galben M	4 + M3
boscalid	Filan	7
captan	Captan, Captan 800 WG, Captan 900 WG, Captan WG	M4
captan + metalaxyl	Duplex WG	M4 + 4
chlorothalonil	Applonil 720, Barrack 720, Barrack Betterstick, Bravo 720, Bravo Weather Stik, Cavalry Weatherguard, Cheers 720, Cheers 720 Weathershield, Chemtura Chlorothalonil, Chlornil 720 SC, Chloro 720, Chloronil Pro, Chlorothalonil 720, Chlorothalonil 900 WG, Conan Sticks 720SC, Echo 500SC, Echo 720, Echo 900 WDG, Elect 500, Fung-o-nil 500, Unite 720, Whack 720, Whack 900 WG	M5
copper ammonium acetate	Cop-IT	M1
copper ammonium complex	Copperguard, Liquicop	M1
copper cuprous oxide	Ag Copp 750, Nordox 750 WG, Red Copper WG	M1
copper hydroxide	Blue Shield DF, Champ Dry Prill WG, Cung Fu 350 SC, Flo-Bordo, Hydrocop, Kocide Blue Xtra, Kocide Opti, Vitra 400 WG	M1
copper hydroxide + mancozeb	ManKocide DF	M1 + M3
copper octanoate	Tricop	M1
copper oxychloride	Copper Oxychloride, Copper Oxychloride 500 WP, Copper Oxychloride WP, Coppox WG, Coppox WP, Neoram 375 WG, Oxydul DF, Uni-Guard 500 WP	M1
copper sulphate tribasic	Bordeaux WG, Cuprofix Disperss, Tri-Base Blue, Tribasic Liquid	M1
copper sulphate tribasic + mancozeb	Copman DF, Novofix Disperss	M1 + M3
cyflufenamid	Flute 50 EW	U6
cyproconazole + iodocarb	Garrison Rapid pruning wound dressing	3 + 28
cyprodinil	Solaris 300 EC	9
cyprodinil + fludioxonil	Switch	9 + 12
dimethomorph	Acrobat SC, Downright, Sphinx	40

Active Constituent(s)	Some registered products	Activity Group from 2009
<b>FUNGICIDE (CONT.)</b>		
dithianon	Delan 700 WG, Dragon 700 WG	M9
fenarimol	Rubigan SC	3
fenhexamid	Teldor 500 SC	17
fluazinam	Emblem, Gem, Shirlan	29
hexaconazole	Viva	3
hydrogen peroxide + peroxyacetic acid	Peracetic Acid, Peratec, Peratec PLUS, Peroxy Treat	M + M
iprodione	Aquaflow 500 SC, Chief 250 Liquid, Chief Aquaflo, Corvette Flowable, Corvette Liquid, Ippon 500 Aquaflo, Ipral 250, Iprine 250, Iprine 500, Iprodex 250, Iprodione 250, Iprodione Aquaflow 500, Iprodione Liquid 250, Rovral Aquaflo, Rovral Liquid, Shelby 250, Sindon 500 SC, Sinpro 500 SC, Subscribe, Transact	2
mancozeb	Choice Mancozeb 750 WG, Dithane Rainshield Neo Tec, innova Mancozeb 750, Kencozeb 750DF, Mancoflo, Mancozeb 750 DF, Mancozeb 750 WG, Mancozeb DF, Manfil, Manzate DF, Manzeb, Penncozeb 420 SC, Penncozeb 750DF, Sinozeb Xtend 750 DF, UniZeb 750 DF	M3
mandipropamid	Revus	40
metalaxyl - M + copper hydroxide	Ridomil Gold Plus	4 + M1
metalaxyl - M + mancozeb	Ridomil Gold MZ WG	4 + M3
metalaxyl + copper oxychloride	Axiom Plus, Copper Plus, Medley Plus, Metalaxyl + Copper Oxychloride WP, Zeemil Plus	4 + M1
metalaxyl + mancozeb	Axiom MZ 720, Max MZ, Maxyl, Medley MZ, Metal-man MZ 720, Zeemil MZB 720 WP	4 + M3
metiram	Polyram DF	M3
metrafenone	Vivando	U8
myclobutanil	Mycloss Xtra	3
oxadixyl + propineb	Rebound WP	4 + M3
paraffinic oil	BioPest	unspecified
penconazole	Azotic, Delos, Ruby 100EC, Topas 100 EC	3
phosphorous acid	Agri-Fos 600, ChemPhos 400, Country Phospot 400, Country Phospot 400 pH 7.2, Country Phospot 600, Dominator 600, Fungacid 600, Fungi-Fos 400, Fungi-Fos 400 pH 7.2, Grow-Phos 600, Phos Phyt 400, Sprayphos 400, Sprayphos 600, Sprayphos 620, Throw Down, Throw Down 600	33
potassium bicarbonate	Ecocarb	M2
potassium salts of fatty acids	Ecoprotector	U1

Active Constituent(s)	Some registered products	Activity Group from 2009
<b>FUNGICIDE (CONT.)</b>		
procymidone	Fortress 500, Metapris, Procymidone 500, Proflex 500, Sumisclex 500	2
proquinazid	Talendo	13
pyraclostrobin	Cabrio, Cabrio WG	11
pyrimethanil	Predict 600 SC, Protector 400SC, Pyrus 400 SC, Scala 400 SC	9
quinoxifen	Legend	13
spiroxamine	Prosper 500 EC	5
sulfur + copper oxychloride	Mildex WG	M2 + M1
sulfur + tebuconazole	Unicorn 745WG	M2 + 3
sulfur, present as elemental or crystalline sulfur	Chemtura Sulphur WG, Cosamil, Cosavet WG, David Grays Sulphur Spray, Dusting Sulphur, Dusting Sulphur 900, Flosul 800, GranuSulf 800 WG, InnoSulph 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Rutec Sulfur, Solo 800WG, Sulfostar DF, Sulfur 800 WG, Sulgran WG, Sulphur 800 WG, Thiovit Jet, Top Wettable Sulphur, Uni-Shield, Wettable Sulphur	M2
tebuconazole	Buzz Ultra 750WG, Folicur 430 SC, Greenseal, Laguna Xtreme 800 WG, Launch, Orius 430 SC, Zolo 430 SC	3
tebuconazole + azoxystrobin	Custodia	3 + 11
tetraconazole	Domark 40ME, Mettle 40ME	3
thiram	Thiragranz, Thiram 800 WG	M3
triadimefon	Slingshot, Triadimefon 125	3
triadimenol	Allitron, Bayfidan 250 EC, Citadel, Triadimenol 250 EC, Tridim 250 EC	3
<i>Trichoderma harzianum</i>	Vinevax Bio-Implants, Vinevax Wound Dressing	unspecified
trifloxystrobin	Flint 500 WG	11
zineb	Zineb	M3
ziram	Ziragranz, Ziram DG, Ziram Granuflo	M3

Active Constituent(s)	Some registered products	Activity Group from 2009
<b>HERBICIDE</b>		
2,2-DPA-sodium (dalapon-sodium)	Atlapon, Dalapon 740 SP	J
amitrole + ammonium thiocyanate	Amitrole T	Q
amitrole + paraquat	Alliance, Para-Trooper	Q + L
bromoxynil + diflufenican	Barracuda, Bentley, Colt, Cougar, Difluken B, Jaguar	C + F
carfentrazone-ethyl	Artillery, Carfentrazone 240 EC, Elevate, Hammer 400 EC, Nail 240 EC, Nail 600 EC, Spotlight Plus	G
dichlobenil	Casoron G	O
diquat	Desiquat, Dia-Kill 200, Diquat 200, Reglone	L
diquat + paraquat	Blowout, Brown Out 250, Combik 250, Di-Par 250, EOS, Kwicknock 250, Paradym 250, Paraquat + Diquat 250, Paraquat/Diquat, Pre-Seed 250, Revolver, Scorcher 250, Speedy 250, Spray & Sow, Spray Out 250, Spray Seed 250, Spraykill 250, Uni-Spray 250	L + L
fluazifop-P	Fusilade Forte, Fuzilier, Resilience, Rootout 212	A
glufosinate-ammonium	Basta, Biffo, Cease, Exile, Exonerate, Exonerate200 SL, Fascinate 200 SL, Faster-TG 200, Fiestar, Glufosinate 200, Glufosinate-Ammonium 200, Kelpie G-FOS 200, Sky-7th 200	N
glyphosate-ipa	AllOut 450, Banish 360, BioChoice 360, ClearUp Glyphosate 450, Enviro-spray 360, Eradicator 450, Eradicator 540, Gladiator, Glister 360, Glister 450, Glymount 450, Glyphos classic 450, Glyphosate 360, Glyphosate 360 SL, Glyphosate 450, Glyphosate 450 CT, Glyphosate 450 SL, Glyphosate 510, Glyphosate 510SL, Glyphosate CT, Ken-Up 450 CT, Ken-Up Aquatic 360, Ken-Up Gold 500, Knockout 450, Knockout Blow 510, Nugget, Pestmaster Aqua-Tech 360, Pestmaster Glyphosate CT, Raze, Rico Glyphosate 450, Roundup, Roundup Biactive, RoundupCT, Sanos 360, Sanos 450, Sickle 540, SquareDown 360, Wipe-Out 450, Wipe-Out Bio	M
glyphosate-ipa + carfentrazone ethyl	Broadway	M + G
glyphosate-ipa + mas	Banish 360 Sync, Credit, Weedmaster Duo	M + M
glyphosate-mas	Bazooka Dry 800 SG, ClearUp 700 Bio-Dri, ClearUp 700 Dri Broadacre, ClearUp 840 Dry-Flo, Gladiator Dry 680 WG, Glister 680 SG, Glyphos 700 SG, Glyphosate 680, Glyphosate 700, Glyphosate 700SG, Glyphosate 875, Ken-Up Dry 680 WG, Nugget Dry 680 WG, Roundup Ready Plantshield	M
glyphosate-mea	Clear Up 450 SL, Glyphosate 450 SL, Wipe-Out Plus	M
glyphosate-potassium salt	Cotton Glyphosate 495, Firebolt, Gladiator Optimax, Glyphosate 540K, Glyphosate K-Tech 500SL, Max Out 540, Roundup PowerMAX, Roundup Ultra MAX, Touchdown Hitech, Warlord 540 Hi-Load, Wipe-Out Accelerate	M

Active Constituent(s)	Some registered products	Activity Group from 2009
<b>HERBICIDE (CONT.)</b>		
glyphosate-potassium salt + ipa	Weedmaster Argo	M + M
glyphosate-potassium salt + mas	Weedmaster Dual Salt Technology	M + M
haloxyfop-R methyl ester	Asset, Convict, Exert 520, Firepower, Haloxyfop 520, Haloxyfop 520 EC, Haloxyfop 900EC, Haloxyken 520, Hermes 520, Jasper 520, Recon 520, Verdict 520	A
isoxaben	Gallery 750 DF	O
napropamide	Devrinol WG	K
norflurazon	Zoliar DF	F
oryzalin	Cameo 500, Oryzalin 500, Prolan 500, Surflan 500	D
oxyfluorfen	Cavalier, Convert 240 EC, Crossbar 240, Goal, GoalTender, Gowel 240 EC, Ox 240, Oxen 240EC, Oxyfan 240 EC, Oxyfluorfen 240 EC , Point, Striker	G
paraquat	Explode250, Gramoxone250, Nuquat 250, Paradox 250, Para-Ken250, Para-Ken334, Paraquat 250, Paraquat 250 SL, Shirquat250, Sinmosa 250, Sprayquat250, Spraytop250SL, Uniquat 250	L
pendimethalin	Cronos 440EC, Fist 330, Panida Grande, Pendimethalin 330, Pendimethalin 330EC, Rifle 440, Romper 440 EC, Stomp 440	D
pine oil	BioWeed	unspecified
quizalofop-P-ethyl	Atomic Selective Herbicide, Elantra, Elantra Xtreme, Leopard, Leopard 200 EC, Quinella 100 EC, Quinella Upgrade, Quiz, Quizalofop-P-ethyl 200 EC, Sextant, Tiger Gold 250	A
quizalofop-P-tefuryl	Pantera	A
simazine	Gesatop 600 SC, Gesatop Granules 900 WG, Simagranz, Simanex 900 WG, SimaPhos 900 WG, Simaquest 900 WG, Simazine 500 Flowable, Simazine 900 DF, Simazine 900 WDG, Simazine 900 WG	C
trifluralin	Trampoline 480, Tricon Flexi 480, Triflur X, Triflur Xcel, Trifluralin 480, Trifluralin 480 EC, Triflurasip 480, Trilogy, Trilogy 600, Uni-Try	D

Active Constituent(s)	Some registered products	Activity Group from 2009
<b>INSECTICIDE</b>		
alpha-cypermethrin	Alpha Duo 100, Alpha Duo 100 EC, Alpha Duop 100, Alpha Forte 250 SC, Alpha-Cyp 100 Duo, Alpha-Cyper 100 EC, Alpha-Cypermethrin 100, Alpha-Cypermethrin 100 EC, Alpha-Scud Elite, Astound Duo, Chieftain Duo 100EC, Dictate Duo 100, Dominex Duo, Fastac Duo, Ken-Tac 100, Mascot Duo, UniChoice 100 EC	3A
azinphos-methyl	Gusathion 200 SC	1B
<i>Bacillus thuringiensis</i> subspecies <i>aizawai</i>	Bacchus WG	11
<i>Bacillus thuringiensis</i> subspecies <i>kurstaki</i>	Delfin, DiPel DF	11
bifenthrin	Arrow 100 EC, Astral 250 EC, Bifenthrin 100, Bifenthrin 100 EC, Bifenthrin 250 EC, Bifenthrin Ultra 300 EC, Bifentin 100EC, Bi-Thrin 100EC, Choice BiFendoff 100, Disect 100 EC, Tal-Ken 100, Talstar 250 EC, Venom 100 EC	3A
buprofezin	Applaud, Scale & Bug Insecticide, Strident	16
carbaryl	Bugmaster Flowable, Carbaryl 500 Flowable, Carbaryl 500 SC, Cricket and Grasshopper Killer Bait	1A
chlorantraniliprole	Altacor	28
chlorpyrifos	Chlorban 500EC, Chlorpos 500EC, Chlorpyrifos 500, Chlorpyrifos 500 EC, Cyren 500 EC, Cyren 500 WP, Generifos 500 EC, Kensban 500, Lorsban 500 EC, Lorsban 750 WG, Strike-Out 500 EC, Strike-Out 500 WP, suSCon Green	1B
clothianidin	Samurai (bare soil application only)	4A
copper complex	Escar-Go	unspecified
diazinon	Diazinon	1B
dicofol	Miti-Fol EC	UN
dimethoate	Danadim, Dimethoate, Dimethoate 400EC	1B
emamectin	Proclaim, Warlock	6
esfenvalerate	Sumi-Alpha Flex	3A
etoxazole	ParaMite	10B
fenamiphos	Assassinator 400, Fenamiphos 400, Fenamiphos 400EC, Nemacur 400	1B
fenitrothion	Fenitrothion 1000, Fenitrothion 1000 EC	1B
fipronil	Albatross 200 SC, Amulet Cue-Lure, Cannonball 200SC, Fipronil 200SC, Regal 800 WG, Regent 200SC	2B
indoxacarb	Avatar	22A
iron EDTA complex	Multiguard Snail and Slug Killer	unspecified
maldison (malathion)	Fyfanon 440 EW, Hy-Mal, Maldison 500	1B
metaldehyde	Meta (pellets), Metarex Snail and Slug bait, Pestmaster Snail and Slug pellets, Slug Out (bait), Slugger Slug and Snail pellets	unspecified

Active Constituent(s)	Some registered products	Activity Group from 2009
<b>INSECTICIDE (CONT.)</b>		
<i>Metarhizium anisopliae</i> var. <i>acridum</i>	Green Guard SC, Green Guard SC Premium	unspecified
methidathion	Suprathion 400 EC	1B
methiocarb	Mesurool Snail and Slug Bait	1A
methomyl	Electra 225, KDpc Metho, Lannate L, Marlin, Methomyl 225, Nudrin 225, Seneca, Sinmas 225	1A
methoxyfenozide	Prodigy	18
paraffinic oil	Bioclear, BioPest, Heavy Paraffinic Dormant Spray Oil, Trump Spray Oil	unspecified
petroleum oil	All Seasons White Oil, D-C-Tron Plus Spray Oil, Sacoa Summer Spray Oil, Stifle, Vicol Summer Oil, Vicol Winter Oil	unspecified
pyrethrins + piperonyl butoxide	Py-Bo Natural Pyrethrum	3A
spinetoram	Delegate	5
spinosad	Naturalure Fruit Fly Bait Concentrate	5
sulfoxaflor	Transform	4C
sulfur, present as elemental or crystalline sulfur	Chemtura Sulphur WG, Cosamil, Cosavet WG, David Grays Sulphur Spray, Flosul 800, GranuSulf 800 WG, InnoSulph 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Rutec Sulfur, Solo 800WG, Sulfostar DF, Sulfur 800 WG, Sulgran WG, Sulphur 800 WG, Thiovit Jet, Top Wettable Sulphur, Uni-Shield, Wettable Sulphur	M2
sulfur, present as polysulfide	Lime Sulphur	M2
tetradecenyl acetate + tetradecadienyl acetate	Isomate LBAM Plus Pheromone, MD LBAM Corto, MD LBAM Flex Pheromone, MD LBAM Pheromone	unspecified
trichlorfon	Dipterex 500 SL, Lepidex 500	1B
<i>Trichogrammanza carverae</i>	Trichogramma parasitic wasp	unspecified
<b>PLANT GROWTH REGULATORS</b>		
chlormequat	Cycocel 77A, Getset	unspecified
cyanamide	Cyan, Dormex, Duomax HC520	unspecified
ethephon	E-Phon, Ethephon 480, Ethephon 720, Ethephon 720 SL, Ethrel 720, K-Ethephon, Promote 720, Promote 900	unspecified
gibberellic acid	Gala, GBR Acid, GBR Acid 200SG, Gibb 100, Gibb 200, Gibber, N-Large, ProGibb SG	unspecified
methyl esters of fatty acids	Waiken	unspecified

### *What is 'chemical resistance'?*

Chemical resistance is the inherited ability of an organism, be it a disease, weed or insect to survive doses of an agrochemical that would normally control it. Resistance may develop after frequent use of one chemical, or chemicals from the same activity group. Incorrect chemical use such as under or over dosing or application at the wrong time in the life cycle of the target can also promote resistance.

### *How does resistance develop?*

Any population might contain a very small number of individuals which are naturally able to survive the application of a particular chemical. If the same chemical, or chemicals from the same activity group are used repeatedly, and exclusively, the susceptible individuals continue to be removed, and those with natural resistance survive and multiply to essentially dominate the population. The chemistry then 'fails' in the field.

It has been observed in vineyards that despite several herbicides being used over a season, they are often applied at the same time each season. As such, the weed species peculiar to that time are treated with the same herbicide each year, therefore promoting resistance.

### *Resistance countering measures*

Manage unwanted pathogens, weeds and insects using non-chemical means when possible.

When using chemicals, get the most out of them by:

- timing them to when the target is most susceptible;
- using the correct dose;
- adding suitable adjuvants;
- applying when the conditions are right.

Minimise chemical selection pressure by not overusing chemicals from the same activity group.

CropLife Australia maintains Resistance Management Strategies for fungicides, insecticides and herbicides. These are available at [www.croplifeaustralia.org.au](http://www.croplifeaustralia.org.au).

## Fungicide resistance status

Resistance to fungicides is a serious problem worldwide and Australia has not been spared.

Resistance to many of the commonly used fungicides now exists.

CropLife Australia incorporates two initiatives in fungicide resistance management which ensures the best control with least risk of developing resistance. These are:

1. All fungicides have been classified by activity group, which appears as a number or letter and number code on the fungicide product label; and
2. Strategies have been developed for the use of fungicides in crops where resistance by a particular organism is already evident or considered a risk. See following page.

The advice given in the CropLife strategies is valid at the time of going to print. Current versions of the strategy are available from the CropLife Australia website: [www.croplifeaustralia.org.au](http://www.croplifeaustralia.org.au).

### Grey mould (Botrytis bunch rot)

#### Powdery mildew

**Fungicide activity groups: Group 3 (DMI); Group 2 (dicarboximide); Group 7 (SDHI) Group 9 (anilinopyrimidine); Group 11 (quinone outside inhibitor); Group 12 (phenylpyrroles); Group 17 (hydroxylanilide)**

1. If three or fewer bunch rot sprays are applied in a season, use no more than one spray from the same fungicide group during the season, for any **Group 2 or 9** (including combinations with **Group 12**), **Group 17** or **7** fungicides.
2. If four or more bunch rot sprays are applied in a season, use no more than two sprays from the same fungicide group during the season, for any **Group 2 or 9** (including combinations with **Group 12**), **Group 17** or **7** fungicides.
3. **DO NOT** apply more than two consecutive sprays from the same fungicide group, for any **Group 2 or 9** (including combinations with **Group 12**) or **Group 17** fungicides, including from the end of one season to the start of the following season.
4. **DO NOT** apply consecutive sprays of **Group 7** fungicides, including from the end of one season to the start of the following season.
5. **DO NOT** apply more than two sprays per season of **Group 11** (including combinations with **Group 3**) fungicides. If two consecutive applications of **Group 11** (including combinations with **Group 3**) fungicides are used, then they must be followed by at least the same number of applications of fungicide(s) from a different group(s) before a **Group 11** (including combinations with **Group 3**) fungicide is used again, either in the current or following season.
6. If a **Group 11** fungicide is used solo, it should only be used in strict alternation with fungicides from a different cross resistance group.
7. If resistance to a fungicide group has been detected, only use that fungicide group in mixtures or in strict alternation with fungicides from a different cross resistance group. A fungicide group that has been applied as the final application of the season should not be the first fungicide in the following season.
8. **DO NOT** apply fungicides curatively.
9. Late season fungicide treatments should be applied before Botrytis infection reaches unacceptably high levels in the vineyard.

## Downy mildew

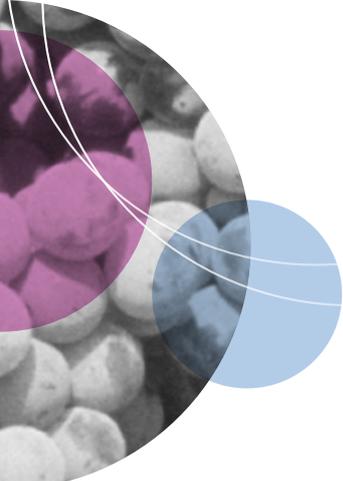
**Fungicide activity groups:** **Group 4** (phenylamide); **Group 11** (quinone outside inhibitor); **Group 40** (dimethomorph)

1. Start disease control sprays using a protectant or non-phenylamide fungicide and continue spraying at intervals of 7-21 days depending on disease pressure and rate of grapevine growth, typically when the shoots are 10 cm (E-L 12 stage) or longer.
2. When conditions favour disease development, apply two consecutive sprays of a **Group 4** product. **DO NOT** apply more than two consecutive sprays of a **Group 4** product. **DO NOT** apply more than four sprays of a **Group 4** product per season.
3. **DO NOT** apply more than three consecutive sprays of a **Group 40** fungicide, and no more than a total of six sprays per season.
4. **DO NOT** apply more than two sprays per season of **Group 11** fungicides. If two consecutive applications of **Group 11** fungicides are used, then they must be followed by at least the same number of applications of fungicide(s) from a different group(s), before a **Group 11** fungicide is used again, either in the current or following season.
5. Apply **Group 11** fungicides preventatively.
6. Apply a maximum of two consecutive applications in alternation with fungicides from a different Mode of Action group with satisfactory efficacy against the target pathogen/s.

## Powdery mildew

**Fungicide activity groups:** **Group 3** (DMI); **Group 5** (amine); **Group 7** (SDHI); **Group 11** (quinone outside inhibitor); **Group 13** (aza-naphthalenenes), **Group U6** (phenylacetamide); **Group U8** (actin inhibitor)

1. **DO NOT** apply more than two consecutive sprays of a **Group 3** or **Group U6** fungicide.  
**DO NOT** apply more than three **Group 3** sprays per season.  
**DO NOT** use **Group 3** fungicides curatively.
2. **DO NOT** apply more than two consecutive sprays of a **Group 5** fungicide.  
**DO NOT** apply more than three **Group 5** sprays per season.
3. **DO NOT** apply consecutive sprays of **Group 7** fungicides, including from the end of one season to the start of the following season.  
**DO NOT** apply more than **three** **Group 7** sprays per season.
4. Apply **Group 11** and other systemic fungicides preventatively.
5. **DO NOT** apply more than two sprays per season of **Group 11** or **Group U6** fungicides.
6. Where **Group 11** products have been routinely used for many seasons, field research indicates there is an increased risk of powdery mildew resistance to **Group 11** fungicides occurring. To ensure continued protection against powdery mildew in these circumstances, either abstain from using **Group 11**s or mix **Group 11** fungicides with a registered rate of a compound from an alternative chemical group for the control of powdery mildew in grapes.
7. Alternatively, if applied alone, **Group 11** fungicides should be used in strict alternation with fungicides from an alternative chemical group for the control of powdery mildew.
8. **DO NOT** apply more than two consecutive sprays of a **Group 13** fungicide.  
**DO NOT** apply more than three **Group 13** sprays per season.



# Agriculture NSW – Horticulture Development Officers and Leaders

Below is a list of Agriculture NSW, Development Officers and Leaders working in Horticulture.

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