Grapevine Management Guide

2011–12

NATIONAL Wine & Grape INDUSTRY CENTRE

Syngenta – Revus full page colour

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Acknowledgments

We would like to acknowledge the valuable contributions made by many members of the Australian wine industry in the preparation of this publication. Particular thanks to staff from:

- Department of Primary Industries Victoria
- Primary Industries and Resources South Australia
- Department of Primary Industries NSW
- Charles Sturt University
- Australian Wine Research Institute
- Swinburne University of Technology
- State Vine Improvement Groups
- South Australian Research and Development Institute
- University of Western Sydney
- Grape and Wine Research and Development Corporation
- NSW Wine Industry Association

Produced by Department of Primary Industries, September 2011
Editing: Ann Munroe, Warriewood NSW
Production: Barry Jensen, DPI, Orange NSW
Main cover images: Top, Stages of vine growth, Anthony Somers, Tocal, DPI;
Main photo, Sauvignon blanc wine grapes, Graham Johnson, formerly DPI

ISSN 1036–7551

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Foreword

Welcome to the *Grapevine Management Guide 2011–12*.

The *Grapevine Management Guide* is a pivotal publication of the National Wine and Grape Industry Centre (NWGIC).

The Guide presents topical information of broad interest to wine grape producers Australia-wide.

It combines the latest findings from the NWGIC's viticultural research with information from many other leading sources to provide a contemporary guide to industry best practice.

The big challenge that still confronts grape producers across Australia is maximising grape quality and minimising costs in a market oversupplied with wine grapes. The focus continues to be on the minimisation of climatic impacts. In this edition we consider the effective control of powdery and downy mildew after widespread infection in the exceptionally wet conditions last season. We highlight the results of NWGIC research that has important implications for Semillon grapegrowers in terms of irrigation scheduling, particularly under hot, dry conditions.

Significant new findings from NWGIC research are presented. The findings confirm the damaging effect of photosynthetic stresses during fruitset and show that warm soil temperatures between budburst and flowering increases flower numbers and influences fruitset through changes in the amount of carbohydrates retained in the roots.

We describe the cause of young vine decline and suggest that its prevention is a shared responsibility between producers of source grapevine cuttings, nursery operators and purchasers of the planting stock.

Finally, with the cooperation of the AWRI, we include the latest update of the 'Dog book' guide to selection of Agrochemicals registered for use in Australian viticulture.

This year's Guide will also be available as a free i-book from the Apple store to enable downloading onto i-pads and i-phones, thus ensuring ready access to the information. We are currently exploring strategies to make the material available in a wider range of formats.

The editors welcome inquiries, feedback and suggestions for future content.

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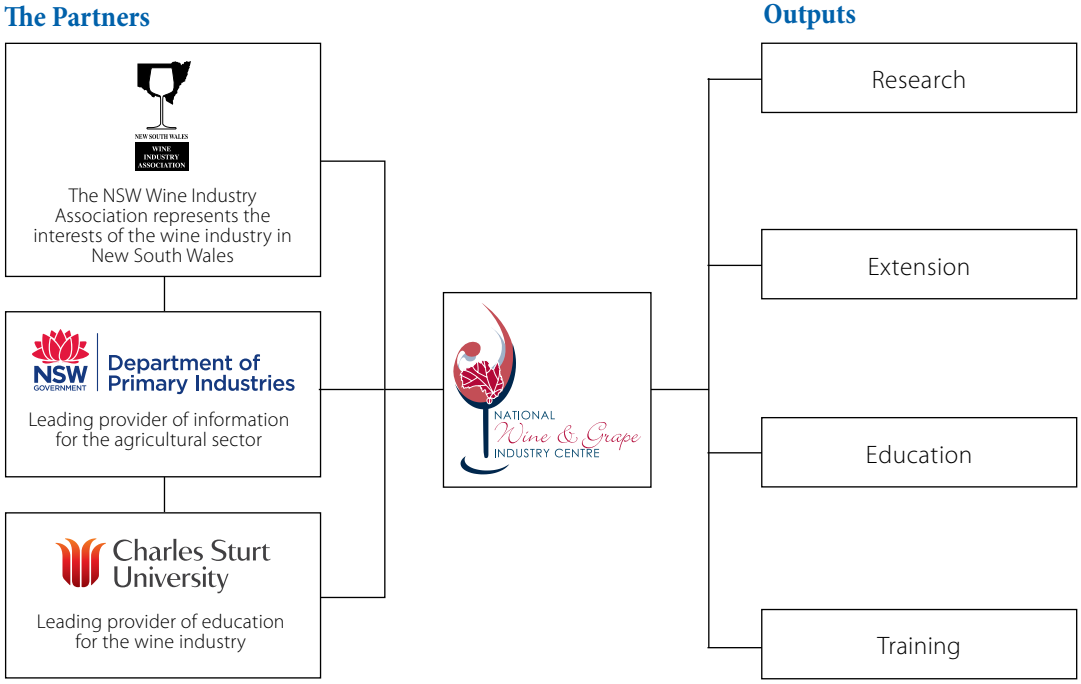
The **NATIONAL** *Wine and Grape* **INDUSTRY CENTRE** is an alliance of Charles Sturt University, Department of Primary Industries and the New South Wales Wine Industry Association. It generates scientific knowledge in viticulture and oenology and related fields to drive value-adding innovation within the Australian wine industry and the broader community through extension, education and training activities.

Schematic diagram of the role of the the National Wine and Grape Industry Centre



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Quality planting stock: it's your business

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It's in the interests of all grape growers and winemakers to care about the quality of planting stock in Australian vineyards.

Establishing a vineyard is a significant investment for grape growers. Much thought and effort goes into site selection, layout, infrastructure and choice of grape variety and clone, but, in my experience, very few growers give much consideration to the quality of the vines that they will plant as the foundation of a profitable business. Vineyard equipment and infrastructure are important, but they play supporting roles. Achieving the best return on investment becomes impossible from the moment a decision is made to purchase anything other than the healthiest, disease-free planting stock. Defective vines often fail in the first season, or, if they do eventually become established, they form short-lived vineyards that produce low yields of fruit of poor quality. It is worth spending time and money to purchase the best vines. It is much easier and cheaper to manage strong, healthy vines to produce a crop of high-quality grapes than it is to attempt to do the same with vines that are stunted and unhealthy.

Healthy planting stocks establish quickly, are better able to withstand stresses such as drought and pests and diseases, and are long lived. All too often planting stock is infected with viruses and fungal pathogens, which cause root and trunk diseases such as *Cylindrocarpon, Botryosphaeria* and Petri disease. Graftlings often have poorly healed graft unions, few roots, and stunted shoots; if they survive they may be very slow to establish in the vineyard. Such plants are susceptible to environmental stress and rarely reach their productive capacity.

Choosing planting stock

Grapevines are relatively easy plants to propagate, but it takes skill to produce a vine that will be long lived and perform to expectations in the vineyard. The most reliable means of obtaining high-quality planting stock is to purchase it from an accredited nursery that obtains propagating stock from vine-improvement societies selling cuttings of certified health status and identity. To be sure of obtaining the desired variety, clone and rootstock, it is important to order vines at least 12 to 15 months in advance to allow the nursery to plan production and ensure that there are adequate supplies of high-quality vines. Late ordering may mean that the nursery is unable to supply the requested variety in the required quantity, thus delaying vineyard development for at least 12 months. Never be tempted to buy 'second'-grade plants. They are graded as 'seconds' for a reason and are unlikely to result in a healthy, productive vineyard.

There are several options when choosing planting stock. The most common type is the dormant, 1-year-old, bare-rooted vine that has been either bench-grafted in the nursery to the desired rootstock or raised as an ungrafted rootling. Another type is the green, potted vine, either grafted or ungrafted, in biodegradable pots that can be planted, pot and all, in late spring. Green vines must be managed carefully in the first few weeks after planting, as they are more susceptible than dormant vines to environmental stress. Failure rates are usually low for both types of planting stock, and any failed vines can be replaced in the same season. Growers can also choose to plant ungrafted rootstocks and have them grafted or budded with the scion variety in the vineyard. However, unless the grafting is done by a skilled person, the failure rate can be high and the resulting vineyard will be uneven and difficult to manage if the vines are grafted over more than one season.

Characteristics of quality planting stock

Quality planting stock has some characteristics that are visible and others that are detectable only by expensive and specialized analyses. To avoid the need to perform

Defective vine after one season in the vineyard. Note the poor shoot growth and excessive callusing at the graft union.
Photo: Helen Waite

Crop Care Spotlight Plus full page colour

specialized analyses along with every purchase, nursery accreditation schemes identify those nurseries that follow protocols designed to guard against the hard-to-detect defects and diseases. Growers should always purchase vines from an accredited nursery.

Visible quality attributes

Dormant and green potted vines should have at least three well-formed roots evenly spaced around the base and one or two well-developed shoots that are neither stunted nor rank. The plants should also be free of external wounds caused by machinery or vermin, as wounds may result in structural weakness and expose the tissue to infections from pathogens. The bark of dormant plants should be uniformly tan. Graft unions should be fully healed and should not break when moderate pressure is applied. Callus growth at the graft union should be from both the rootstock and the scion but should not be excessive. Unless both the stock and scion produce callus tissue from the cambium, a proper union does not occur and the scion will die when it has consumed stored carbohydrates or is water stressed. Defective grafts normally break under moderate pressure.

Accreditable quality attributes

Accreditable quality attributes not readily apparent from a visual inspection of dormant stock include correct variety and clone, freedom from trunk diseases and serious viruses, and freedom from the effects of stress during propagation and handling. Determining the variety of dormant planting stock is difficult, and it is very difficult for people other than expert ampelographers (i.e. those who classify and identify grapevines) to identify a clone, even when the vines are in leaf. It is also difficult to determine the disease status of a dormant vine without recourse to specialized plant pathology services. The presence of viruses and the propagules of other organisms such as *Phomopsis* are not always easy to see, particularly when vines are dormant, although powdery mildew traces can be seen on shoots.

Dissection of a few sample vines from a batch is a useful way of detecting advanced infections with trunk disease pathogens, but early-stage infections are not visually detectable. Healthy rootstock wood is a creamy colour and scion wood is usually cream or green. There should be no dead tissue. Brown streaking in the wood of the rootstock or scion indicates that the vine has been infected with one or more of the trunk disease fungi. These diseases are most commonly isolated from rootstocks, but they have also been isolated from scion wood. If the graft union has been infected with these diseases, dissection of the graft will show brown streaking in the wood leading away from the graft union, and the graft union will be poorly healed.

Hot-water treatment

Hot-water treatment (HWT) of dormant grapevine propagating and planting stock to control pests and

A high-quality, sound, healthy vine. *Photo: Helen Waite*

A poorly healed graft union with dead and diseased tissue. *Photo: Helen Waite*

Cross-section of the scion (L) and rootstock (R) of a defective vine. The scion wood is healthy, but the brown spots in the rootstock indicate the presence of fungal trunk disease.
Photo: Helen Waite

pathogens has been in use for some time. There are two commonly used HWT regimes. Short-duration HWT (5 min at 55°C) is used to control external pests and pathogens such as nematodes on rooted vines, and long-duration HWT (30 min at 50°C) is used to control internal and external pests and pathogens (including nematodes, crown gall, phytoplasmas and trunk diseases) on cuttings and rooted vines. The long-duration treatment is generally applied to cuttings before propagation to control pests and pathogens. The short-duration treatment is applied to both cuttings and rooted vines to comply with quarantine requirements when cuttings and vines are being shipped. Long-duration treatment has also been used to treat dormant planting stock. However, there is a risk attached to HWT if post-HWT handling and storage conditions are poor; consequently, long-duration HWT is generally reserved for propagating stock rather than planting. Remember that HWT does not control virus diseases.

Handling and storage

Correct handling and storage of grapevine planting stock received from nurseries is a critical factor in maintaining vine quality. It should be remembered that dormant vines are living plants and need to be treated as such. Many growers choose to store dormant vines in coolrooms until planting. However, the viability of vines can be affected if they are stored with apples and other ethylene-producing fruit, or with potatoes and onions treated with growth-inhibiting substances. These substances are able to penetrate plastic wrapping and can result in severely inhibited growth when the vines are planted in the vineyard. It is also important to ensure that there are several small holes in bags of vines so that the vines have an adequate oxygen supply during storage. If vines do not receive adequate oxygen they may begin to ferment in storage. Storage temperature is also important. The ideal storage temperature for vines is 1°C to 2°C rather than 4°C to 5°C. *Botrytis* development is favoured once the temperature reaches 4°C, or if the temperature fluctuates. Moving vines in and out of a coolroom is also undesirable, as it disturbs their metabolism.

Once dormant vines have been removed from the coolroom they should be planted within 36 to 48 hours, particularly if the weather is warm. Bales or boxes of vines should not be exposed to high temperatures, agrochemicals or fuel, and care should be taken to prevent dehydration during the trimming and handling process. Prolonged soaking of the vines in water – particularly untreated water – does not necessarily compensate for the stress of dehydration and may cause oxygen deprivation and facilitate the entry of pathogens through the wounds made on roots and shoots during trimming. If dehydration is a potential problem it is preferable to spray the vines with clean water, rather than to soak them. If vines are not able to be planted for a few days they can be 'heeled in' by placing bundles upright in a trench and loosely covering the root with soil, sand or well-rotted sawdust, making sure that the planting medium is kept moist and there are no large air pockets around the roots of the vines.

When green potted vines are received, until they are planted out they should be placed in a holding area that has dappled shade and is protected from the wind. Depending on the temperature the vines may need to be watered two or three times each day. If the potting mix is allowed to dry out it may become water-repelling and will not rewet easily; consequently the vines will suffer severe water stress in spite of regular watering. If an anti-transpirant has not been applied at the nursery, it may be useful to do so to reduce water loss from the leaves.

Newly planted vines have small root systems and are unable to utilise moisture at deeper levels in the soil until the roots have begun to grow or (in the case of potted vines) until they have emerged from the cardboard pot. Therefore, irrigation should be applied in small amounts at frequent intervals, gradually increasing in amount and decreasing in frequency to prevent water stress and encourage root development.

Growing your own planting stock

Some growers like to propagate their own vines. However, for inexperienced propagators there are some significant pitfalls that can result in the production of inferior vines. Problems start when uncertified cuttings of unknown type and disease status are used. Consequently, growers may inadvertently take cuttings from misidentified or diseased vines. Serious problems also arise if cuttings are inadvertently harvested from a vineyard affected by phylloxera and if cuttings are handled incorrectly and are damaged, or allowed to dehydrate.

Management of cuttings in a field nursery is also often incompatible with other vineyard operations, and nursery beds can be easily neglected. Callused cuttings have very small root systems, particularly in the early stages of root initiation, and they require small, frequent waterings. Close planting in nursery beds also means that the cuttings are susceptible to powdery mildew and other fungal diseases. Moreover, because the cuttings are small and in closely planted rows, fungicides cannot be applied by using standard vineyard equipment. Weeds are also a problem in field nurseries and can soon smother the vines, blocking out light and competing for water and nutrients. Consequently, losses can be high and the quality of vines can be poor unless the nursery is properly cared for.

Summary

Quality planting stock is the best investment a grower can make to establish a long-lived and productive vineyard. Sound, healthy grapevine planting stock is more productive and requires fewer inputs than defective stock, which often results in vineyards that are difficult and costly to manage. Defective vines fail or are slow to establish, and they result in vineyards that are uneven and less productive in both the short and the long term. Sound, healthy vines have strong root and shoot systems, are free of trunk diseases and serious viruses, and are not damaged or stressed by poor handling or environmental factors. Problems can be avoided by ensuring that planting stock is sourced from an accredited nursery that uses propagating stock of known type and disease status, by ordering vines 12 to 15 months in advance, and by storing and handling planting stock correctly when it is received at the vineyard. Never buy 'seconds'.

Potential mildew disease carry-over from last season

SHAYNE HACKETT, DISTRICT HORTICULTURIST, NWGIC, WAGGA WAGGA

The 2010–2011 season was one that led to widespread infections with both powdery mildew and downy mildew across the south-eastern parts of Australia. After higher than average infection levels in many vineyards comes concern for a greater potential carry-over into the following season. To better understand the potential carry-over effect it is important to understand the life cycles of the organisms causing each of these diseases and how they overwinter and develop each year.

Downy mildew

Downy mildew of grapevines requires specific weather conditions to become established and infect the plant tissues. It can attack all green tissue with functioning stomata; this includes the undersides of leaves, shoots and flowers. Downy mildew can be extremely devastating if infections are permitted to become established early – especially before flowering, as was the case in the 2010–2011 season.

Repeated downy mildew infection conditions led to heavy crop losses in south-eastern Australia in the 2010–2011 Season.
Photo: S Hackett

Overwintering

Downy mildew overwinters as small survival structures called oospores. Those spores are formed in previous infection sites and remain in the soil after infected grapevine tissue breaks down, or in grapevine bark. The spores are very resilient and can survive for 7 to 10 years.

Spore germination and primary infection

Specific wet-weather conditions are necessary for oospores to germinate, but only those that are mature will germinate upon wetting.

The rule of thumb for a primary infection is 10:10:24:

- 10 mm rainfall
- 10°C minimum temperature
- over a 24-hour period.

However, the primary infection cycle is more accurately described in three phases.

1. Initial wetting and germination of the oospores to form a sporangium. The sporangium then releases motile spores called zoospores. This phase is temperature dependent and can take more than 16 hours, depending on the minimum temperature at the time.
2. Following release of the zoospores, a rain-splash event is required to carry the zoospores to the underside of the leaf or other susceptible green tissue.
3. Infection of the plant occurs when a zoospore invades a stoma, but this occurs only if the leaves remain wet for 2 to 3 hours.

Under Australian conditions, primary infections typically result in about one to three typical 'oilspot-like' symptoms in 50 metres of vine row. As such, primary infections pose little threat to the crop. However, where primary infections have previously become established, secondary infections arising from them can lead to significant losses of both crop and leaf area. Those losses can be particularly severe when secondary infections are allowed to occur before flowering.

Secondary infection

Secondary infection conditions are quite different from those required for primary infection.

For a secondary infection to occur there must already be primary 'oilspots' in the vineyard or nearby. Secondary infections occur when the mildew at the oilspots produces sporangia.

The sporangia-bearing sporangiophores emerge through the stomata of infected tissue, and detached sporangia are then wind-dispersed to other tissues, where they germinate in surface water and release zoospores. Sporangia are produced from existing mildew oilspots when the following conditions are met:

- 98% humidity
- temperature more than 13°C
- 4 hours of darkness
- leaves are wetted 2 or 3 hours before sunrise.

Under optimum conditions the time from germination to infection can be less than 90 minutes.

Secondary infections cause far more damage than the primary infections and are the greater threat. They result in as many as 100,000 new oilspots from as few as 20 to 50 primary ones.

Sporangiophores and sporangia produced from a leaf infection. The sporangia typically survive for 7 to 10 hours. Another infection event is required to trigger the release of fresh sporangia from the infection site. *Photo: S Hackett*

The key to managing downy mildew is to know when the primary infection conditions occur. Because oilspot symptoms do not appear for several days after infection, the weather data need to be monitored closely to determine when the infection criteria have been met. This will ensure that primary infections can be anticipated and destroyed before they can generate secondary infections. Where possible, an eradicant spray should be applied within 5 days of the infection event and before oilspots first appear.

This is particularly important when the primary infection has occurred before flowering.

Routinely applied protective sprays may be used to cover susceptible parts and thus prevent both primary and secondary infections in the first place. However, it is important to note that flower cap-fall exposes the flower parts and leaves them susceptible to infection. Therefore, a protectant spray should be applied after flowering to protect the young developing bunches if the forecast is for wet, humid conditions.

Protective sprays such as copper are lost from flowers as the flower caps fall. Follow-up sprays are required to maintain coverage after cap-fall is complete. *Photo: S Hackett*

Summary

Downy mildew overwinters as oospores trapped in the bark of the trunk and cordons and in the soil. These spores can remain viable for 7 to 10 years.

Despite the likelihood of there being high numbers of overwintering oospores this year, whether or not downy mildew regenerates in the upcoming season will be solely determined by the prevailing weather conditions. Monitoring of the weather conditions in spring will allow both primary and secondary infections to be anticipated and controlled with post-infection sprays.

Protecting developing leaves, shoots and inflorescences before flowering is critical for minimising damage. Follow-up sprays after flowering are crucial to re-establish protective coverage on the developing berries.

Powdery mildew

The potential for powdery mildew to become a problem depends on the amount of the fungus surviving from one season to the next. Carry-over infection can be in the form of either mildew-infected buds or spore-bearing cleistothecia. Grapevine buds become infected with the fungus as they form during the season and emerge as infected 'flag' shoots the following spring.

Cleistothecia are hard, overwintering structures that develop when powdery mildew builds up to high levels late in the previous season. Cleistothecia-generated infections occur in spring after rain of approximately 2 mm or more and when temperatures are above 10°C. The cleistothecia swell in water and discharge their spores (ascospores) into the air. The spores are blown to nearby leaves and inflorescences, where they germinate and begin the growth of a fungal colony on the surface of the infected tissue. Those first infections of the season are very small and not readily detected, usually occurring on the undersides of leaves near the trunks and cordons of the vines where the cleistothecia have overwintered.

In general, ascospore discharge starts as soon as the weather conditions are suitable in spring and is completed soon after flowering. Once the cleistothecia have discharged their ascospores there is no rainfall requirement for further infections to occur.

Characteristic folding of the leaf where a cleistothecia-generated infection has started. *Photo: S Hackett*

At budburst, the 'flag' shoots emerge heavily infected with powdery mildew fungus. Under the right conditions the fungus produces conidial spores that spread to infect green shoots, leaves, flowers and grape bunches. Because the flag shoots emerge at budburst already infected with the mildew, it is likely that the buds already formed on those shoots will have become infected, and that these infected buds will produce new flag shoots the following season. However, grapevine buds remain susceptible to powdery mildew infection for about 18 days from the time they first appear at the base of each leaf. The retention of spurs bearing such buds means that powdery mildew tends to first appear season after season on the same vines in the same part of the vineyard. Identifying and treating those 'hotspots' is the most effective way of breaking the reinfection cycle and minimising the need for chemical remedies.

One of the keys to controlling powdery mildew is to ensure that adequate spray coverage is achieved early in the season. Protectant sprays should begin soon after budburst and continue every 10 to 14 days, depending on the vine growth rates and prevailing weather conditions.

If powdery mildew has been a persistent problem in the vineyard for a number of seasons, consider using a systemic fungicide about 4 weeks after budburst to minimise the disease development resulting from flag shoots. Spraying with systemic fungicides earlier than this is not considered as effective, as often the flag shoots don't emerge until several weeks after normal budburst.

Take care when applying non-systemic sprays at flowering, because once the flower caps begin to drop from the developing inflorescences the protective barrier is also lost, leaving the flower parts susceptible to infection.

Further sprays for powdery mildew after the flowering period should be applied according to the rate of new growth in the vineyard and the prevailing weather at the time.

Summary

Early protection is critical to protecting new developing leaves, shoots and bunches and minimising the potential for disease build-up.

Where there has been a history of problems with powdery mildew, application of a systemic fungicide about 4 weeks after budburst should help to minimise the spread of the disease from flag shoots.

Acknowledgments

Particular thanks go to Peter Magarey, Bob Emmett and Trevor Wicks for their valuable contributions to the understanding of these diseases.

Young vine decline in the Riverina: a riddle solved

MELANIE WECKERT, RESEARCH PLANT PATHOLOGIST, NWGIC, WAGGA WAGGA

In 2002, Harry Creecy, then a NWGIC District Viticulturist based in Griffith, NSW, was getting a lot of enquiries from growers concerned that their newly planted vines were diseased. The vines either died soon after planting or grew very slowly, produced few grapes, and died in the next few years. The disorder was described as 'young vine decline' (YVD). Our challenge was to answer the question: Why was this now appearing in the Riverina? Adding to our challenge was a certain amount of confusion over the causes of other conditions, referred to collectively as 'restricted spring growth'.

A typical diseased grapevine in a Riverina vineyard affected by 'young vine decline'. Note very short shoots compared with those on normal vines in the background.

Photo: Melanie Weckert

Questionnaire survey

Our first step was to prepare a questionnaire survey in collaboration with the Wine Grapes Marketing Board, Griffith. The survey was posted to 560 Riverina growers, and we were assisted by a 30% response rate. This indicated that YVD was obviously important to the industry. We found that over 65% of Riverina growers had experienced economically serious problems with plantings of grafted vines. Many respondents described it as a 'Chardonnay/Ramsey' problem', but this appears to have been due to the predominant use of Ramsey rootstock for the large number of Chardonnay plantings in the district at that time. Many growers reported YVD with rootstocks other than Ramsey and scions other than Chardonnay. As a result of the survey questionnaire, we sought a solution within the Winegrowing Futures program, jointly funded by NWGIC and the GWRDC.

Isolation of YVD fungi

The next step was to find what caused YVD. We suspected that the problem was caused by pathogenic fungi—but which ones? And how were they entering the grape production system? We thoroughly surveyed 30 YVD-affected vineyards in the Riverina – most, but not all of them, grafted. In our laboratory we isolated a range of fungi from roots, trunks, cordons and shoots. From this study we invariably found the fungi *Cylindrocarpon* (Cyl) and *Botryosphaeria* (Bot) in rootstock stems (i.e. below the graft unions) of YVD-affected plants. Cyl was also consistently found in the roots of affected plants, and Bot was isolated from the roots in some affected plants. YVD-affected ungrafted plants were similarly infected. Neither fungus was found in unaffected plants. *Cylindrocarpon* is known to cause blackfoot, a root rot disease of grapevines that is associated with poorly drained soils but had not previously been reported in the Riverina. *Botryosphaeria* is known to cause bot canker, a debilitating grapevine trunk disease now known to occur in many Australian vineyard regions.

The rootstock stems of newly planted vines had many dark, discoloured patches or wedges, but the scions were not discoloured and were free of pathogens. However, after a few years' growth the scions also became diseased, presumably because the pathogens had moved up the trunk, through the graft union, and into the scion wood.

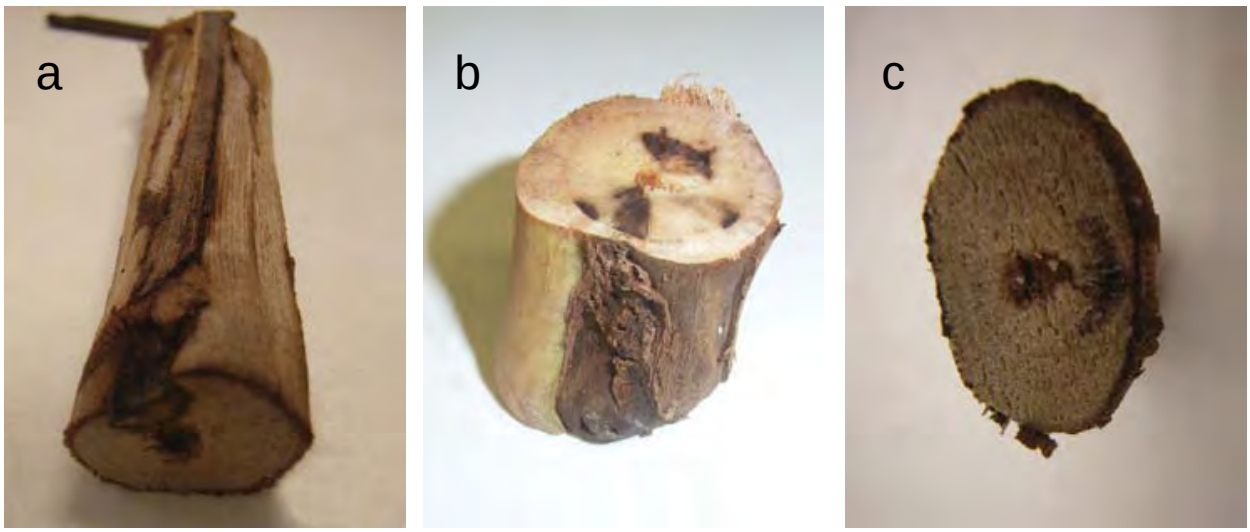
Effect of YVD on vine performance

Early in the season the YVD-affected vines had very short shoots that tended to 'catch up' later to a certain extent but remained significantly shorter at harvest. Colleague Dr Andrew Hall organised an aerial 'fly-over' with remote-sensing equipment, and the resulting images showed clearly that the diseased vines had much less growth than their healthy neighbours (Figure 1). The roots of affected vines were also far less developed, and the poor root systems limited the total amount of root starch reserves. Yields of YVD-affected vines were low (Figure 2). The low yields were caused by low bunch numbers, not smaller bunches, leading us to conclude that the lower carbohydrate reserves in the diseased vines precluded normal inflorescence initiation and development.

YVD studies

We infected the roots of potted Chardonnay with both Bot and Cyl, separately and together. Bot and Cyl alone were able to cause disease in the potted vines, but the disease symptoms were worse when the two fungi were applied together (Figure 3).

From our studies in the vineyards and the glasshouse, we concluded that the two causal agents of YVD in



Plant tissue from vineyards with YVD: (a) Ramsey stem from a vineyard with a 40% strike rate. We isolated Cyl from roots and Bot and Cyl from wood. (b) Ramsey stem from a vineyard with a 40% strike rate. We isolated Bot and Cyl from roots and Bot from wood. (c) Ramsey stem from a vineyard with a 10% strike rate. We isolated Bot and Cyl from both roots and wood. *Photos: Melanie Weckert*

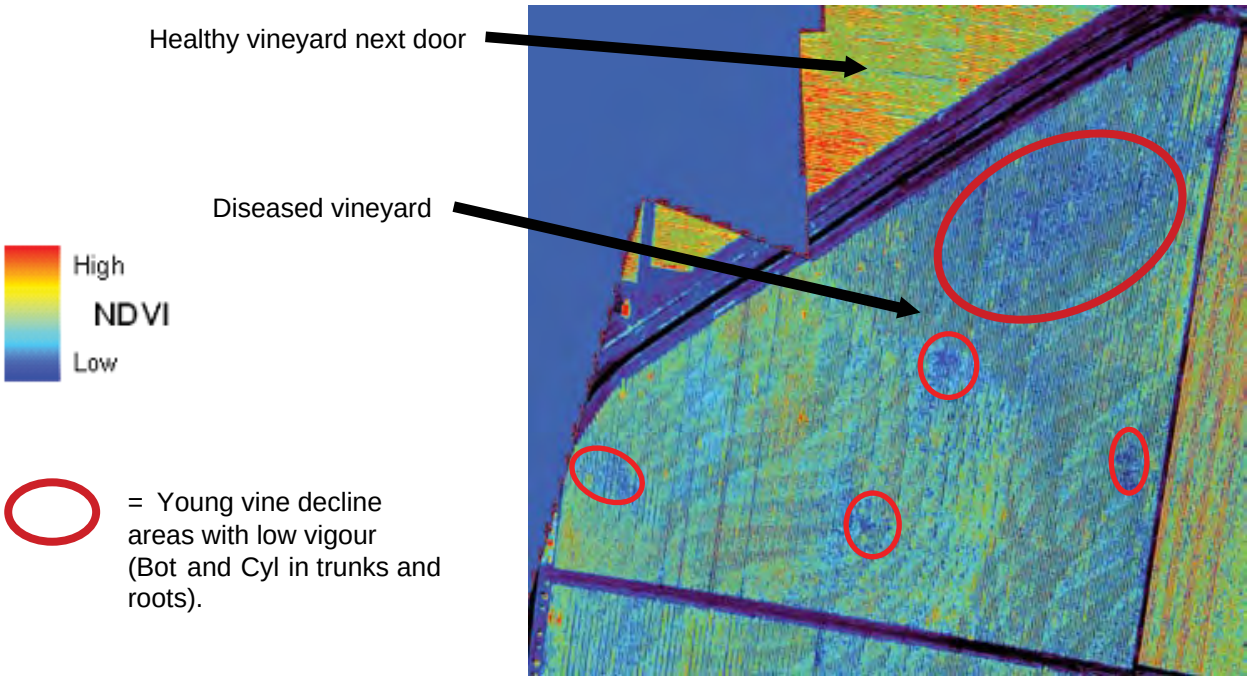
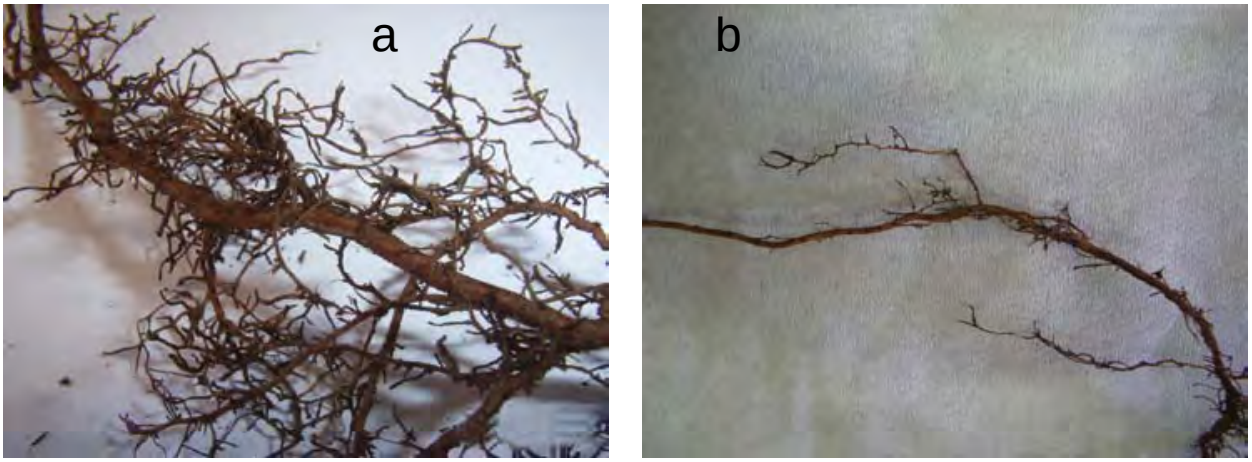


Figure 1: Distribution of diseased vines, as evidenced by blue colours, within a YVD-affected Riverina vineyard. The vineyard next door was healthy, as evidenced by the yellow and red. *Photo: Andrew Hall*



Roots from healthy vines (a) and diseased vines (b) in a YVD-affected Riverina vineyard. *Photos: Melanie Weckert*

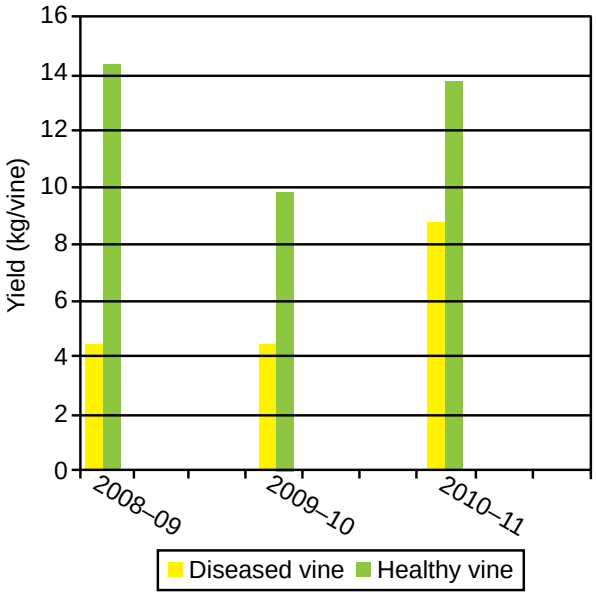


Figure 2: Yields from one YVD-affected Riverina vineyard, showing decreased yields for diseased vines over 3 years.

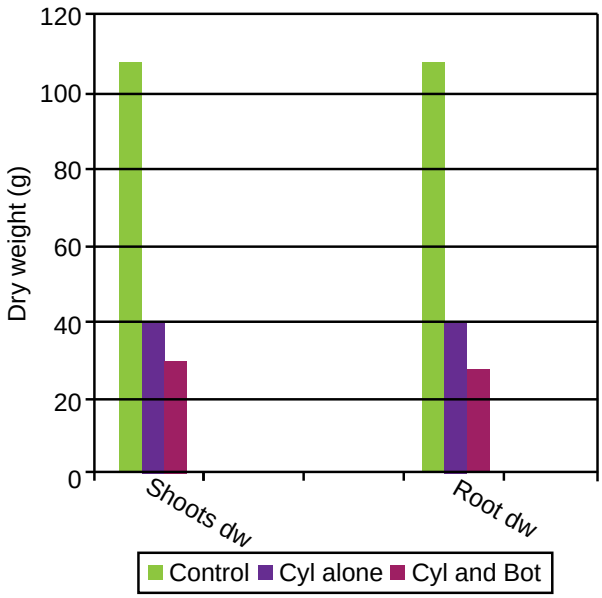


Figure 3: Results of pot trial showing that shoot and root dry weights were greatly decreased when roots were inoculated with Cyl alone. There was a further decrease when roots were inoculated with both Cyl and Bot.

Riverina grafted vines were Cyl in the roots and Bot in the rootstock stem.

But how does YVD happen?

Our next question was: Where and how did both these fungi enter the production system (i.e. rootstock source blocks, nurseries and vineyards)? Our studies led us to the following sequence of infection.

First, some shoots of rootstock source vines become infected with Bot. As evidence of this, we isolated Bot from the canes of vines in some rootstock source blocks. Bot infection seems to be favoured by the common practice of managing rootstock source vines to give short trunks and unlimited buds and pruning the shoots back to the trunk each season. Shoots from such vines sprawl on the ground, where they can pick up Bot from the soil. Furthermore, Bot spores can infect the many pruning wounds each season. Our colleagues have found Bot in most Australian viticultural regions now, and its spores disperse readily in the air.

Next, the Bot-infected rootstock cuttings can contaminate uninfected cuttings when the cuttings are soaked in water for several hours or more for rehydration. Rootstock cuttings are often hydrated twice—once before cool storage and again before grafting. The practice of disbudding rootstock cuttings creates many infection-susceptible wounds.

Finally, Cyl already in the soil infects the roots in the field-nursery rows. Bot can also infect wounds at this stage. Infected plants may look outwardly healthy and may grow reasonably well in the nursery for a year before they are lifted for planting in the vineyard.

Do Bot and Cyl enter the vine in the vineyard?

After being planting out in the vineyard, the 'healthy'-looking but internally infected vines soon show disease symptoms. Originally, some believed that, in some cases of YVD, infection occurred in the vineyard rather than earlier. Although such infection may occur, we found evidence that this was generally not so. Bot and Cyl are slow-growing fungi, and in all of our microscopic examinations of stems just after planting the infections were well advanced, extending from the oldest (innermost) xylem ring to younger tissue. This provided evidence that the diseases in these cases must have started before planting. We also found no Cyl and Bot in the vineyard soil of recently planted but diseased vines.

Prevention

1. Rootstock source vines should be trellised with their shoots trained off the ground to avoid *Botryosphaeria* infection.
2. Nurseries should:
   - Ensure that canes have been correctly disinfected by hot water treatment
   - Check plant stock for disease at every propagation stage by visual inspection and diagnostics.
   - Rotate field nursery sites to avoid build-up of *Cylindrocarpon*.
   - Avoid using heavy soils that favour *Cylindrocarpon*.
3. Growers should ensure, by visual testing, that planting stock is healthy before planting: cut up a few stems in every batch and look for dark patches, spots or wedges. See *Quality planting stock: it's your business* in this issue of the Guide to find out what to look for in a healthy vine.

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Remedies

We have found that YVD-affected vines may eventually recover to normal growth, but only after very careful management to avoid all stresses. Some stressors in the vineyard include overcropping of young vines, too little or too much water, insufficient nutrients, and low soil organic carbon levels. Composts may be applied to increase organic carbon, increase water infiltration and decrease evaporation. High soil organic carbon levels also increase the abundance of suppressive microbes and beneficial nematodes to improve nutrient cycles. However, in our view it is usually less costly to avoid using infected planting stock in the first place.

Further reading

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Soil warming before flowering increases grape flower numbers but decreases fruit set during severe photosynthetic stress

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It is well known that low light interception by grapevine leaves during flowering can lead to inflorescence necrosis (or bunch stem necrosis), shedding of young flowers and ovaries, and consequently poor fruit set (the proportion of flowers that form expanding ovaries, i.e. potential berries). This is caused by a reduction in the photosynthetic capacity of the vine leaves. In low light the supply of carbon and energy from photosynthesising leaves is evidently insufficient for fertilisation and the growth of flower ovaries. Low light intensity is one cause of photosynthetic stress, but there are others, such as leaf loss, drought and excessive heat. Given the importance of fruit set and the number of opportunities for photosynthetic stress to affect it, we wondered whether, under photosynthetic stress conditions, grapevines are able to draw on carbohydrates stored in the roots from the previous season as an alternative carbon and energy source for fruit set. If so, greater attention would be directed to vineyard management to ensure adequate carbohydrate restoration in the roots and trunks each season.

To answer this question we had to first create sets of vines with low and high levels of stored carbohydrates.

Not CO_2 stressed

CO_2 stressed

Fruit set after photosynthetic stress induced by stripping carbon dioxide (CO_2) from the air at capfall. *Photos: Suzy Rogiers*

We achieved this by warming the soil around one set of potted vines between budburst and first capfall. Soil warming depleted the carbohydrate reserves stored as starch in the roots and promoted shoot and inflorescence growth. At capfall we then placed vines with low and high carbohydrate reserves in controlled-environment rooms and subjected them to photosynthetic stress, which we induced very directly by stripping carbon dioxide from the air.

The fruit set of photosynthetically stressed vines was more than half that of vines grown at the normal carbon dioxide level. Furthermore, fruit set during photosynthetic stress was not improved by the utilisation of carbohydrates stored previously, before capfall; under photosynthetic stress most of the available carbohydrate went into shoot growth.

However, when there was no photosynthetic stress the fruit set of vines with low carbohydrate stores at capfall was 26% less than that in vines with high carbohydrate stores.

The low-carbohydrate plants did have more flowers, because the soil warming we used to create their low-carbohydrate state induced them to use stored carbohydrates in greater shoot and flower development before capfall. Even so, their fruit set and number of potential berries were both lower, and a greater a proportion of carbohydrate from concurrent photosynthesis was used in root growth than in setting fruit.

We found that, regardless of the amount of carbohydrate at capfall, vines in normal air actively restored similar amounts of root reserves of carbohydrate while fruit set was taking place.

The findings were clear:

1. Fruit set under normal conditions was positively related to the amount of carbohydrates stored previously, at capfall.
2. Fruit set was greatly reduced by severe photosynthetic stress but was not affected by the amount of stored carbohydrate present at capfall.

These findings confirm the sensitivity of fruit set to photosynthetic stress. Of course, in vineyards, photosynthetic stress is not caused by low atmospheric CO_2 levels but can be caused by environmental factors such as low light intensity, low temperature, and drought stress. Leaf shading and leaf removal also cause photosynthetic stress. Although some of these factors can be avoided by good management, others, if severe enough, can represent a seasonal risk. Our findings show that this risk cannot be reduced by the utilisation of carbohydrate reserves from perennial parts.

The message from this is:

Use irrigation, disease control and canopy management to maintain healthy, unshaded leaves to minimise photosynthetic stress and optimise fruit set.

The increase in flower numbers in response to soil warming between budburst and capfall is an important finding. It helps us to understand the consequences of season-to-season differences in springtime temperatures and indicates that soil temperature has an important influence on flower numbers and hence potential yield. Although soil temperature and air temperature are generally related, our findings now direct attention to the temperature of the soil, rather than the air, in relation to grape flower development. The research also reveals the important role of carbohydrate reserves stored in the previous season in enabling this response.

Conclusion

In summary, the study highlights the important role of carbohydrate reserves in determining flower numbers and fruit set. It raises the question:

What can a grower do to assure adequate vine carbohydrate reserves during early-season flower development and fruit set?

Answers:

- Each season, use irrigation, disease control and canopy management to maintain healthy, unshaded leaves from budburst to leaf fall and thus optimise photosynthesis and carbohydrate reserve restoration.
- Avoid excessive fruit loads (i.e. cropping beyond the capacity of the vine to ripen its fruit without drawing on carbohydrate reserves).

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Semillon: a variety that can't hold its water

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Semillon is an important white wine variety grown in Australia and is particularly important to the regional economies of the Riverina and Hunter Valley. Unfortunately, as we have shown, it is more sensitive than other common varieties to dehydration. Related problems are wilting and leaf burn, which are most likely to occur when there is low leaf-water status. Some varieties have very tight control over water loss, but Semillon is not one of them.

Typical symptoms of leaf burn in Semillon. Photo: Suzy Rogiers

The cause of Semillon's sensitivity to dehydration and leaf burn is the lack of responsiveness of its stomata to drying conditions (i.e. conditions of high evaporative demand) and to darkness. Normally, when plant water stress rises during the middle of the day, the stomata close. This decreases carbon uptake for photosynthesis, but it prevents the plant from reaching an extreme state of dehydration from which it may not recover. Lack of stomatal responsiveness to drying conditions means that, on hot days, Semillon canopies are cooler than those of other varieties because they have high transpiration rates. Nevertheless, the edges of Semillon leaves are more likely to die ('burn'), because little water reaches these extremities.

Grapevines are generally very photosynthetically active during the day, taking up carbon dioxide and converting it into sugars, which they use as an energy supply for growing roots, shoots, leaves and fruit. Carbon dioxide enters through the stomata on the undersides of the leaves; at the same time, water vapour escapes. Accordingly, the plant can become dehydrated if the soil moisture level is low or if moisture uptake by the roots can't match what is being lost through the stomata. In the late afternoon, when the light begins to fade, the photosynthetic process slows down and the stomatal pores generally close. Water absorption by the roots continues throughout the night and, if there is enough soil moisture, the plant is rehydrated by morning to start another day of photosynthesis. Lack of tight stomatal responsiveness to light means that, unlike other varieties, Semillon often does not fully rehydrate overnight. This leaves it more susceptible to water stress and impaired photosynthesis during the day.

What do these features mean for Semillon growers?

First, Semillon needs more water than other common varieties (e.g. Chardonnay, Shiraz and Grenache) to prevent dehydration. Our findings suggest that this need might be several times more than that of Shiraz; the actual amount will depend on the evaporative demand where Semillon is grown.

Second, because it more rapidly depletes soil water, Semillon is best grown in deep soils with high water-holding capacity and is not well suited to deficit irrigation strategies. Withholding water before the fruit is ripe generally only causes leaf dysfunction, cessation of sugar accumulation, and the production of 'baggy' or partly shrivelled fruit. Because of their greater susceptibility to dehydration, Semillon plantings require careful attention to maintaining soil moisture at high levels, particularly when hot and/or windy conditions are anticipated.

In the Riverina, we have found that drip irrigation is well suited to the responsive water applications that are required in predicted heat waves.

Our research has also demonstrated that the adverse effects of high air temperatures and low water status on Semillon are greatest in north–south rows and may be offset to some degree by careful management to create a degree of leaf shading. We have also found from pot experiments that dehydration can be aggravated or alleviated by using different rootstocks. These aspects of Semillon management warrant further research.

Further reading

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Phylloxera

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What is Phylloxera?

Grape phylloxera, *Daktulosphaira vitifoliae*, is an aphid-like insect that lives and feeds on the roots of grapevines and occasionally in distinctive galls on grapevine leaves. Phylloxera originates from eastern North America, where it lives on native grapevines. However, the insect is now distributed throughout much of the world as a result of the movement of phylloxera infested grapevines especially in the late 1800s. European (*Vitis vinifera*) vines have little or no tolerance to phylloxera feeding and almost always die. Phylloxera is thus regarded as the world's worst grapevine pest.

Phylloxera is a sap sucking insect that feeds on soft vine root tissue. Yellow, fleshy galls (nodosities) develop on young fibrous roots, and brown, warty galls on storage roots from feeding. Phylloxera insects live mainly on the surface of root galls, but occasionally crawl to the soil surface or canopy, from where they can disperse to new roots and vines. Leaf galls of phylloxera rarely occur in Australia, and tend to occur mainly in humid conditions and only on the leaves of American *Vitis* species or hybrids.

Life cycle

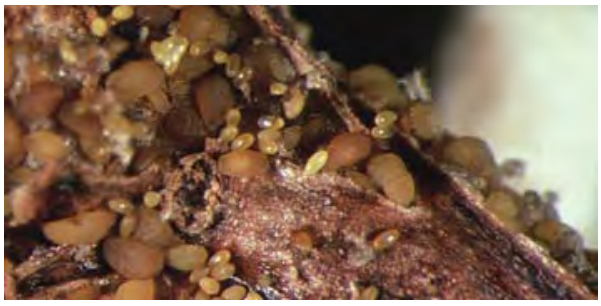
Recent research in Australia has shown that the insect almost certainly reproduces exclusively by clonal or asexual reproduction. Several generations of phylloxera develop during the growing season. During spring and summer, the adults lay eggs that hatch into crawlers. Crawlers feed on roots and increase in size and moult four times before becoming adults. Winged adults, which are the forerunners of the leaf-galling cycle on American vines, sometimes develop later in the season during March and April in Australia. Winged adults do not appear to undergo a sexual reproduction cycle in Australia. During winter, phylloxera lies dormant, mostly sheltering under bark on roots.

Symptoms

The first symptom of phylloxera feeding is decline in vigour. Premature yellowing of vines in March tends to occur about 1 to 3 years after the vines are infested. Expression of symptoms tends to be accelerated in stressed vines. Patches of vines become progressively weaker, and the area affected increases as the phylloxera population increases and spreads. Good growing conditions reduce the effects of phylloxera, especially in sandy soils.

Satellite spots develop after 2 to 3 years of infestation. These spots appear to occur at random in the infested vineyard. Spread of phylloxera tends to be more rapid in the direction of the prevailing winds. Crawlers are known to be dispersed by wind.

Feeder root galls (nodosities) *Photo: Kevin Powell*



Phylloxera adults, crawlers and eggs on a root
Photo: Kevin Powell

Phylloxera leaf galls *Photo: Kevin Powell*

Phylloxera crawlers *Photo: Kevin Powell*

Symptoms of phylloxera attack: premature yellowing and poor vigour *Photo: Andrew Loch*

To check vines for phylloxera, examine fibrous roots within 0.5 m of the base of the vine during December to April. Infested vines will have fleshy yellow galls on fibrous roots, with pinhead-sized yellow insects living on the surface of the galls. Most insects are found on vines at the margins of areas of weak vines. Vines in the centre of weak patches have badly damaged root systems. Fibrous roots are lacking, and the older roots have cracks and warty bumps caused by phylloxera.

Growers with any vines with phylloxera-like symptoms must contact their nearest Department of Primary Industries office.

Prevention and control

In Australia, crawlers developing from eggs laid on the root system are the most important dispersive stage. Winged adults may also disperse but they are not regarded as a risk because they do not appear to undergo sexual reproduction in Australia. Where leaf galls occur, crawlers from eggs in the leaf gall can be wind-blown and spread infestations. Phylloxera crawlers can be present on leaves and fruit of infested grapevines, especially during summer and autumn. Any harvesting machines, picking buckets, wine bins or other equipment in contact with fruit or foliage may be contaminated with phylloxera crawlers.

New infestations of phylloxera are generally a result of unintentional spread by people. Phylloxera can be transferred on grapevine rootlings, through equipment that has been used in infested vineyards, and by people moving from infested vineyards. Observe signs discouraging entry into phylloxera-free vineyards.

Planting material should always be purchased from nurseries in phylloxera-free areas, and preferably should have been hot-water treated. The use of tolerant rootstocks is the only established, proven way of managing phylloxera. Rootstocks can also manage nematodes, and various rootstocks can be chosen to suit soil types and cultural conditions.

All vineyards in actual or potential danger from phylloxera should be planted with vines grafted onto resistant rootstocks. Even in sandy soils where phylloxera appears less damaging, the use of rootstocks is advisable to manage nematodes. At present there is no effective and economic long-term way of managing phylloxera on ungrafted vines.

Phylloxera quarantine

Australia is one of the few countries to keep its main vineyard regions free of phylloxera. Quarantine boundaries have been established in Australia to prevent movement of phylloxera from known infested areas into free or exclusion zones (Figures 4, 5 and 6). Areas of unknown status (Phylloxera Risk Zones; PRZ) are also protected under legislation. Three quarantine zones exist.

Main dispersive stages of phylloxera – winged adult (left) and crawler (right) *Photo: Kevin Powell*

Phylloxera Infested Zones (PIZs)

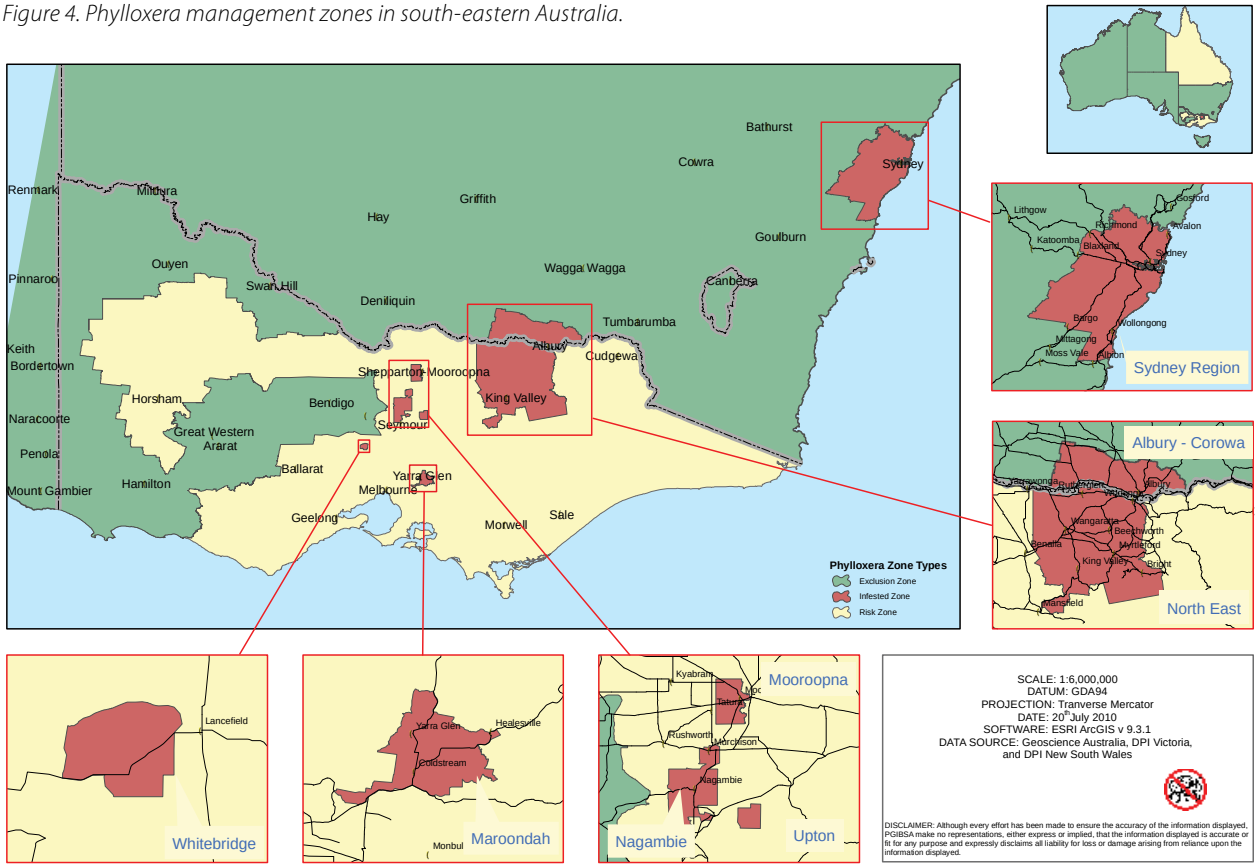
Phylloxera Infested Zones (PIZs) include the North East PIZ (Rutherglen, Wangaratta and King Valley), Nagambie PIZ (Nagambie and Murchison), Mooroopna PIZ (Shepparton), Upton PIZ (Upton) and the recently declared Maroondah PIZ (Yarra Valley) and Whitebridge PIZ between Rochford and Cobaw in the Macedon Ranges.

The NSW PIZ includes 1) the Albury/Corowa Infested Zone, which includes the local government areas of Albury, Corowa (that part within the County of Hume) and Greater Hume (excluding Culcairn and Holbrook, which were abolished as part of the amalgamation of local government areas); and 2) the Sydney Region Infested Zone, including the Camden zone and part of the Wollondilly local government area, within the County of Cumberland, as well as the Wollongong local government area.

Phylloxera Risk Zones (PRZs)

Phylloxera Risk Zones (PRZs) are zones that have no evidence of phylloxera infestation but could be a risk to the free areas because of nil or inconclusive investigations. The whole of the State of Queensland and large areas of Victoria have PRZ status.

Figure 4. Phylloxera management zones in south-eastern Australia.



Map produced by the Phylloxera and Grape Industry Board of South Australia – 2010
Please note zone boundaries can change, particularly if there is a new phylloxera outbreak
Visit www.phylloxera.com.au to check for the latest version.

Disclaimer: This map is based on publically available data. PGIBSA do not warrant that this map is definitive nor free from error and do not accept liability for loss arising from use of this product.

Phylloxera Exclusion Zones (PEZs)

Phylloxera Exclusion Zones (PEZs) are the States of South Australia, Western Australia and Tasmania, the Northern Territory, plus declared areas in Victoria (Henty–West Wimmera, Grampians–Pyrenees, and Greater Sunraysia Exclusion Zones) and most of NSW except those areas declared a PIZ (see above).

The law and phylloxera in NSW

Phylloxera is a declared pest under Proclamation P172 of the *Plant Diseases Act 1924*, and if the occupier of any land or premises finds it, they must report its presence to an DPI NSW Regulatory Officer within 24 hours after they first discover it or become aware of its appearance. In NSW there are phylloxera infested zones in the southern part of the State (Albury–Corowa; Figure 5) and the Sydney Region, including Wollongong (Figure 6).

Department of Primary Industries (formerly I&I NSW) recently completed a 4-year ground survey (2002–2006) for phylloxera in all vineyards in the previously declared PRZ in NSW. These surveys did not find phylloxera or any signs of phylloxera in these vineyards, and therefore the legislation was changed on 22 December 2006 to declare most of NSW a PEZ.

Proclamation P176 of the Plant Diseases Act outlines regulations on movement of the following items into NSW and between infested and exclusion zones within NSW: phylloxera insects or anything infested with them, potted grape plants, cuttings and rootlings of the genus *Vitis*, products such as table and wine grapes, must, juice and marc, used vineyard machinery and equipment, vineyard soil and garden organics.

Movement of grapevine cuttings, rootlings, potted vines, whole wine grapes, must, unfiltered juice, pre-fermentation marc and soil is prohibited from entering a NSW PEZ or PIZ from a NSW or interstate PIZ. Vineyard soil is prohibited from entering NSW from interstate. Germplasm, diagnostic samples and used vineyard machinery or equipment are allowed regulated entry into NSW from NSW or interstate PIZ if accompanied by a Permit issued by the Principal Director, Biosecurity, or delegated Directors and a Plant Health Certificate certifying that all conditions in the approval have been met. Similarly, germplasm and diagnostic samples

Figure 5. Southern NSW Phylloxera infested zone.

entering NSW from an interstate PRZ require a Permit and a Plant Health Certificate. Table grapes are allowed entry into NSW from an interstate PEZ if free from soil and leaf material, and from interstate PRZ and NSW or interstate PIZ if packed for sale as table grapes with sulfur pads and free from soil and leaf material. Most other grape-related movements between different NSW zones and between NSW and other States are permitted if accompanied by a Plant Health Certificate or Plant Health Assurance Certificate (if the business is under an approved Interstate Certification Assurance (ICA) arrangement) certifying that specific conditions have been met.

Maintenance of phylloxera freedom

Grape growers, winemakers and industry groups in grape-growing regions without phylloxera must demonstrate ongoing passive maintenance to confirm their phylloxera-free status. Maintenance includes ensuring adherence to vineyard, winery and regional entry regulations, increasing industry and public awareness of phylloxera and associated regulations, and reporting of any suspected infestation or violation of regulations.

Phylloxera quarantine contacts

For further information on Phylloxera quarantine, contact your nearest DPI NSW Regulatory Officer. If a permit is required, contact the Plant Biosecurity Unit, Head Office, Orange (02 6391 3244).

Figure 6. Sydney region Phylloxera Infested Zone.

Further information on phylloxera and current regulations can be found on the DPI NSW website at www.dpi.nsw.gov.au/agriculture/horticulture/grapes/grape-phylloxera

Syngenta – Growth stages of grapevine, full page colour

Syngenta – Growth stages of grapevine, full page colour

Movement of wine grapes into the NSW Fruit Fly Exclusion Zone

ANDREW LOCH, ENTOMOLOGIST, NWGIC AND DPI, WAGGA WAGGA
JOHN SLACK, FORMER POLICY OFFICER, PLANT BIOSECURITY, DPI, ORANGE

Introduction

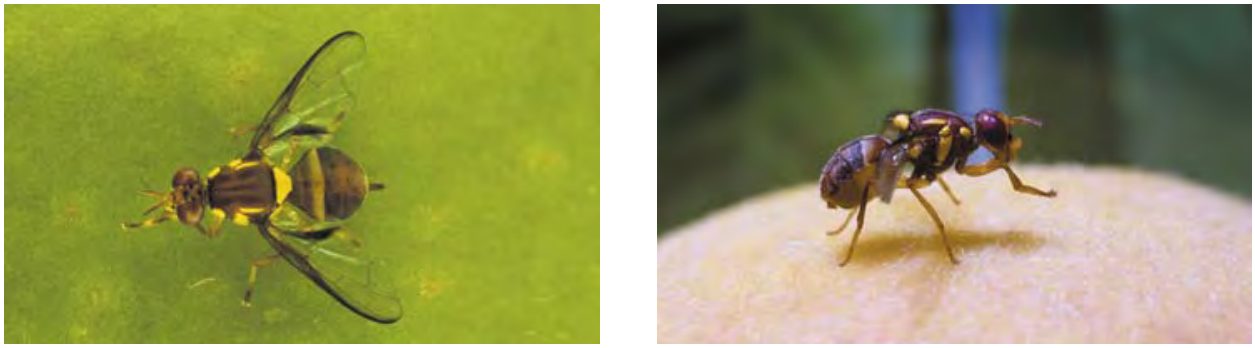
Queensland fruit fly, *Bactrocera tryoni*, is the most serious and widespread fruit pest of eastern Australia. It is found in parts of the Northern Territory, Queensland, NSW and Victoria, and occasionally in South Australia. The damaging stage is the larva, which feeds in the fruit, making it rot inside. Fruit may also rot through fungal decay around wounds in the fruit surface caused by the adult female stinging the fruit to lay her eggs. Fruit fly infests a wide range of species of fruiting host trees and vines, including vegetables such as tomato, capsicum and chilli. Host suitability and preference for vary greatly among different fruit species. In general, fruit is most susceptible to attack as it approaches maturity.

Grapes as hosts for Queensland fruit fly

During the 2007–2008 wine grape growing season, many Hunter Valley vineyards were seriously affected by Queensland fruit fly. Historically, wine grapes have not been regarded as hosts for the fruit fly, or at the very least they have been seen as occasional, or poor, hosts. Table grapes are also regarded as poor hosts, but Queensland fruit fly can in fact complete its development in a range of table grape varieties. The significant Queensland fruit fly damage recorded in the Hunter Valley during 2007–2008, coupled with the successful development of the fruit fly in several wine grape varieties, confirms that wine grapes are suitable hosts for fruit fly development. However, it is highly likely that they are not preferred hosts.

Distribution and fruit fly exclusion zones

Queensland fruit fly occurs in most grape-growing areas throughout Queensland, NSW and Victoria. South Australia is declared free of Queensland fruit fly, although occasional minor outbreaks in other horticultural crops occur there. Some areas of New South Wales (Murrumbidgee Irrigation Area), Victoria (Sunraysia, Mid Murray and Goulburn Valley) and South Australia (Riverland) have been declared as part of the Fruit Fly Exclusion Zone (FFEZ, Figure 7). This zone has been established to allow fruit growers in these areas to have access to export markets through the elimination of Queensland fruit fly from this zone and surrounding areas.



Top and side views of adult Queensland fruit flies (female on left, male on right). *Photos: M. Hill*

Queensland fruit fly larva and associated feeding damage inside grape berry. *Photo: A. Loch*

Bunch of grapes affected by Queensland fruit fly. Note the sting marks on the fruit and the discolouration indicating internal rotting as a result of larval feeding. *Photo: A. Loch*

Figure 7. The Fruit Fly Exclusion Zone (FFEZ) of south-eastern Australia. Note that there may be temporary outbreaks of Queensland fruit fly within this zone from time to time. Contact your State's primary industries office for up-to-date information on outbreaks within the FFEZ.

Movement of wine grapes into the NSW FFEZ

Queensland fruit fly host materials such as wine grapes are prohibited from entering the NSW FFEZ unless the conditions below are met. For movement conditions for entry of wine grapes into the FFEZ in Victoria or South Australia, contact the relevant State primary industries department.

1. Certification of consignments of host fruit entering the NSW FFEZ

Each wine grape consignment must be accompanied by a Plant Health Certificate or a Plant Health Assurance Certificate certifying that the applicable conditions of Proclamation P184, Director's Approval P184/08/01, Condition 15 have been met.

Certification is required for entry of wine grapes into the NSW FFEZ if the grapes were grown and packed in the Greater Sunraysia FFEZ under Area Freedom Certification [Interstate Certification Assurance (ICA) arrangement ICA-23] certifying that the area is Queensland fruit fly free.

A Plant Health Certificate is a certificate issued by an inspector or a person authorised by the primary industries department of the relevant State or Territory to issue Plant Health Certificates; it certifies that the host fruit has been treated in compliance with Proclamation P184.

A Plant Health Assurance Certificate is a certificate issued by a business accredited under an ICA scheme and authorised by the primary industries department of the relevant State or Territory to issue Plant Health Assurance Certificates; it certifies that the host fruit has been treated in compliance with the applicable conditions in this approval. ICA-33 is an accreditation system specifically designed for this purpose.

2. Accreditation of a business introducing wine grapes into the NSW FFEZ

A business introducing wine grapes into the NSW FFEZ for processing must be accredited under a compliance agreement (ICA-33) administered by the Plant Biosecurity Unit, Head Office of DPI NSW, Orange.

3. Secure postharvest storage of wine grapes

All wine grapes must remain securely stored up to the time of dispatch and transport into the NSW FFEZ. All practical measures must be taken to ensure that security of grapes is maintained during activities that may expose the fruit to the risk of fruit fly infestation.

4. Movement conditions

In the case of wine grapes originating from outside the NSW FFEZ or from a declared suspension area within the NSW FFEZ:

- all bins or containers and trucks and trailers intended to be used for transporting wine grapes must be free from all plant debris and soil before packing and loading
- before dispatch, the wine grape consignment must be covered by a tarpaulin, shadecloth, bin covers or other coverings, or contained inside the covered vehicle, so as to prevent spillage of fruit during transport to the processing winery
- the bins or containers must be loaded onto a transport vehicle on a hard surface and not in the vineyard
- the transport vehicle must be cleaned free of all soil and plant matter such as leaves, stems and fruit after the consignment is loaded and before it leaves the vineyard, and the vehicle must travel by the most direct route to the processing winery
- the wine grapes must be processed within 24 hours of when the consignment is received by the winery
- every effort must be taken to avoid spillage of the wine grapes at the processing winery, and spilled material must be disposed of in a way that is generally accepted as likely to prevent the spread of Queensland fruit fly within the FFEZ.

Wine grape quarantine movement contacts

For further information on wine grape quarantine movements into the NSW FFEZ, contact your nearest DPI NSW Regulatory Officer. Questions about ICA-33 should be directed to the Plant Biosecurity Unit, Head Office, Orange (02 6391 3244).

Information on the current NSW Queensland fruit regulations can be found at www.dpi.nsw.gov.au/aboutus/about/legislation-acts/plant-diseases

Information on ICA-33 can be found on the Domestic Quarantine Market Access website www.domesticquarantine.org.au

References and further reading

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Appendix 1

Agrochemicals registered for use in Australian Viticulture 2011–12

COMPILED BY MARCEL ESSLING AND KATE KUIJVERS
REPRODUCED COURTESY OF THE AUSTRALIAN WINE RESEARCH INSTITUTE.

Always read the label

Users of agricultural (or veterinary) chemical products must always read the label, and any Permit before using the product, and strictly comply with the directions on the label and conditions of any permit.

Users are not absolved from compliance with the directions on the label or the conditions of the Permit by reasons of any statement made or omitted to be made in this publication.

The product trade names in this publication are supplied on the understanding that no preference between equivalent products is intended and the inclusion of a product does not imply endorsement by the Department of Primary Industries over any other equivalent product from other manufacturers.

Some of the chemical use patterns quoted in this publication are approved under Permits issued by the Australian Pesticides and Veterinary Medicines Authority and were in force at the time the publication was prepared. Persons wishing to use a chemical in a manner approved under Permit should obtain a copy of the relevant Permit from APVMA. They must read all the details, conditions and limitations relevant to that Permit and must comply with the details, conditions and limitations prior to use.

AWRI
The Australian Wine Research Institute

Agrochemicals registered for use in Australian viticulture **11/12**

A must for grapegrowers and winemakers exporting wine

Compiled by Marcel Essling and Kate Cuijvers
Updated 31 May 2011

The support provided by the Grape and Wine Research and Development Corporation, and the member companies of CropLife Australia in the publication of this document is gratefully acknowledged.

ISBN 978 0 987 0480 2 8

ISSN 1320 3703

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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 $2.0 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 2011/2012 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, or by contacting Marcel Essling on telephone (08) 8303 6600.

If you are a member of the Australian wine industry and would like to subscribe to receive email notices from the AWRI on technical issues, including agrochemicals, please supply the following details to our Manager - Communication and Information Services,

Ms Rae Blair (Rae.Blair@awri.com.au): Name of email account holder, Organisation, Contact Telephone. Your email address can be removed from the list at any time should you request it in the future.

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

- 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/
- 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(s)	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 (see page 20)	List of chemical products available	The recommended withholding period for export grapes

Recommendations

Active Constituent (s)	Activitiy group	Some registered products	Restriction on Use
BLACK SPOT			
benalaxyl + mancozeb	4 + M3	Galben M	Use no later than 80% capfall.
chlorothalonil	M5	Applonil 720, Barrack 720, Barrack Betterstick, Bravo 720, Bravo Weather Stik, Cavalry 720 SC, Cheers 720, Cheers 720 Weathershield, Chemtura Chlorothalonil, Chlornil, Chlorothalonil 500 SC, Chlorothalonil 720, Echo 720, Echo 900 WDG, Elect 500, Fung-o-nil 500, Unite 720, Unite Ultrastick, Whack, Whack 900 WG	
metiram	M3	Polyram DF	
thiram	M3	Thiragranz, Thiram DG	
ziram	M3	Ziragranz, Ziram DG, Ziram Granuflo	
captan	M4	Captan 900 WG, Captan WG, Merpan	Use no later than 30 days before harvest.
copper hydroxide + mancozeb	M1 + M3	ManKocide DF	
copper oxychloride	M1	Copper Oxychloride WP, Oxydul DF	
dithianon	M9	Delan 700 WG	
mancozeb	M3	Choice Mancozeb 750 WG, Dithane Rainshield Neo Tec, innova Mancozeb 750, Kencozeb 750DF, Kendon Mancozeb, Mancozeb 750 DF, Mancozeb 750 WG, Mancozeb 800, Mancozeb DF, Mancozeb DG, Manfil, Manzate DF, Manzeb, Penncozeb 750DF, UniZeb 750 DF	
BOTRYTIS BUNCH ROT			
boscalid[1]	7	Filan	Use no later than 5% capfall (E-L 19-20[5]).
azoxystrobin	11	Amistar 250 SC, Mirador 250 SC, Supernova 250SC	Use no later than 80% capfall.
chlorothalonil	M5	Applonil 720, Barrack 720, Barrack Betterstick, Bravo 720, Bravo Weather Stik, Cavalry 720 SC, Cheers 720, Cheers 720 Weathershield, Chemtura Chlorothalonil, Chlornil, Chlorothalonil 500 SC, Chlorothalonil 720, Echo 500SC, Echo 720, Echo 900 WDG, Elect 500, Fung-o-nil 500, Unite 720, Unite Ultrastick, Whack, Whack 900 WG	
fenhexamid	17	Teldor 500 SC	
pyrimethanil	9	Pyrus 400 SC, Scala 400 SC	
cyprodinil + fludioxonil[2]	9 + 12	Switch	Use no later than E-L 31[5] (before bunch closure). Do not use within 60 days of harvest.
captan	M4	Captan 900 WG, Captan WG, Merpan	Use no later than 30 days before harvest.

Active Constituent (s)	Activitiy group	Some registered products	Restriction on Use
BOTRYTIS BUNCH ROT *(CONT.)*			
potassium salts of fatty acids	U1	Ecoprotector	Use no later than 14 days before harvest.
hydrogen peroxide + peroxyacetic acid (suppression only)	M + M	Peratec, Peroxy Treat	Use no later than 7 days before harvest.
iprodione	2	Chief Aquaflo, Corvette Flowable, Corvette Liquid, innova Iprodione 500 Aquaflo, Ippon 500 Aquaflo, Ipral 250, Iprine 250, Iprine 500, Iprodione 250, Iprodione Aquaflow 500, Iprodione Liquid 250, Rovral Aquaflo, Rovral Liquid, Subscribe, Transact	Use no later than 7 days before harvest. Consult your winery/ grape purchaser before spraying within 30 days of harvest.
DOWNY MILDEW			
phosphorous acid[3]	33	Agri-Fos 600, ChemPhos 400, Country Phospot 400, Country Phospot 400 pH 7.2, Country Phospot 600, Dominator 600, Fungi-Fos 400, Fungi-Fos 400 pH 7.2, Phos Phyt 400, Sprayphos 400, Sprayphos 620, Throw Down, Throw Down 600	Not recommended for use on grapes destined for export wines. Consult your winery/ grape purchaser[3].
azoxystrobin	11	Amistar 250 SC, Mirador 250 SC, Supernova 250SC	Use no later than 80% capfall.
benalaxyl + mancozeb	4 + M3	Galben M	
chlorothalonil	M5	Applonil 720, Barrack 720, Barrack Betterstick, Bravo 720, Bravo Weather Stik, Cavalry 720 SC, Cheers 720, Cheers 720 Weathershield, Chemtura Chlorothalonil, Chlornil, Chlorothalonil 500 SC, Chlorothalonil 720, Echo 500SC, Echo 720, Echo 900 WDG, Elect 500, Fung-o-nil 500, Unite 720, Unite Ultrastick, Whack, Whack 900 WG	
dimethomorph	40	Acrobat SC	
metiram	M3	Polyram DF	
oxadixyl + propineb	4 + M3	Rebound WP	
zineb	M3	Zineb	
mandipropamid	40	Revus	Use no later than E-L 26[5] (cap-fall complete)
trifloxystrobin	11	Flint 500 WG (suppression only)	Use no later than E-L 31[5] (before bunch closure).
pyraclostrobin	11	Cabrio, Cabrio 200WG	Use no later than E-L 31[5] (before bunch closure). Do not use within 63 days of harvest.
captan	M4	Captan 900 WG, Captan WG, Merpan	Use no later than 30 days before harvest.
copper ammonium acetate	M1	Cop-IT	

Active Constituent (s)	Activitiy group	Some registered products	Restriction on Use
DOWNY MILDEW *(CONT.)*			
copper ammonium complex	M1	Copperguard, Liquicop	Use no later than 30 days before harvest.
copper cuprous oxide	M1	Ag Copp 750, Nordox 500, Norshield, Norshield 750 WP, Norshield WG	
copper hydroxide	M1	Blue Shield DF, Cung Fu 350 SC, Champ Dry Prill WG, Flo-Bordo, Hydrocop DF, Kocide Blue Xtra, Kocide Opti	
copper hydroxide + mancozeb	M1 + M3	ManKocide DF	
copper octanoate	M1	Tricop	
copper oxychloride	M1	Copper Oxychloride, Copper Oxychloride WP, Coppox WG, Country Copper Oxychloride 500 WP, Oxydul DF	
copper sulphate tribasic	M1	Bordeaux WG, Cuprofix Disperss, Tri-Base Blue	
copper sulphate tribasic + mancozeb	M1 + M3	Novofix Disperss	
dithianon	M9	Delan 700 WG	
mancozeb	M3	Choice Mancozeb 750 WG, Dithane Rainshield Neo Tec, innova Mancozeb 750, Kencozeb 750DF, Kendon Mancozeb, Mancozeb 750 DF, Mancozeb 750 WG, Mancozeb 800, Mancozeb DF, Mancozeb DG, Manfil, Manzate DF, Manzeb, Penncozeb 420 SC, Penncozeb 750DF, UniZeb 750 DF	
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, Medley Plus	
metalaxyl + mancozeb	4 + M3	Axiom MZ 720, Maxyl, Medley MZ, Zeemil MZB 720 WP	
sulfur + copper oxychloride	M2 + M1	Mildex WG	
PHOMOPSIS CANE AND LEAF SPOT			
fluazinam[4]	29	Gem, Shirlan	Dormancy spray only.
metiram	M3	Polyram DF	Use no later than 80% capfall.
captan	M4	Captan 900 WG, Captan WG, Merpan	Use no later than 30 days before harvest.
copper sulphate tribasic + mancozeb	M1 + M3	Novofix Disperss	
dithianon	M9	Delan 700 WG	
mancozeb	M3	Choice Mancozeb 750 WG, Dithane Rainshield NeoTec, innova Mancozeb 750, Kendon Mancozeb, Mancozeb 750 DF, Mancozeb 750 WG, Manfil, Manzate DF, Penncozeb 420 SC, Penncozeb 750DF, UniZeb 750 DF	

Active Constituent (s)	Activitiy group	Some registered products	Restriction on Use
POWDERY MILDEW			
boscalid[1]	7	Filan	Use no later than 5% capfall (E-L 19-20[5]).
azoxystrobin	11	Amistar 250 SC, Mirador 250 SC, Supernova 250SC	Use no later than 80% capfall.
flusilazole	3	Nustar DF	
hexaconazole	3	Hex 50 SC, Viva	
metrafenone	U8	Vivando	
paraffinic oil	n/a	BioPest	
spiroxamine	5	Prosper 500 EC	
tebuconazole	3	Folicur 430 SC, Orius 430 SC	
trifloxystrobin	11	Flint 500 WG	Use no later than E-L 31[7] (before bunch closure).
sulfur, present as elemental or crystalline sulfur	M2	Dusting Sulphur, Dusting Sulphur 900	Use no later than 12 weeks before harvest.
pyraclostrobin	11	Cabrio, Cabrio 200WG	Use no later than E-L 31[5], (before bunch closure). Do not use within 63 days of harvest.
penconazole	3	Topas 100 EC	Use no later than E-L 31[5], (before bunch closure). Do not use within 60 days of harvest.
tetraconazole	3	Domark 40ME	
quinoxyfen	13	Legend	Use no later than E-L 34[5], (before commencement of veraison). Do not use within 42 days of harvest.
fenarimol	3	Rubigan SC	Use no later than 35 days before harvest.
myclobutanil	3	Mycloss Xtra	
triadimefon	3	Slingshot, Triad 125, Triadimefon 125, Triadimefon 125 EC, Turret	
triadimenol	3	Allitron, Bayfidan 250 EC, Triadimenol 250 EC, Tridim 250 EC	
copper ammonium acetate	M1	Cop-IT	Use no later than 30 days before harvest.
copper ammonium complex	M1	Copperguard, Liquicop	
sulfur + copper oxychloride	M2 + M1	Mildex WG	

Active Constituent (s)	Activitiy group	Some registered products	Restriction on Use
POWDERY MILDEW *(CONT.)*			
sulfur, present as elemental or crystalline sulfur	M2	Barmac Wettable Sulphur, Brysulf 800 WG, Chemtura Sulphur WG, Cosavet WG, David Grays Sulphur Spray, GranuSulf 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Ozcrop Sulgran WG, Rutec Sulfur, Stollers Flowable Sulphur, Sulfostar DF, Sulfur 800 WG, Thiovit Jet, Titan Sulphur 800 WG, Top Wettable Sulphur, Uni-Shield	Use no later than 30 days before harvest.
potassium bicarbonate	M2	Ecocarb	Use no later than 7 days before harvest.
AUSTRALIAN PLAGUE LOCUST			
Metarhizium anisopliae var. *acridum*	n/a	Green Guard SC, Green Guard SC Premium	Use no later than 7 days before harvest.
BUD MITE			
sulfur, present as polysulfide	M2	Lime Sulphur	Apply as near as possible to budburst.
sulfur, present as elemental or crystalline sulfur	M2	Barmac Wettable Sulphur, Brysulf 800 WG, Chemtura Sulphur WG, Cosavet WG, GranuSulf 800 WG, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Ozcrop Sulgran WG, Sulfostar DF, Sulfur 800 WG, Thiovit Jet, Titan Sulphur 800 WG, Top Wettable Sulphur, Uni-Shield	Use no later than 30 days before harvest.
BUNCH MITE			
sulfur, present as polysulfide	M2	Lime Sulphur	Apply as near as possible to budburst.
sulfur, present as elemental or crystalline sulfur	M2	Barmac Wettable Sulphur, Brysulf 800 WG, Chemtura Sulphur WG, Cosavet WG, GranuSulf 800 WG, Microsul WG Elite, Sulfur 800 WG, Thiovit Jet, Titan Sulphur 800 WG	Use no later than 30 days before harvest.
GARDEN WEEVIL			
esfenvalerate	3A	Sumi-Alpha Flex	Foliar spray only. Use no later than 80% capfall.
indoxacarb	22A	Avatar	Use no later than E-L 31[5] (before bunch closure). Do not use within 56 days of harvest.
GRAPE LEAF BLISTER MITE			
petroleum oil	n/a	Caltex Winter Spray Oil, Stifle, Vicol Winter Oil	Dormant spray only.
sulfur, present as polysulfide	M2	Lime Sulphur	Apply as near as possible to budburst.

Active Constituent (s)	Activitiy group	Some registered products	Restriction on Use
GRAPE LEAF BLISTER MITE *(CONT.)*			
sulfur, present as elemental or crystalline sulfur	M2	Barmac Wettable Sulphur, Brysulf 800 WG, Chemtura Sulphur WG, Cosavet WG, David Grays Sulphur Spray, GranuSulf 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Ozcrop Sulgran WG, Rutec Sulfur, Stollers Flowable Sulphur, Sulfostar DF, Sulfur 800 WG, Thiovit Jet, Titan Sulphur 800 WG, Top Wettable Sulphur, Uni-Shield	Use no later than 30 days before harvest.
GRAPE LEAF RUST MITE			
sulfur, present as polysulfide	M2	Lime Sulphur	Apply as near as possible to budburst.
sulfur, present as elemental or crystalline sulfur	M2	Barmac Wettable Sulphur, Brysulf 800 WG, Chemtura Sulphur WG, Cosavet WG, David Grays Sulphur Spray, GranuSulf 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Ozcrop Sulgran WG, Rutec Sulfur, Stollers Flowable Sulphur, Sulfostar DF, Sulfur 800 WG, Thiovit Jet, Titan Sulphur 800 WG, Top Wettable Sulphur, Uni-Shield	Use no later than 30 days before harvest.
GRAPEVINE MOTH			
chlorantraniliprole	28	Altacor	Use no later than 80% capfall.
spinosad	5	Entrust Naturalyte, Success 2 Naturalyte	Use no later than E-L 31[5] (before bunch closure).
emamectin indoxacarb	6 22A	Proclaim Avatar	Use no later than E-L 31[5] (before bunch closure). Do not use within 56 days of harvest.
Bacillus thuringiensis subspecies *aizawai*	11	Bacchus WG	May be used until harvest.
Bacillus thuringiensis subspecies *kurstaki*	11	BioCrystal Kurstaki, Delfin, DiPel DF	
Trichogrammanza carverae	n/a	Trichogramma parasitic wasp	
GRAPEVINE SCALE			
azinphos-methyl	1B	Gusathion 200 SC	Dormant spray only.
chlorpyrifos	1B	Chlorpos, Chlorpyrifos 500, Chlorpyrifos 500 EC, Cyren 500 EC, Generifos 500 EC, Kensban 500, Lorsban 500 EC, Strike-Out 500 EC	
maldison/malathion	1B	Fyfanon 440 EW, Hy-Mal, Maldison 500	
methidathion	1B	Supracide 400, Suprathion 400 EC	
paraffinic oil	n/a	Bioclear, BioPest, Trump Spray Oil	

Active Constituent (s)	Activitiy group	Some registered products	Restriction on Use
GRAPEVINE SCALE *(CONT.)*			
petroleum oil	n/a	All Seasons While Oil, Caltex Summer Spray Oil, Caltex Winter Spray Oil, D-C-Tron Plus Spray Oil, Sacoa Summer Spray Oil, Stifle, Vicol Summer Oil, Vicol Winter Oil	Dormant spray only.
LIGHT BROWN APPLE MOTH			
chlorantraniliprole methoxyfenozide	28 18	Altacor Prodigy	Use no later than 80% capfall.
spinosad	5	Entrust Naturalyte, Success 2 Naturalyte	Use no later than E-L 31[5] (before bunch closure).
emamectin indoxacarb	6 22A	Proclaim Avatar	Use no later than E-L 31[5] (before bunch closure). Do not use within 56 days of harvest.
Bacillus thuringiensis subspecies *aizawai*	11	Bacchus WG,	May be used until harvest.
Bacillus thuringiensis subspecies *kurstaki*	11	BioCrystal Kurstaki, Delfin, DiPel DF	
tetradecenyl acetate + tetradecadienyl acetate	n/a	Isomate LBAM Plus Pheromone	
Trichogrammanza carverae	n/a	Trichogramma parasitic wasp	
WINGLESS GRASSHOPPER			
indoxacarb	22A	Avatar	Use no later than E-L 31[5] (before bunch closure). Do not use within 56 days of harvest.
Metarhizium anisopliae var. *acridum*	n/a	Green Guard SC, Green Guard SC Premium	Use no later than 7 days before harvest.

Notes

1. Do not apply Filan to any set berries.
2. Do not apply Switch at both flowering and growth stage E-L 31.
3. Contact your winery or grape purchaser prior to the application of any phosphorous acid spray.
4. Gem and Shirlan have a 32 day re-entry period.
5. Definitions of stages of grapevine growth: Coombe, B (1995) Adoption of a system for identifying grapevine growth stages. Aust. J. Grape and Wine Res. 1:104-110.
6. Check product labels as registration may apply to a specific mealybug species.

5% capfall: E-L stage 19-20; 5% capfall and no developing berries present.

80% capfall: E-L stage 25; 80% caps off.
E-L stage 26 (cap-fall compete).
E-L stage 31 (before bunch closure): Bunches hanging down. Berries pea-size (7mm diameter).

E-L stage 34 (before veraison): Berries begin to soften and Brix starts increasing.

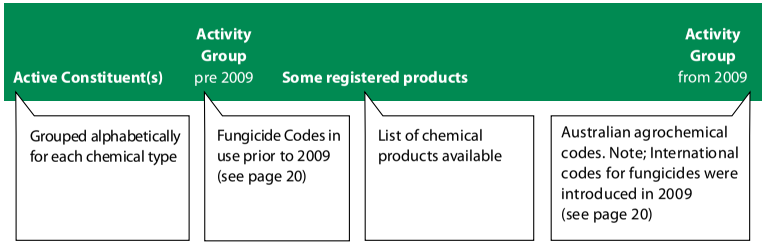
Agrochemicals registered for use in Australian viticulture

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 18. More information regarding activity groups can be found on the CropLife Australia website: 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, organochlorines and carbamates is not encouraged. The recommended restriction on use for all 1A, 1B and 2B insecticides listed in this booklet is 'Use no later than 80% capfall'. In addition, it is recommended that any 2C or 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, or 3A insecticide.

How to use the following table



Active Constituent(s)	Activity Group pre 2009	Some registered products	Activity Group from 2009
FUNGICIDE			
azoxystrobin	K	Amistar 250 SC, Mirador 250 SC, Supernova 250SC	11
benalaxyl + mancozeb	D + Y	Galben M	4 + M3
boscalid	G	Filan	7
captan	Y	Captan 900 WG, Captan WG, Merpan	M4
chlorothalonil	Y	Applonil 720, Barrack 720, Barrack Betterstick, Bravo 720, Bravo Weather Stik, Cavalry 720 SC, Cheers 720, Cheers 720 Weathershield, Chemtura Chlorothalonil, Chlornil, Chlorothalonil 500 SC, Chlorothalonil 720, Echo 500SC, Echo 720, Echo 900 WDG, Elect 500, Fung-o-nil 500, Unite 720, Unite Ultrastick, Whack, Whack 900 WG	M5
copper ammonium acetate	Y	Cop-IT	M1
copper ammonium complex	Y	Copperguard, Liquicop	M1
copper cuprous oxide	Y	Ag Copp 750, Nordox 500, Norshield, Norshield 750 WP, Norshield WG	M1
copper hydroxide	Y	Blue Shield DF, Cung Fu 350 SC, Champ Dry Prill WG, Flo-Bordo, Hydrocop DF, Kocide Blue Xtra, Kocide Opti	M1
copper hydroxide + mancozeb	Y + Y	ManKocide DF	M1 + M3
copper octanoate	Y	Tricop	M1
copper oxychloride	Y	Copper Oxychloride, Copper Oxychloride WP, Coppox WG, Country Copper Oxychloride 500 WP, Oxydul DF	M1
copper sulphate tribasic	Y	Bordeaux WG, Cuprofix Disperss, Tri-Base Blue	M1
copper sulphate tribasic + mancozeb	Y + Y	Novofix Disperss	M1 + M3
cyprodinil + fludioxonil	I + L	Switch	9 + 12
dimethomorph	X	Acrobat SC	40
dithianon	Y	Delan 700 WG	M9
fenarimol	C	Rubigan SC	3
fenhexamid	J	Teldor 500 SC	17
fluazinam	Y	Gem, Shirlan	29
flusilazole	C	Nustar DF	3
hexaconazole	C	Hex 50 SC, Viva	3
hydrogen peroxide + peroxyacetic acid	Y + Y	Peratec, Peroxy Treat	M + M
iprodione	B	Chief 250 Liquid, Chief Aquaflo, Corvette Flowable, Corvette Liquid, innova Iprodione 500 Aquaflo, Ippon 500 Aquaflo, Ipral 250, Iprine 250, Iprine 500, Iprodione 250, Iprodione Aquaflow 500, Iprodione Liquid 250, Rovral Aquaflo, Rovral Liquid, Subscribe, Transact	2

Active Constituent(s)	Activity Group pre 2009	Some registered products	Activity Group from 2009
FUNGICIDE *(CONT.)*			
mancozeb		Choice Mancozeb 750 WG, Dithane Rainshield Neo Tec, innova Mancozeb 750, Kencozeb 750DF, Kendon Mancozeb, Mancozeb 750 DF, Mancozeb 750 WG, Mancozeb 800, Mancozeb DF, Mancozeb DG, Manfil, Manzate DF, Manzeb, Penncozeb 420 SC, Penncozeb 750DF, UniZeb 750 DF	M3
mandipropamid	n/a	Revus	40
metalaxyl - M + copper hydroxide	D + Y	Ridomil Gold Plus	4 + M1
metalaxyl - M + mancozeb	D + Y	Ridomil Gold MZ WG	4 + M3
metalaxyl + copper oxychloride	D + Y	Axiom Plus, Medley Plus	4 + M1
metalaxyl + mancozeb	D + Y	Axiom MZ 720, Maxyl, Medley MZ, Zeemil MZB 720 WP	4 + M3
metiram	Y	Polyram DF	M3
metrafenone		Vivando	U8
myclobutanil	C	Mycloss Xtra	3
oxadixyl + propineb	D + Y	Rebound WP	4 + M3
paraffinic oil	n/a	BioPest	unspecified
penconazole	C	Topas 100 EC	3
phosphorous acid	Y	Agri-Fos 600, ChemPhos 400, Country Phospot 400, Country Phospot 400 pH 7.2, Country Phospot 600, Dominator 600, Fungi-Fos 400, Fungi-Fos 400 pH 7.2, Phos Phyt 400, Sprayphos 400, Sprayphos 620, Throw Down, Throwdown 600	33
potassium bicarbonate	Y	Ecocarb	M2
potassium salts of fatty acids	n/a	Ecoprotector	U1
procymidone	B	Fortress 500, Procymidone 500, Rumble 500, Spiral Aquaflo, Sumisclex 500	2
pyraclostrobin	K	Cabrio, Cabrio 200WG	11
pyrimethanil	I	Pyrus 400 SC, Scala 400 SC	9
quinoxyfen	M	Legend	13
spiroxamine	E	Prosper 500 EC	5
sulfur + copper oxychloride	Y + Y	Mildex WG	M2 + M1
sulfur, present as elemental or crystalline sulfur	Y	Barmac Wettable Sulphur, Brysulf 800 WG, Chemtura Suphur WG, Cosavet WG, David Grays Sulphur Spray, Dusting Sulphur, Dusting Sulphur 900, GranuSulf 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Ozcrop Sulgran WG, Rutec Sulfur, Stollers Flowable Sulphur, Sulfostar DF, Sulfur 800 WG, Thiovit Jet, Titan Sulphur 800 WG, Top Wettable Sulphur, Uni-Shield	M2

Active Constituent(s)	Activity Group pre 2009	Some registered products	Activity Group from 2009
FUNGICIDE *(CONT.)*			
tebuconazole	C	Folicur 430 SC, Greenseal, Orius 430 SC	3
tetraconazole	C	Domark 40ME	3
thiram	Y	Thiragranz, Thiram DG	M3
triadimefon	C	Slingshot, Triad 125, Triadimefon 125, Triadimefon 125 EC, Turret	3
triadimenol	C	Allitron, Bayfidan 250 EC, Triadimenol 250 EC, Tridim 250 EC	3
Trichoderma harzianum	n/a	Vinevax Bio-Implants, Vinevax Wound Dressing	unspecified
trifloxystrobin	K	Flint 500 WG	11
zineb	Y	Zineb	M3
ziram	Y	Ziragranz, Ziram DG, Ziram Granuflo	M3
HERBICIDE			
2,2-DPA-sodium (dalapon-sodium)	Atlapon, Propon		J
amitrole + ammonium thiocyanate	Amitrole T		Q
amitrole + glyphosate-ipa + ammonium thiocyanate	Illico		Q + M
amitrole + paraquat	Alliance		Q + L
bromoxynil+diflufenican	Barracuda, Jaguar		C + F
carfentrazone-ethyl	Spotlight Plus		G
dichlobenil	Casoron G		O
diquat	Desiquat, Diquat 200, Reglone		L
diquat + paraquat	Brown Out 250, EOS, Kwicknock 250, Paraquat/Diquat, Pre-Seed 250, Revolver, Scorcher 250, Speedy 250, Spray & Sow, Spray Out 250, Spray Seed 250, Uni-Spray 250		L + L
diuron	Diurex WG, Diuron 500, Diuron 900 DF, Diuron 900 WDG, Diuron 900 WG, Diuron Flowable, Striker 500 SC, Zee-Uron 900 WG		C
fluazifop-P	Fusilade Forte, Fuzilier		A
glufosinate-ammonium	Basta, Biffo, Cease, Exile		N
glyphosate-ipa	AllOut 450, Banish 360, BioChoice 360, ClearUp Bio 360, Clearup 450, Country 360, Envirospray 360, Eradicator 450, Eradicator 540, Fire 450, Gladiator, Gladiator Maximus, Glymount, Glyphos classic 450, Glyphosate 360, Glyphosate 450, 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 CT, Raze, Ripper 480, Roundup, Roundup Biactive, Roundup Ready Plantshield, RoundupCT, Sanos 360, Sanos 450, Sickle 540, SquareDown 360, Wipe-Out 360, Wipe-Out 450, Wipe-Out Bio, Wynca 450		M

Active Constituent(s)	Some registered products	Activity Group from 2009
HERBICIDE *(CONT.)*		
glyphosate-ipa + carfentrazone ethyl	Broadway	M + G
glyphosate-ipa + mas	Banish 360 Sync, Credit, Weedmaster Duo	M + M
glyphosate-mas	ClearUp 450 SL, ClearUp 700 Bio-Dri, ClearUp 700 Dri Broadacre, ClearUp 840 Dry-Flo, Glyphosate 700SG, Ken-Up Dry 680 WG, Roundup Ready	M
glyphosate-mea	Wipe-Out Plus	M
glyphosate-potassium salt	Firebolt, Gladiator Optimax, Glyphosate 495 K Salt, Roundup PowerMAX, Touchdown Hitech, Wipe-out Accelerate	M
glyphosate-potassium salt + mas	Roundup DST	M + M
glyphosate-trimesium	innova Glyphosate Trimesium 480	M
haloxyfop-R methyl ester	Asset, Convict, Exert 520, Gallant West, Haloxyfop 520, Haloxyfop 520 EC, Haloxyken 520, Hermes 520, Recon 520, Verdict 520	A
isoxaben	Gallery 750 DF	O
napropamide	Devrinol WG	K
norflurazon	Zoliar DF	F
oryzalin	Cameo 500, Oryzalin 500, Oryzalin 500 Flowable, Prolan 500, Surflan 500	D
oxyfluorfen	Cavalier, Convert 240 EC, Goal, GoalTender, Ox 240, Oxen, Oxyfan, Oxyfluorfen 240 EC , Point, Striker	G
paraquat	Explode 250, Gramoxone 250, Nuquat 250, Para-Ken 250, Paraquat 250, Paraquat 250 SL, Shirquat 250, Sprayquat 250, Spraytop 250SL, Uniquat 250	L
pendimethalin	Argo 440EC, Cyclone 330 EC, Cyclone 440 EC, Fist 330, Panida Grande, Pendimethalin 330, Pendimethex, Rifle 330, Rifle 440, Stomp 440	D
pine oil	BioWeed	unspecified
quizalofop-P-ethyl	Atomic Selective Herbicide, Elantra, Elantra Xtreme, Leopard, Quinella 100 EC, Quiz, Quizalofop-P-ethyl 200 EC, Sextant, Tiger	A
quizalofop-P-tefuryl	Pantera	A
simazine	Gesatop 600 SC, Gesatop Granules 900 WG, Simagranz, Simanex 600 SC, Simanex 900 WG, SimaPhos 900, Simaquest 900 WG, Simazine 500, Simazine 500 Flowable, Simazine 500 SC, Simazine 900 DF, Simazine 900 WDG, Simazine 900 WG, Simazine 900DF, Simazine 900WG, Simazine Flowable, Simazine Hi-Load 600	C
trifluralin	Tricon Flexi 480, Triflur X, Triflur Xcel, Trifluralin 480, Trifluralin 480 EC, Triflurasip 480, Trilogy, Uni-Try	D

Active Constituent(s)	Some registered products	Activity Group from 2009
INSECTICIDE		
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, Alphasip Duo, Astound Duo, Dictate Duo 100, Dominex Duo, Fastac Duo, innova Alpha 100 Duo, Ken-Tac 100, Unitox	3A
azinphos-methyl	Gusathion 200 SC	1B
Bacillus thuringiensis subspecies *aizawai*	Bacchus WG	11
Bacillus thuringiensis subspecies *kurstaki*	BioCrystal Kurstaki, Delfin, DiPel DF	11
bifenthrin	Arrow 100 EC, Bifenthrin 100, Bifenthrin 100 EC, Bifentin, Choice BiFendoff 100, Disect 100 EC, Tal-Ken 100, Talstar 100 EC, Talstar 250 EC, Venom 100 EC	3A
buprofezin	Applaud, Clap, Scale & Bug Insecticide	16
carbaryl	Bugmaster Flowable, Carbaryl 500 Flowable, Carbaryl Wettable Powder, Cricket and Grasshopper Killer Bait	1A
chlorantraniliprole	Altacor	28
chlorpyrifos	Chlorpos, Chlorpyrifos 500, Chlorpyrifos 500 EC, Country Chlorpyrifos 500, 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	4A
copper (silicate) complex	Escar-Go	unspecified
diazinon	Country Diazinon 800, Diazinon	1B
dicofol	Miti-Fol EC	UN
dimethoate	Danadim, Dimethoate, Dimethoate 400, Rogor, Rover, Saboteur	1B
emamectin	Proclaim	6
esfenvalerate	Sumi-Alpha Flex	3A
etoxazole	ParaMite	10B
fenamiphos	Assassinator 400, Country Fenamiphos 400, Fenamiphos 400, Nemacur 400	1B
fenitrothion	Fenitrothion 1000, Fenitrothion 1000 EC	1B
fenthion	Lebaycid	1B
fipronil	Amulet Cue-Lure, Regal 800, Regent 200SC	2B
indoxacarb	Avatar	22A
iron EDTA complex	Multiguard Snail and Slug Killer	unspecified

Active Constituent(s)	Some registered products	Activity Group from 2009
INSECTICIDE *(CONT.)*		
maldison (malathion)	Fyfanon 440 EW, Hy-Mal, Maldison 500	1B
metaldehyde	Meta (pellets), Metarex Snail and Slug bait, Slug Out (bait), Slugger (slug and snail pellets)	unspecified
Metarhizium anisopliae var. *acridum*	Green Guard SC, Green Guard SC Premium	unspecified
methidathion	Supracide 400, Suprathion 400 EC	1B
methiocarb	Mesurol Snail and Slug Bait	1A
methomyl	Electra 225, Lannate L, Marlin, Methomyl 225	1A
methoxyfenozide	Prodigy	18
paraffinic oil	Bioclear, BioPest, Trump Spray Oil	unspecified
parathion-methyl	Parashoot CS, Penncap-M	1B
petroleum oil	All Seasons White Oil, Caltex Summer Spray Oil, Caltex Winter Spray 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
spinosad	Entrust Naturalyte, Naturalure Fruit Fly Bait Concentrate, Success 2 Naturalyte	5
sulfur, present as elemental or crystalline sulfur	Barmac Wettable Sulphur, Brysulf 800 WG, Chemtura Sulphur WG, Cosavet WG, David Grays Sulphur Spray, GranuSulf 800 WG, Kendon Sulphur, Kumulus DF, Microsul WG Elite, Microthiol Disperss, Notion, Ozcrop Sulgran WG, Rutec Sulfur, Stollers Flowable Sulphur, Sulfostar DF, Sulfur 800 WG, Thiovit Jet, Titan Sulphur 800 WG, Top Wettable Sulphur, Uni-Shield	M2
sulfur, present as polysulfide	Lime Sulphur	M2
tetradecenyl acetate + tetradecadienyl acetate	Isomate LBAM Plus Pheromone	unspecified
trichlorfon	Dipterex 500 SL, Lepidex 500	1B
Trichogrammanza carverae	Trichogramma parasitic wasp	unspecified
PLANT GROWTH REGULATORS		
chlormequat	Cycocel 77A	unspecified
cyanamide	Cyan, Dormex	unspecified
ethephon	Country Ethephon 480, Ethephon 720, Ethrel, K-Ethephon, Promote 720	unspecified
gibberellic acid	Gala, N-Large, ProGibb	unspecified
methyl esters of fatty acids	Waiken	unspecified

Fungicide resistance management strategies

What is 'fungicide resistance'?

Fungicide resistance is the inherited ability of a plant disease causing organism to survive doses of a fungicide that would normally control it. Resistance may develop after frequent use of one fungicide, or fungicides from the same ACTIVITY GROUP.

Resistance status

Resistance to fungicides is already a serious problem worldwide. Australia has not been spared. Resistance to many of the commonly used fungicides now exists.

What produces fungicide resistant diseases?

Any population might contain a very small number of individuals which are naturally able to survive the application of a particular fungicide. If the same fungicide, or fungicides 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. The ratio of resistant to susceptible individuals essentially dominate the population and the fungicide 'fails' in the field.

Resistance countering measures

With any resistance management program it is important to:

- prevent the build-up of resistant individuals in the population; and
- minimise fungicide selection pressure by not overusing fungicides from the same activity group.

For successful resistance management it is important to know how to use these fungicides to obtain best results, while at the same time delaying or minimising the potential development of resistance. CropLife Australia has developed a Fungicide Resistance Management Strategy. It 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.

The strategy is updated regularly and can be accessed via http://www.croplifeaustralia.org.au

Resistance management strategies

Grey mould (Botrytis bunch rot)	
Fungicide activity group(s)	**Resistance management strategy**
Group 1 = A (methyl benzimidazole carbamates) **Group 2 = B** (dicarboximide) **Group 9 = I** (anilinopyrimidine), and combinations of **Group 9 = I** and **Group 12 = L** (phenylpyrroles) **Group 17 = J** (hydroxyanilide) **Group 7 = G** (carboxamide) **Note:** the new code is the number and the old code is the letter.	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 1**, **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 1**, **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 1**, **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. Late season fungicide treatments should be applied before Botrytis infection reaches unacceptably high levels in the vineyard.

Downy mildew	
Fungicide activity group(s)	**Resistance management strategy**
Group 4 = D (phenylamide) **Group 11 = K** (quinone outside inhibitor) **Group 40 = X** (dimethomorph) **Note:** the new code is the number and the old code is the letter.	1. Start disease control sprays when the vine shoots are approximately 20 cm long and continue spraying at intervals of 7–21 days using a protectant or non-phenylamide fungicide. 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 MOA group with satisfactory efficacy against the target pathogen/s.

Powdery mildew	
Fungicide activity group(s)	**Resistance management strategy**
Group 3 = C (DMI) **Group 5 = E** (amine) **Group 11 = K** (quinone outside inhibitor) **Group13 = M** (quinoline) **Note:** the new code is the number and the old code is the letter.	1. **DO NOT** apply more than two consecutive sprays of a **Group 3** 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 more than two sprays per season of **Group 11** fungicides. If two consecutive applications of **Group 11** fungicides are used, then they must be alternated with a fungicide from a different activity group. 4. Apply **Group 11** fungicides preventatively. 5. Apply a maximum of two consectutive applications in alternation with fungicides from a different MOA group with satisfactory efficacy against the target pathogen/s. 6. **DO NOT** apply more than two consecutive sprays of a **Group 13** fungicide. **DO NOT** apply more than three **Group 13** sprays per season.

Changes to the fungicide activity group codes

CropLife Australia changed the activity group codes for fungicides in October 2008 to bring them in line with International codes. None of the groupings change, they have simply been assigned a new code. Chemical companies have until October 2011in which to change their product labels to reflect these new codes so it is expected that there will be a mix of old (pre 2009) and new (from 2009) activity group codes for fungicide products. The Agrochemicals registered for use in Australian viticulture tables list both old and new fungicide activity codes.

Recommendations: The new (from 2009) activity group codes for fungicides are listed because product labels will reflect the changes this year. Due to a space restriction we have replaced activity codes that are unspecified with n/a.

Agrochemicals registered for use in Australian viticulture: Both the old (pre 2009) and new (from 2009) activity codes for fungicides are displayed in this table.

Appendix 2
Internet sites for wine and grape industries

CB PAGE, LEO QUIRK AND JEREMY BRIGHT, DEPARTMENT OF PRIMARY 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 Department of Primary Industries website, www.dpi.nsw.gov.au, and search for 'grapes'.

General weather sites

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/index.shtml

Water and the land 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

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

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

www.ifoam.org

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

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

www.bfa.com.au

Biological Farmers of Australia Co Op Ltd. Australian organisation for biological farming (both biodynamic and organic farming). BFA helps the organic industry with education and trade and is also a certifying body for the following programs:

www.australianorganic.com.au

Australian Certified Organic is Australia's largest certifier for organic and biodynamic produce. ACO currently certifies 55% of the Australian organic industry.

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

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

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

www.ausqual.com.au

Aus-Qual is an Australian company offering a range of quality assurance and certification systems, including organic certification.

Wine industry organisations

www.wineaustralia.com/australia

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 provides statistical information and an interactive wine tasting challenge (BYO bottle).

www.gwrdc.com.au

The Grape and Wine Research and Development Corporation 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

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

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

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

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

www.csu.edu.au/nwgic

The National Wine and Grape Industry Centre was formed by bringing together the resources of the 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

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.

Government sites

www.dpi.nsw.gov.au

Department of Primary Industries in NSW 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.agriculture.gov.au

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

www.agric.wa.gov.au

Department of Agriculture and Food, Western Australia.

www.dpi.vic.gov.au

Victorian Department of Primary Industries.

www.pir.sa.gov.au

Department of Primary Industries and Resources South Australia.

www.dpi.qld.gov.au

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

www.dpiwe.tas.gov.au

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

www.csiro.au

Commonwealth Scientific and Industrial Research Organisation.

www.daff.gov.au

Department of Agriculture, Fisheries and Forestry, Australia. Australian Federal department of agriculture.

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/aqis

Australian Quarantine and Inspection Service. AQIS manages quarantine controls at our borders to minimise the risk of exotic pests and diseases entering the country. AQIS 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

Austrade 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

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.abare.gov.au

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

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

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

Publisher of Australian Viticulture.

www.winebiz.com.au

Publisher of Australian & New Zealand Grapegrower & Winemaker.

Pest, disease and pesticide information

www.dpi.qld.gov.au/infopest

Infopest is a comprehensive listing of registered agricultural and veterinary chemicals and their uses. Also available is a compilation of Material Safety Data Sheets for agvet chemicals. The web site provides details on key features of the Infopest DVDs, how Infopest works, and an order form.

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

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

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 Department of Primary Industries web site for information on short courses.

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

CB Alexander Agricultural College or 'Tocal' is a part of the 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

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

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

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

www.cals.cornell.edu/nysaes

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

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

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

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

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

German sites

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

www.genres.de/en/

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

Other overseas sites

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/

Brock University: The Cool Climate Oenology and Viticulture Institute. Canadian web site features research, academic programs, background and links.

Appendix 3
Where to buy your planting material

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

Vine improvement organisation	Address and Email	Mobile	Telephone	Facsimile
MIA Vine Improvement Society	PO Box 486, YENDA NSW 2681 miavis@bigpond.com	0429 318 397	(02) 6968 1202	(02) 6968 1479
Victorian and Murray Valley Vine Improvement Association Contact: Gary Thomas Orders accepted at any time	PO Box 5051, MILDURA VIC 3502 www.vamvvia.org.au vamvvia@bigpond.com	0418 997 730	(03) 5022 8499	(03) 5021 4833
Riverland Vine Improvement Committee* Contact: David Nitschke Preference given to orders received by 31 May	PO Box 292, MONASH SA 5342 www.rvic.org.au rvic@hotkey.net.au	0407 974 149	(08) 8583 5366	(08) 8583 5504
Australian Vine Improvement Association Inc. Contact: Gary Thomas	PO Box 5051, MILDURA VIC 3502 www.avia.org.au	0418 997 730	(03) 5022 8499	(03) 5021 4833

* Denotes that the nursery is accredited under the Vine Industry Nursery Association (VINA) grape propagation scheme

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

Nursery Name	Address and Email	Mobile	Telephone	Facsimile
Adro Grafted Vines*	PO Box 539, GRIFFITH 2680 adrografted@bigpond.com	0428 447 246	(02) 6964 4288	(02) 6964 4288
Binjara Vine Nursery Pty Ltd*	PO Box 75, EUSTON 2737 www.binjara.com.au justin@binjara.com.au	0417 148 429	(03) 5026 1661	(03) 5026 1050
Hanwood Grafted Vines	PO Box 55, HANWOOD 2680 lndepoli@dragnet.com	0412 699 476	(02) 6963 0247	(02) 6963 0247
Mallee Point Nursery*	PO Box 438, YENDA 2681 jimmaier@bigpond.com	0428 690 208	(02) 6968 1086	(02) 6968 1786
Omega Grafted Vines*	PO Box 2050, GRIFFITH 2680 akmacril@bigpond.com	0429 955 061 0412 994 004	(02) 6963 4935 (02) 6964 3012	(02) 6963 4935 (02) 6964 3012
Sunraysia Nurseries*	PO Box 45, GOL GOL 2738 www.sunraysianurseries.com.au sales@sunraysianurseries.com.au	–	(03) 5024 8502	(03) 5024 8551

* Denotes that the nursery is accredited under the Vine Industry Nursery Association (VINA) grape propagation scheme

Victoria

Nursery Name	Address and Email	Mobile	Telephone	Facsimile
Ausvine Nursery	PO Box 243, MILDURA 3502	0429 950 031	(03) 5021 0068	(03) 5021 0068
Boulevarde Nurseries	PO Box 816, IRYMPLE 3498 www.boulevarde.com.au alan@boulevarde.com.au	–	(03) 5024 9000	(03) 5024 6692
Binjara Vine Nursery Pty Ltd*	See NSW details			
Freck's Vine Nursery	PO Box 1161, RED CLIFFS 3496 freck94@bigpond.com	0412 947 426	(03) 5024 2885	(03) 5024 2885
KC Vines & Rootstocks*	PO Box 1054, MILDURA 3502 www.kcvines.com.au info@kcvines.com.au	0407 309 961	(03) 5024 8812	(03) 5024 8834
Fussy Britches Nursery	PO Box 5033, MILDURA 3502 fussbrit@iinet.net.au	0428 502 588	(03) 5023 4370	(03) 5023 5393
Jackson's Vine Nursery	PO Box 20, CARDROSS 3496	0408 596 685	(03) 5024 2485	–
Murray Lea Nurseries	PO Box 201, RED CLIFFS 3496 grahamnice@bigpond.com	0407 349 466	(03) 5024 3245	(03) 5024 3805
TJ Schreiber Nurseries Pty Ltd	PO Box 498, IRYMPLE 3498 schreibernurseries@bigpond.com	0429 873 114	(03) 5024 5986	(03) 5024 6596
Sunraysia Nurseries*	See NSW details			

* Denotes that the nursery is accredited under the Vine Industry Nursery Association (VINA) grape propagation scheme

South Australia

Nursery Name	Address and Email	Mobile	Telephone	Facsimile
Adelaide Hills Vine Improvement Inc*	C/- Box 38, KANGARILLA 5157 www.adelaidehillsvineimprovement.org	0422 644 825	(08) 8383 7532	(08) 8383 7532
Barossa Vine Improvement*	PO Box 293, NURIOOTPA 5355	0409 302 657	(08) 8562 2011	(08) 8562 4410
Fleurieu Vine Nursery*	3 Clemens Road, LANGHORNE CREEK 5255 gdwarren@bigpond.com	0429 676 014	(08 8537 3286	–
Glenavon Nurseries Pty Ltd*	Bremer Rd, LANGHORNE CREEK 5255 www.glenavon.com.au	0417 883 826	(08) 8537 3207	(08) 8537 3250
Golding Vine Nursery	C/- Box 700, LOBETHAL 5241 darren@goldingwines.com.au	0413 942 272	(08) 8389 5120	(08) 8389 5290
Langhorne Creek Vine Improvement*	C/- PO, LANGHORNE CREEK 5255	0439 373 450	(08) 8537 3450	(08) 8537 3450
Loxton Vine & Citrus Nursery Pty Ltd	PO Box 491, LOXTON 5333 www.pippos.com	0418 815 655	(08) 8584 5544	(08) 8584 5544
RVIC Nursery	PO 292, MONASH 5345 www.rvic.org.au	0407 974 149	(08) 8583 5366	(08) 8583 5504
Ramco Wine Group	Box 889, NURIOOTPA 5355 scott@vinlogic.com.au	0400 742 603	(08) 8541 9013	–
River Murray Nursery	PO Box 995, LOXTON 5333	0428 819 540	(08) 8584 4968	–
Yalumba Nursery*	PO Box 10, ANGASTON 5353 www.yalumbanursery.com tjones@yalumba.com	0411 487 495	(08) 8568 7700	(08) 8568 7710
Vinewright*	PO Box 180, MOUNT PLEASANT 5235 www.vinewright.com.au plwright@vinewright.com.au	0438 682 345	(08) 8568 2385	(08) 8568 2345

* Denotes that the nursery is accredited under the Vine Industry Nursery Association (VINA) grape propagation scheme

Tasmania

Nursery Name	Address and Email	Mobile	Telephone	Facsimile
Woodlea Nursery*	49 Whish-Wilson Road, SCOTSDALE 7260 woodlea@microtech.com.au	–	(03) 6352 7262	(03) 6352 7252

* Denotes that the nursery is accredited under the Vine Industry Nursery Association (VINA) grape propagation scheme

Western Australia

Nursery Name	Address	Mobile	Telephone	Facsimile
Viticlone Supplies*	Box 202, DUNSBOROUGH 6281 viticlone@netserv.net.au	0418 946 901	(08) 9755 2030	(08) 9755 2030

* Denotes that the nursery is accredited under the Vine Industry Nursery Association (VINA) grape propagation scheme

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

Appendix 4
Herbicides for use in vineyards

CLARRIE BECKINGHAM, FORMERLY NWGIC, AND GREG MOULDS, NWGIC, DARETON

Herbicide resistance

What is herbicide resistance?

Herbicide resistance is the inherent ability of a weed to survive a herbicide applied at a rate that would normally control it; it is not the increase in numbers of some weeds that are naturally tolerant to a herbicide (e.g. marshmallow or hair willow herb) that occurs when susceptible weed species are controlled by herbicides, thus reducing competition.

Resistant weeds

Resistant weeds have developed in many plant populations where resistance strategies have not been used. Weeds in which resistance has developed include annual ryegrass, Indian hedge mustard, wild turnip, wild oats, bindweed, capeweed, barley grass, dirty Dora, and arrowhead in some regions. Without appropriate resistance management strategies the number of resistant populations will increase dramatically.

Annual ryegrass resistant to glyphosate is on the increase across Australia, and most cases reported in 2009 were found in vineyards.

How do weeds become resistant?

Weed populations contain individual plants able to withstand particular herbicides. Repeated use of these herbicides and others with the same mode of action kills susceptible individuals and, over time, allows the offspring of resistant individuals to dominate. The population is then considered to be resistant. The more selective herbicides are, the greater the risk of resistance, but if resistance management strategies are not practised it is probable that weeds will develop resistance to all herbicides.

To prevent herbicide resistance:

Take an integrated approach to weed management

- Rotate herbicides from different groups. (Know the herbicide groups.)
- Use as many non-chemical weed control options as possible.
- Give special attention to resistant weeds before they set seed. Hand-rogue if necessary.
- Use a low-risk herbicide in preference to a high-risk herbicide.
- Do not allow weeds to seed.

Herbicide groups (see following tables)

- High Risk: Groups A, B
- Moderate Risk: Groups C–R, Z

Remember:

- Read and follow the label directions of registered herbicide products before using.
- Calibrate spraying equipment and provide sufficient agitation of herbicide in tank, especially when using
  WP – wettable powder
  WG – wettable granule
  DF – dry flowable
  SC – suspension concentrate.
- Consult the label for recommendations for use of wetting agents.
- Use herbicide-resistance strategies.

Check withholding periods of herbicides before use, as well as rainfast times

Table A4.1 lists post-emergent herbicides registered in NSW for use in vineyards. Table A4.2 lists the residual herbicides registered for use in vineyards, and Table A4.3 shows non-selective post-emergent herbicides registered for grapevine sucker control in vineyards.

Remember: Read the product label before using a herbicide

Table A4.1. Post-emergent herbicides registered in NSW for use in vineyards. Read the product label before use

Group	Chemical	Trade names	Rates	Weeds controlled	Comments
Q	250 g/L amitrole and 220 g/L ammonium thiocyanate	Amitrole T	4–12 L/100 L water	Broadleafed weeds and grasses	Apply when weeds are small and making active growth. Repeat application may be needed in 6–8 weeks. Apply as a directed spray to weeds only. Use higher rates for larger and more tolerant weeds.
Q + M	160 g/L amitrole and 60 g/L glyphosate – ipa and 220 g/L ammonium thiocyanate	Illico	6–12 L/ha 9–12 L/ha	Broadleafed weeds and grasses Marshmallow, common storksbill	For best results, apply when weeds are small and actively growing. Use higher rates for larger weeds. Apply as a directed spray to weeds only.
J	740 g/kg 2,2-DPA-sodium	Propon, Agspray Atlapon	Boom 10.0 kg per sprayed hectare	Annual and perennial grasses including couch, paspalum	Vines must be at least 4 years old. DO NOT exceed 10 kg/ha per year. Apply as a direct spray into vine rows. Half rate at 10–14 day intervals.
G	240 g/L carfentrazone-ethyl	Spotlight Plus	25–75 mL/ha	Small-flowered mallow and certain other broadleafed annual weeds	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.
N	200 g/L glufosinate-ammonium	Basta	1.0–5.0 L/ha	Annual and perennial weeds	Apply as a directed or shielded spray. Refer to the label section **Application Equipment** for specific information on application methods. Controlled Droplet Application equipment must **not** be used for application in cherry orchards. **Warnings:** Do not allow spray or spray drift to contact desirable foliage or green (uncalloused) bark. To avoid potential crop damage, refer to the label sections on **Application Equipment** and **PROTECTION OF CROPS, NATIVE AND OTHER NON-TARGET PLANTS.** Basta may be used around trees/vines less than 2 years old provided that they are effectively shielded from spray and spray drift.
M	360 g/L glyphosate – ipa	Roundup, Roundup Biactive	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.	Apply as a directed or shielded spray or using wiper equipment. 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. Do NOT allow wiper surface to contact any part of the tree, vine or palm. Avoid painting out stumps with this product, as injury resulting from root grafting may occur in adjacent trees. **Citrus fruit, nuts, olives, pome fruit and vineyards:** Do NOT allow spray or spray drift to contact green bark or stems, canes, laterals, suckers, fresh wounds, foliage or fruit. DO NOT allow wiper equipment to contact vines. For residual control of annual weeds, glyphosate may be tank-mixed with certain residual herbicides. See label for directions.
M	360 g/L glyphosate (present as ipa and mono-ammonium salts)	Weedmaster Duo	See label for directions	See label for directions.	See label for directions
M	450 g/L glyphosate – ipa	Various	See label for directions.	See label for directions.	See label for directions.
M	540 g/L glyphosate – ipa/mas	Credit	See label for directions.	See label for directions.	See label for directions.

Group	Chemical	Trade names	Rates	Weeds controlled	Comments
M	540 g/L glyphosate (present as the potassium salt)	Roundup Power Max	See label for directions.	See label for directions.	See label for directions.
A	130 g/L haloxyfop-R-methyl	Asset	Annual grasses: 800 mL/ha Couch: 1.6–3.2 L/ha Paspalum, Johnson grass: 0.8–1.6 L/ha	Wide range of annual and perennial grasses (couch and paspalum)	Direct the spray to the bases of trees or vines at any growth stage, but make sure contact with fruit and foliage is avoided. See Directions for use table for rates. Couch grass (established): Use the higher rate if couch is at the late tillering mature stage. Paspalum/Johnson grass: Use the lower rate when weed is in the vegetative to early tillering stage. Higher rate required at the late tillering stage. Annual grasses: Use the lower rate when weed stage is from 2-leaf to early tillering.
A	520 g/L haloxyfop-R-methyl	Verdict 520	Annual grasses: 200 mL/ha Perennial grasses: Couch, Rhodes, slender rats tail 400–800 mL/ha Paspalum, kikuyu, buffel, Johnson, setaria 200 mL/ha	See label for additional plants 2-leaf to tillering Established stands Vegetative to early tillering Use 400 mL for late tillering	Spray should be directed to the base of the vine. Avoid contact with fruit and foliage. Spot spray use 25–50 mL/100 L (High rate on late-tillering mature grasses). Verdict 520 rates are to be used with spraying oil or non-ionic wetter, according to label directions. When using perennial rates, annual grasses are also controlled.
Q+L	250 g/L amitrole 125g/L paraquat	Alliance	See label for directions.	See label for directions.	See label for directions.
L	250 g/L paraquat	Gramoxone Nuquat	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. If product rate is less than the ratio 400 mL/100 L, add 100 mL Agral or 60 mL BS1000/100 L of spray mix. Add diquat if capeweed is present. See label for rates.	Broad-spectrum annual weed control. Most active against grasses. See label for rates with increased wetting agent where fat hen and *Portulaca* spp. are present.	Spray as necessary for control of annual weeds. Avoid contacting crop foliage. In bananas apply soon after weed emergence and before weeds reach 15 cm in height. Use spraying pressure less than 240 kPa. Avoid chemical contact with roots and peepers near the pseudo stem. Repeat sprays as required. GRAMOXONE 250 will not harm trees or vines with mature brown bark if this alone is sprayed. Use the higher rate for dense weed growth.
L	200 g/L diquat	Reglone	1.5 L + 1.4 L Agral in 700 L water/ha plus 1.6 L/ha Gramoxone 250	Capeweed	Apply as a directed spray under trees or vines. 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 broadleafed weeds in orchards, but where heavy infestations of capeweed occur REGLONE should be added to Gramoxone 250 at the rate of 1.5 L/ha. For inter-row or around butts use high-volume applications. Gramoxone 250, Spray.Seed 250 and REGLONE have no effect on brown bark, but care should be taken when spraying around trees to avoid spray contacting green bark or plant material.

Group	Chemical	Trade names	Rates	Weeds controlled	Comments
L	135 g/L paraquat + 115 g/L diquat	Spray·Seed® 250 Herbicide	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.	Broad spectrum. For rapid kill of a wide range of annual grasses and broadleafed weeds see label.	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. Addition of Spark at 250 mL/ha will improve control of small-flowered mallow, evening primrose and other weeds sensitive to Spark. Refer to the Spark label. **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 OR Measure how much spray is required to cover an area of 100 m^2 using your normal application volume. Your dilution rate is 24 to 32 mL of Spray·Seed 250 in this volume.
A	128 g/L fluazifop-P	Fusilade Forte	1.65 L/ha 2.5 L/ha 3.3 or 6.6 L/ha	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 3–5-leaf: 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.	Apply in not less than 200 L/ha. Direct the spray to the base of the vine. Withholding period: 4 weeks. 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. Use the higher rate for well established infestations or where greater control is required in one season. Or consider a double knock of Spray·Seed followed by Fusilade when fresh growth has emerged – this may be necessary for couch control. **Note:** Tank mixes of Fusilade are not recommended and there should be a minimum of 3 days before any other herbicide is applied. Fusilade does not control winter grass or silver grass.
A	400 g/L quizalofop-P-ethyl	Navigator, Targa, Targa Forte, Leopard, HiJack	65–125 mL/100L	Selected post-emergent systemic grass control. For details on control of awnless barnyard, crowsfoot, paspalum, Johnsons grass and kikuyu, see label.	Avoid spraying stressed weeds. Consult label for withholding periods and wetting agents.
C+F	25 g/L diflufenican 250 g/L bromoxynil	Jaguar	500 mL to 1 L	Certain broadleafed weeds in cover crops.	Apply during vine dormancy only. Avoid contact with vines. 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.

Table A4.2. 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.

Group	Chemical	Trade names	Rates	Weeds controlled	Comments
C	500 g/L simazine	Various	Boom 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.	Grapevines must be established for 3 years. In the first year a split application is preferred. Normally apply to bare, moist soil before weed emergence. Damage may result from using high rates on sandy soils low in organic matter. 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.
C	600 g/L simazine	Gesatop 600 SC	Boom: 1.9 to 3.8 L/ha Use 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.	Annual ryegrass, annual thistles, barley grass, bindy-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, turnips (not NSW), wild mustard, wild oats, winter grass, wireweed (not TAS) and suppression of soursob.	As for above
C	900 g/kg simazine	Various	1.25 kg/ha – light soil 2.5 kg/ha – heavy soil	As for above.	As for above. Use on vines 2 years or older. 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. **Warning:** do not use on excessively sandy soils, as crop damage may occur.
C	500 g/kg diuron	Various	3.5–7.2 L/ha or kg/ha	Broad spectrum – germinating annual broadleafed weeds and grasses. Reduced rates may be applied if existing weed control is good.	Grapevines must be over 3 years old. Apply to moist soil prior to weed emergence. Do not apply to vines with butt diameter less than 4 cm. Use lower rate where annual and winter weeds are to be controlled. Avoid spray drift on to fruit and foliage. Use higher rate for longer term control and low rate for short-term control, for topping up or for lighter soil types. Don't use on sandy, loamy sand or gravelly soils. Do not apply if vine butt diameter is less than 4 cm.
C	800 g/kg diuron	Various	2.2–4.5 L/ha or kg/ha	As for above.	As for above
C	900 g/kg diuron	Various	1.9–3.9 kg/ha (some products 2–4 kg/ha)	As for above.	As for above
D	500 g/L oryzalin	Surflan 500 Flowable	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.	Controls many annual grasses and broadleafed weeds.	Suitable for nurseries and newly planted and established vineyards. For best results, if irrigation or rain is not expected in 21 days after application, then mechanically incorporate into top 2.5 cm of soil. Soil must be free of weeds, of good tilth, and firm.
K	500 g/kg napropamide	Devrinol WG	4.5 kg/ha – light to medium soils 6.7 kg/ha – heavy clay soils. Apply in 500–1000 L of water/ha as a band spray	Germinating seeds of annual grasses and some broadleafed weeds.	Soil must be free of weeds and trash and of fine tilth. Suitable for nurseries, newly planted vineyards and established vineyards. For best results, shallow incorporation (2.5 cm) by mechanical means or followed by irrigation to 5 cm on the same day as spraying is recommended. Addition of simazine will help with broadleafed weed control. In non-irrigated winter rainfall areas apply in late autumn to winter. In irrigated areas apply in early spring.
O	67.5 g/kg dichlobenil	Casoron G	60–90 kg/treated hectare (2 m × 5 km)	Annual grasses and broadleafed weeds.	For bearing and non-bearing. Spread granules evenly over the soil of the area to be treated. Remove existing weeds. Use higher rate on heavier soils.

Group	Chemical	Trade names	Rates	Weeds controlled	Comments
O	750 g/kg isoxaben	Gallery 750	375–750 g/ha	Broad-spectrum residual broadleaved weed control. See Gallery 750 label for full weed list.	Apply to weed-free, even soil surface. Needs moisture via rainfall or irrigation within 21 days of application to be activated. Mix with pendimethalin or oryzalin to provide additional grass weed control.
D	330 g/L pendimethalin	Various	9–12 L/ha	Annual grasses and broadleafed weeds. See label for simazine rates when controlling caltrop, cobblers peg, curious weed and stinking Roger. Do not use simazine on alkaline soils.	Do not apply after vine budswell. Use low rate on light-textured soils. If used on freshly transplanted vines, soil should be compacted. Incorporate herbicide with minimum of 5 mm rain or sprinkler irrigation within 10 days of application.
A	120 g/L quizalofop-P-tefuryl	Pantera	125–250 mL/100 L	As for above.	As for above.
G	240 g/L oxyfluorfen	Goal, Point Herbicide, Spark, Striker	Weed-free soil: 3–4 L/ha	Before germination: Wild radish, giant pigweed, thornapple, starburr, capeweed, blackberry nightshade, sour sob, caltrop, bladder ketmia, shepherd's purse, wild mustard, redshank, small-flower mallow, deadnettle, sow-thistle, fat hen, pigweed, prickly lettuce, chickweed, *Amsinckia*, wireweed, ryegrass, barnyard grass, summer grass, liverseed grass, barley grass, burrgrass, crowsfoot grass, stink grass, pigeon grass, lovegrass.	Weed-free soil: apply to freshly worked weed-free soil. Use the higher rate when longer residual control is required (up to 4 months). 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 Surflan 500 per treated hectare. Use the higher rate when longer residual activity (up to 4 months) is required. When young seedling grasses and/or broadleafed weeds are present, apply as a tank mix with certain post-emergent herbicides to produce both knockdown and residual control. A non-ionic surfactant should be used in the spray mixture at 100 mL/100 L. Mature established weeds must be eliminated by mechanical or chemical means before application. See label for more details.
			75 mL/ha plus certain knockdown herbicides. See label for directions.	Seedlings: Small-flowered mallow, deadnettle, stinging nettle, *Amsinckia*, sowthistle, shepherd's purse, redshank, wild radish, capeweed, pigweed, stink grass, crowsfoot grass, liverseed grass.	
D	480 g/L trifluralin	Various	1.2 L/ha – light soils 1.7 L/ha – medium soils 2.3 L/ha – heavy soils	Annual grasses and certain broadleafed weeds. Does not control established weeds.	Mechanically incorporate into soil. New plantings: apply during pre-plant cultivation. Established vines: apply during spring.

Group	Chemical	Trade names	Rates	Weeds controlled	Comments
F	800 g/L norflurazon	Zoliar DF Solicam DF	2.5 kg	Annual ryegrass, barley grass, blackberry nightshade, *Brachiaria* (green summer grass), caltrop, capeweed, chickweed, common sowthistle (milk thistle), dandelion seedlings, curled dock seedlings, false caper seedlings, fat hen†, Indian hedge mustard, innocent weed (spring burrgrass), medic, hedge mustards, paspalum, plantain seedlings, pigweed (*Portulaca*), prairie grass, prickly lettuce, great brome (ripgut brome), salvation Jane, scarlet pimpernel, shepherd's purse, silver grass, skeleton weed seedlings, sorrel seedlings, soursob†, stinkgrass, stinking Roger, subterranean clover, summer grass (crabgrass), three-cornered jack (doublegee, spiny emex), variegated thistle, wild oats, wild radish, wild turnip, winter grass, wireweed, witch grass, yellow weed, Yorkshire fog grass.	Apply using a boom spray to bare ground prior to weed emergence. Apply as a directed spray in 300 to 500 L water/ha. Avoid contact with foliage or fruit. An application in early autumn will give winter weed control, or in early to midspring will give full summer weed control. **Notes:** Not recommended for grapes grown in sand or loamy sand soils with less than 1% organic matter and pH greater than 7.5, as veinal chlorosis may occur. For grapes only: Do not apply to nursery stock. Do not use more than 5 kg/ha each year. † Suppression only
			5.0 kg	Couch grass†, dandelion, curled dock, false caper, Johnson grass†, skeleton weed, sorrel, soursob†.	
			1.25 kg Zoliar DF + 2.0 L Simazine 500 g/L	Pigweed (*Portulaca*)	
			1.9 kg Zoliar DF + 2.0 L Simazine 500 g/L	Barnyard grass, clammy goosefoot, cobbler's pegs, green pigeon grass, redroot amaranth, summer grass, wireweed.	

† Suppression only

Table A4.3. Chemical desuckering: Non-selective post-emergent 'knockdown' herbicides registered in NSW for use in vineyards. Read the product label before use.

Group	Chemical	Trade names	Rates	Weeds controlled	Comments
G	240 g/L carfentrazone-ethyl	Spotlight Plus	75 mL/100 L plus Supercharge at 500 mL/100 L. A minimum spray volume of 50 L/km of row (both sides sprayed) is recommended.	Control of unwanted suckers (water shoots) arising from the main stem or trunk.	Apply to suckers less than 300 mm long, before any lignification is present. Preferably apply with a fully shrouded sprayer designed for the purpose, or with a directed sprayer targeting the bottom 60 cm of the trunk. The sprayer should be fitted with nozzles that produce spray of a coarse quality. Off-target drift of Hammer will cause marked damage to leaves and green stems. Do not apply to vines less than 2 years old or vines with green bark unless they are protected from the spray solution by a physical barrier.

Plant Health Laboratories – Grape Diagnostics – full page colour

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