

A growers' guide to

Topworking Grapevines



Phylloxera and Grape Industry Board of South Australia

First published April 2004

Second edition July 2008



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National Library of Australia Cataloguing-in-Publication

Phylloxera and Grape Industry Board of South Australia
A growers' guide to top-working grapevines

Bibliography

ISBN 0-9750882-2-X

Design and production Sandy Hathaway, PGIBSA, Adelaide

Desktop publishing Desert Sun Desktop Publishing, Adelaide

2nd edition printed by Centreprint, Adelaide.

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ACKNOWLEDGEMENTS

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Australian Viticulture magazine / Tony Bass (SARDI)

Thanks to the following people for reviewing the draft document:

Jim Caddy, Richard Hamilton, Jim Hardie, Robin Nettelbeck, Bill Wilden, Trevor Wilksch.

This publication was an initiative of the Phylloxera and Grape Industry Board's Riverland regional committee.

Disclaimer

While the Phylloxera and Grape Industry Board has made every effort to ensure the accuracy of the information contained in this document, it accepts no liability for the use of the information and any consequences arising from doing so.

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A GROWERS' GUIDE TO TOPWORKING GRAPEVINES

OVERVIEW

Recently, there has been increased interest among growers and wineries in the practice of top-working. If successful, top-working is – at best – a short-term method of bringing the varietal mix of a vineyard into line with current market demands. It is not generally advisable on a large scale (more than 30% of the vineyard), or as a long-term redevelopment strategy, as grafted vines will not usually be in top producing condition ten years later. *It should never be considered a solution to a poor performing block.*

There are a number of potential problems associated with top-working, which present the very real possibility of a serious failure. Several years of production can be lost while it becomes apparent that the project has failed, putting significant pressure on cash flow and vineyard profitability. A top-working exercise should therefore be undertaken with caution, only after the risks and benefits have been fully assessed, and all other options considered.

Following the critical steps in this guide will reduce the risk of an unsuccessful top-working project. For some growers, the **risk assessment** may indicate that it would be better to redevelop using new material, or stay with the existing variety, rather than top-work in a situation where there is a relatively high risk of failure, or the potential benefits do not outweigh the costs. Growers who decide to proceed with top-working can increase their chances of a successful outcome by following the **best practice guidelines**.

The pictures on the centre pages of this Guide provide illustrations and further information to support the text.

PART ONE: RISK ASSESSMENT

The benefits of a successful top-working venture are:

- ◆ Rapid response to changes in market demand - with only one year loss of production, and up to full production in the second bearing year.
- ◆ Less impact on cash-flow.
- ◆ Less lead time to obtain planting material.
- ◆ Lower cost than full redevelopment.

The main problems that can occur with top-working are:

- ◆ Poor strike requiring replanting with rootlings, leading to variability in vine age with subsequent increased vineyard management costs.
- ◆ Reduced yield and long-term decline in vine health (this may only become apparent after one or two successful harvests initially).
- ◆ Early rapid growth of the new vine, which puts pressure on the graft union to keep the vine hydrated, and makes the graft union vulnerable to being broken by wind or machinery – particularly machine harvesters.

Any of these problems may result in additional vineyard management costs and reduced returns due to uneven fruit quality, or in the vineyard becoming unviable, and having to be redeveloped.

Before commencing a top-working venture, it is therefore essential to carry out a risk assessment to determine whether it is a wise commercial decision to go ahead. Poor vine health status is the major reason for failure; therefore vine health must be assessed first. Provided that the health assessment is satisfactory, the next step is then a business assessment, to see whether the benefits outweigh the costs of top-working, and whether this is the best option for maximising vineyard returns.

A. Health assessment

The most significant diseases that affect the performance of grafted vines are virus and virus-like diseases. These are readily transmitted by grafting, and can cause problems where the new scion is more sensitive to a particular virus than the existing vine, or where there is a mix of viruses from infected rootstock and budwood.

Fungal and bacterial diseases can also affect top-worked vines, where these are already present in the vine or enter through pruning wounds made when top-working.

The purpose of the health assessment is to determine whether any of these diseases may be present in the vineyard. There are three parts to the health assessment:

Step one: assess the past performance and characteristics of the vineyard

Step two: conduct a visual assessment of the vineyard

Step three: test a sample of vines for known viruses and other agents

STEP ONE: VINEYARD PERFORMANCE AND CHARACTERISTICS

Is it currently performing well or poorly?

Is it already grafted or on own roots?

Is it over 10 years old – particularly Shiraz, Cabernet Sauvignon or Grenache?

A vineyard that already suffers from poor growth, poor nutrition and lower yields is unlikely to respond well to top-working. It may already be suffering the effects of viruses or other infections, or be stressed for other reasons (such as poor soil).

A vineyard that is performing well may still have viruses present. Vines on their own roots that have a virus load often give no indication of any problems. However, the introduction of more virus through grafting scion material often results in problems, particularly when the introduced virus is different from that already present, or the scion material is a more sensitive variety.

Vines on rootstocks are at an even greater risk, because they already have the potential for mixed infections.

Older vineyards, particularly Shiraz, Cabernet Sauvignon and Grenache, often show symptoms of Eutypa infection. Eutypa-infected vines should not be top-worked, as this can lead to accelerated degeneration and a pattern of diminishing yield in addition to poor growth and budburst disorders. Even healthy vines of susceptible varieties that are approaching 15 years old should be considered at risk.

Eutypa infection can also enter a vine through a pruning wound; therefore hygiene is essential when top-working (see part two).

Other trunk fungal diseases Petri disease (formerly known as Black Goo) - and Esca are present in some Australian vineyards, but may have no obvious leaf or growth symptoms. These have been associated with poor results from grafting. If vines are in poor health as a result of these diseases then top-working would be considered high risk. Diagnostic testing is available for Petri disease but not Esca. A pre-trial may be the only way to determine the likelihood of problems with top-working at a result of the presence of Esca.

STEP TWO: VISUAL ASSESSMENT

A visual inspection of the vines may reveal symptoms of leafroll or other viruses or Eutypa, which would indicate that the vineyard is unsuitable for top-working. The best time for a visual inspection is in April-May for leafroll virus, and in October-November for Eutypa. However, many viruses display no visual symptoms, or only cause symptoms at certain phenological stages of the vine. This is particularly true for white varieties. Therefore a decision to proceed with top-working should not be based on a visual assessment alone.

For more information on visual health inspections of vineyards, contact your local vine improvement committee.

STEP THREE: VIRUS TESTING

There are at least 15 viruses known to be present in grapevines in Australia. The role that many of these viruses play in vine performance is not known; however research indicates that some graft-transmitted viruses are particularly detrimental to vine performance. The combination of different viruses from an existing vine and introduced budwood may be even more detrimental. Effects may range from gradual decline in vine health and associated growth and yield, through to poor strike and vine death within a short timeframe. Graft transmission of viruses has been shown to be one cause of restricted spring growth symptoms.

Prediction of the effects on vine performance associated with combinations of viruses is difficult as varieties differ in their sensitivity. Environmental conditions will also have an impact on the expression of symptoms.

The main viruses found by research to cause major damage to top-worked vines are:

- ◆ Leafroll-associated viruses (1, 2 and 3)
- ◆ Redglobe virus (a strain of leafroll virus 2)
- ◆ Grapevine virus A
- ◆ Grapevine virus B
- ◆ Fan-leaf virus

Laboratory testing can assist in determining the presence of virus in either the vineyard to be top-worked or the budwood¹. There are two main types of virus testing: PCR (Polymerase Chain Reaction) and ELISA (Enzyme Linked Immunosorbent Assay). ELISA testing is less expensive, but is not as sensitive as PCR and it is not able to detect all known viruses present in Australia.

Successful virus testing requires that an adequate sample of vines be obtained, using an appropriate statistical sampling method for the vineyard and taken at the optimal time for detection of the viruses. As a general rule, a sample of 0.5% of the vines should be taken (ie one vine sampled per 200 vines), and five vines can be tested together as one sample. Therefore one sample can screen 1000 vines or approximately 2/3 of a hectare. Before sampling, however, contact the testing facility and/or a vineyard consultant for more information on taking samples.

Interpretation of results

Results of virus testing need to be interpreted carefully. A negative result may not mean that the vine is virus-free. Viruses can be present at levels too low to be detected. In the vineyard they may eventually

¹ A list of testing facilities is provided at the end of this Guide.

multiply to a level at which symptoms appear. There are also viruses for which no convenient diagnostic test has yet been developed.

The test is also based on a small sample size, and there may be virus present in other vines in the block that were not sampled. Records of the origin of planting material are helpful to ensure that a representative sample of vines from all different sources is taken for testing.

A positive result is a definite indication that virus is present. However, some viruses - for example, *rupestris* stem-pitting virus and grapevine fleck virus - are routinely detected but have not been shown to have any significant detrimental effect on the performance of grafted vines, when found in isolation from other viruses.

In summary, virus testing will not always provide a definite answer as to whether or not top-working should proceed; however, the information from the test results will assist in determining the level of risk associated with the proposed top-working venture. *It is very important to seek expert advice on the implications of test results for a top-working venture.*

HEALTH ASSESSMENT SUMMARY

Where does your vineyard fit?

You are strongly advised not to proceed with top-working if:

- ◆ your vineyard tests positive for any leafroll virus, grapevine virus A or B, or shows symptoms of *Eutypa* dieback or other trunk disease; or
- ◆ your vineyard is performing poorly, is of mixed, unknown origin, and/or is already grafted and has not been virus tested.

A vineyard that is most suitable for top-working is one which:

- ◆ is performing well;
- ◆ shows no visual symptoms of disease or stress;
- ◆ is less than ten years old; and
- ◆ tests negative for the major viruses listed.

EXAMPLES OF SUCCESSFUL TOP-WORKING



Successful top-working (Riesling on Sauvignon Blanc). Vines in their fourth season.

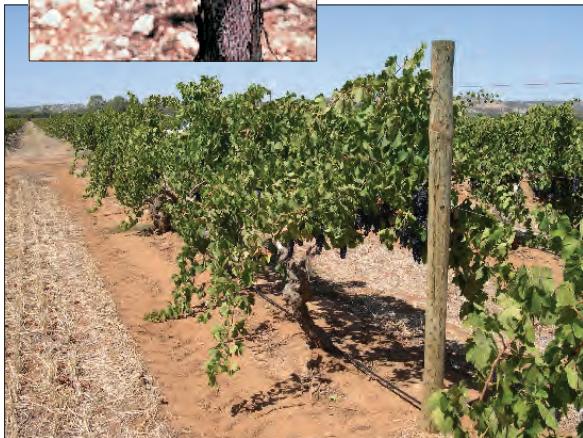
Both top-worked scions successfully taken up to the cordon.



This vine framework has been achieved using one scion only.



Successful strike of both buds.



Successful topworked block (1st crop after 2 seasons). Note the new trellis with foliage wire used to stop cane rolling and grafts breaking out in the 1st year.

EXAMPLES OF TOP-WORKING FAILURE



Unhealthy vine with new growth from the old variety appearing below the grafting point.

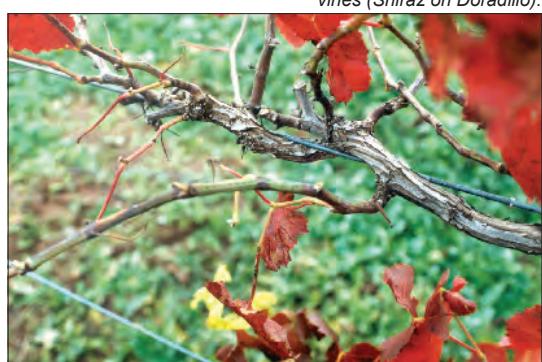
Overcropping affects overall vine balance (note the short shoots).



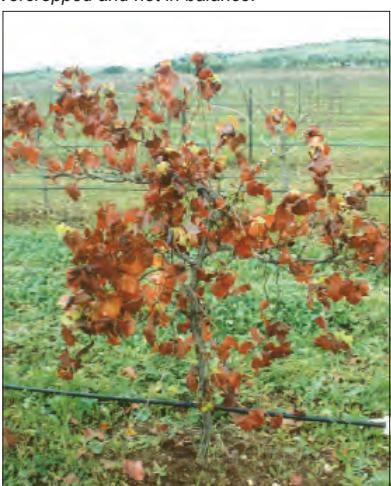
Vine failure after one season's growth post top-working.



A top-worked block with many failures leads to vine variability as a result of the need to replant misses with new rootlings. Also note the successful vine is overcropped and not in balance.



(Below and right)
Leafroll symptoms on grafted vines (Shiraz on Doradillo).



TOP-WORKING METHODS



Cuttings taken from dormant vines are stored in cold store until required to be cut into buds for grafting.



Chip bud graft prior to wrapping with grafting tape.



Low level cleft graft done to remove eutypa infected wood.

GENERAL CONSIDERATIONS WHEN TOP-WORKING

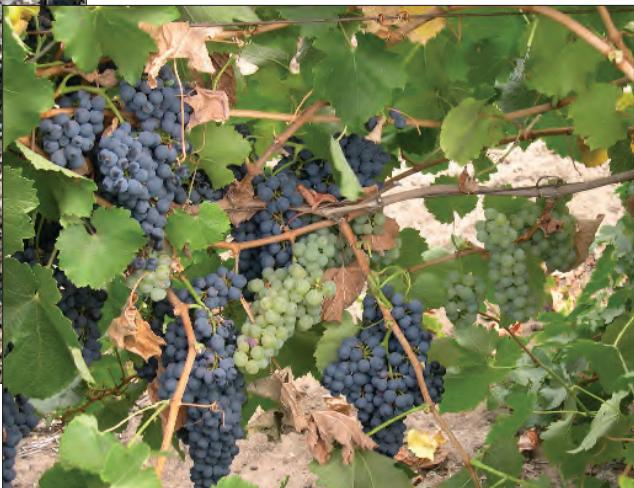


Eutypa infected vines as shown here are not good candidates for top-working.

Successful strike of both buds with shoots taped to the training string to avoid breakage.



Unwanted growth from the top of the rootstock will lead to mixed varieties in this situation if not removed.



Shiraz top-worked on Riesling, with scion failure on one vine leading to variety mix.

B. Business assessment

Top-working is a possible strategy for improving vineyard returns in the short- to medium-term. It should only be carried out if there is a sound business reason for doing so, if the likely financial benefits outweigh the costs, and the risk of failure is tolerable.

ARE THERE SUFFICIENT REASONS FOR CHOOSING TOP-WORKING?

Top-working (if successful) can deliver a change in varietal mix within one year, with near full production in the second vintage after grafting. In a cool climate region there is likely to be a 12 month advantage compared with replanting; however in a warm climate region such as the Riverland, there may be no difference in time to full production between top-working and replanting.

Top-working can update a vineyard's varietal mix to suit current market demand. It is unlikely to result in vines that will still be producing in top condition in ten years' time. Each time top-working is repeated, the risk of failure increases. Therefore the long-term development of the vineyard should be taken into consideration as well as the immediate future.

Changing the variety may allow the grower to sell the new variety at a higher price. However, the pay-back period for top-working is likely to be at least three years (if a reasonably good strike is achieved). Therefore if there is no medium-term commitment from a purchaser to keep buying the new variety, then it may be better to keep the existing variety. This is particularly true of the "staple" Australian varieties of Shiraz, Cabernet Sauvignon and Chardonnay, which might suffer in the short-term from over-supply, but are not likely to suffer long-term from changes in consumer preferences like the minor varieties such as Verdelho or Tempranillo.

The performance of the new scion-rootstock combination needs to be considered. For example, Merlot grafted onto another variety is likely to be more vigorous than on its own roots; Shiraz grafted onto a vine with a Ramsey rootstock might produce undesirable fruit characteristics.

COST OF TOP-WORKING COMPARED WITH A NEW DEVELOPMENT

If the vineyard structure (irrigation and trellis) is to be retained in the top-worked vineyard, this can save money. However, because of the time and care required, the saving may not be much compared with clearing the land with a bulldozer and redeveloping. This would also allow irrigation systems to be updated, vine planting density to be changed and soil to be reconditioned.

It may be easier to access budwood for top-working than grafted rootlings for replanting (which often need to be ordered two years in advance). The cost of the cuttings for budwood compared with grafted rootlings is also much lower, although the grafting cost itself reduces the differential. If replanting on own roots² then the total cost of planting material would actually be lower for a new development.

A top-worked vineyard in the first two years also has increased management costs including: training the new shoots, thinning and hand-picking. A non-uniform vineyard with variability in scion development as a result of a high percentage of replants may also require different management in terms of irrigation and herbicide application, nutrition and harvest, making it more labour-intensive and hence more expensive. In addition, the quality of fruit from top-worked vines, particularly with a high proportion of replants, is more uncertain than that from a uniform young vineyard. This may impact on the price received per tonne for fruit. If a white variety is grafted onto a red variety, and some shoots from the original vine produce fruit, the mix is likely to be rejected or downgraded by the winery.

² The PGIB recommends that replants be on vines grafted on phylloxera resistant rootstocks. See the Board's publication: "A Growers' Guide to Choosing Rootstocks in SA".

These factors need to be taken into account in assessing the financial benefits of top-working a vineyard compared with either retaining the existing variety, or a full redevelopment.

Economic modelling undertaken in the development of this Guide³ indicates that a successful top-working venture will return the vineyard to profitability one year sooner than a redevelopment; however, this does not allow for a poor initial strike rate, requiring either replants or a subsequent decision to redevelop instead.

BUSINESS ASSESSMENT SUMMARY

In summary, it is important to consider all the alternatives before deciding on top-working as a means of maximising vineyard returns, and to understand its limitations as a long-term development strategy for the vineyard. Top-working will have a lower impact on cash-flow and return the vineyard to profitability sooner if successful; however, the probability of some replanting, management and other costs being incurred means that a decision to top-work instead of redevelop should not be made purely on financial grounds.

³ Available from the Board's office

PART TWO: BEST PRACTICE TOP-WORKING GUIDELINES

If you have decided to proceed with top-working on the basis of the risk assessment, you can maximise your chance of success by following the best practice guidelines given below.

These guidelines cover all aspects of top-working, from the selection of the material to use, through to the management of the young grafted vines.

Selection of material

Obtain virus-tested budwood. It is technically not possible to guarantee that vine material is free of viruses, but the risk of problems can be reduced by purchasing from accredited nurseries that supply material with a history of virus testing.

Budwood should be hot water treated (50°C for 30 minutes) as this treatment reduces the titre of certain bacterial diseases (crown gall) and anecdotal evidence indicates that it removes fungal diseases (eg Petri disease, phomopsis) as well as phytoplasmas (eg AGY).

Grafting methods

Grapevines can be grafted using a number of different techniques, depending on vine age and vine phenology. Top-working generally involves vines at least three years old, and is normally best done in spring. The grafting techniques that are most commonly used in early spring are 'chip budding' and 'cleft grafting'. Later in spring when the bark of the rootstock begins to slip 'T-budding' can be undertaken.

There are regional and site-specific considerations to take into account when grafting, and it is important to use a grafter with knowledge of and practical experience in your region.

The following is a brief summary of the common grafting methods mentioned above.

1. CHIP-BUD GRAFTING

This is the most common method used to top-work vines because of its high success rate. It is most successful in early spring after budburst through to flowering – or when bark slip starts to occur. The budwood used is taken from vines when fully dormant. It is usually taken as a cutting and stored in a cold store at approximately 2°C until required. Chip buds are then taken from each dormant cutting and stored in cool water until grafted, which is best done within 12 hours of bud preparation.

The chip-budding technique can also be used later in the season (December-January) using a green bud from the current season, or a lignified brown bud from the current season (from February to March). Green buds are more susceptible to hot weather than the lignified brown buds.

2. CLEFT GRAFTING

Cleft grafting can be done high or low on the trunk (even below the soil surface). Low level cleft grafting is normally only done when disease (eg Eutypa) needs to be removed from the vine. This type of graft is done from budburst to bark slip (ie October to December).

Cleft grafting is best suited to mature vines with a large trunk diameter (over 10cm). Thinner trunks are not able to hold the budwood firmly enough to ensure callusing. Grafting ideally occurs within 30 minutes of removing the vine framework. The budwood, which is cut to a wedge at the base, is inserted into a split made into the trunk to a depth of 5cm.

This grafting technique requires the use of a pruning wound sealant because of the size of the wound. If rain washes the sealant into the grafting union while it is still soluble following application, then problems with strike can occur; therefore timing is particularly important in grapegrowing regions with frequent spring rainfall. Otherwise, the cleft graft is normally very robust and successful.

3. T-BUD GRAFTING

T-bud grafting is normally used when top-working is done late spring to summer (late November to early February) once bark slip occurs on the trunk. The bark on the trunk is cut in a T-shape under which the bud wood, cut into the shape of a shield, is inserted. The union is then wrapped with grafting tape.

The budwood is taken from fully dormant vines - usually taken as a cutting, and stored in a cold store at approximately 2°C until required. Chip buds are then taken from each dormant cutting and stored in cool water until grafted, which is best done within 12 hours of bud preparation.

The T-bud graft can also be done using a green bud from the current season, provided there is bark slip. However, the graft union is susceptible to hot weather, which is prevalent in most grapegrowing regions at this time of the year.

General considerations when grafting

For budding methods, sap flow past the point of grafting is critical, hence it is *very important* to leave a number of buds (up to 12) at the top of the vine so that flow continues (except for cleft grafting where grafting occurs straight away after the removal of the tops). If using the existing trellis system, then one method is to leave one permanent arm on the cordon as this assists with vine stability (particularly young vines) and facilitates sap flow past the grafting point.

However, excessive sap flow over the graft union has a negative effect on strike. Removal of the tops is best done when the vines are fully dormant so that vine bleeding has ceased prior to grafting. When excess bleeding is prevalent, major cuts should be angled so as to direct sap flow away from the point of grafting.

Eutypa dieback, Petri disease, Esca and other fungal diseases can enter pruning wounds made in preparing the vines for top-working, hence hygiene when making large cuts is essential. The susceptibility of pruning wounds to infection is dependent on the size of the cut

(age of the wood), timing and conditions during the healing process. Immediately after making large cuts apply a sealant or fungicide. Some benzimidazole fungicides used for Botrytis control have been shown to be effective, but are not registered as pruning wound protectants⁴.

Grafting two scions enables both shoots to be trained in a bilateral framework maximising yield potential the following season. This also avoids having to tip a single growing shoot at the cordon wire and setting back growth for up to three weeks before the laterals take-off for bi-lateral training. In addition, two scions provides a back-up to allow successful strike if one scion fails or is broken off (eg by wind or mechanical damage). Buds should be grafted in line with the row and not too close to the wire, to reduce the chance of both grafts being broken off mechanically or by twisting when vine training.

Avoid clear grafting tape where hot weather is expected within two weeks of top-working as this can contribute to overheating the graft union to the point of failure.

Management implications for top-worked vines

The requirements for top-worked vines may be different from those of a mature vineyard, or a uniform new development. In general terms, top-worked vines in their first season of growth need more attention to training to limit excessive shoot growth, which can lead to the scion breaking out at the graft union. Adequate water and nutrition are also essential to establish a uniform vineyard with a maximum amount of cordon wire coverage.

If topworking grafts fail, replants will be required. The greater the number of replants required, the less uniform the vineyard becomes, potentially reducing fruit yield and quality and making management more difficult.

Some specific guidelines are presented on the following pages.

⁴ There is an article on fungicide control of Eutypa in The Grapegrower & Winemaker (no.465 - Oct 02) by Mette Creaser and Trevor Wicks.

- ◆ An irrigation system needs to be in place to ensure adequate soil moisture for the top-worked vines from prior to grafting though to the end of the growing season. (Note, however, that excessive soil moisture can generate too much sap flow and subsequent callusing problems at the graft union.)
- ◆ Vine training (potentially more than one pass per week) is essential as new growth can be very vigorous, putting pressure on the graft union to keep the vine hydrated, and making it vulnerable to being knocked off – eg by wind. Crossing each scion over onto the opposite side of the wire reduces whipping from the wind and stress on the graft.
- ◆ With budding methods, once the new buds have progressed past woolly bud and the leaves are green it is safe to assume the graft has connected. Training strings need to be in place soon after this time given the rapid growth possible.
- ◆ Once the scion shoots start growing it is desirable to remove the trunk suckers to limit competition. Rapid growth of the shoot often coincides with a slowing of growth of the suckers. In situations of extremely rapid scion shoot growth some suckers may be retained in an attempt to slow scion growth.
- ◆ Care needs to be taken to ensure the new scion is trained to the wire and suckers removed so as to avoid a variety mix. Adequate supervision of training labourers is required.
- ◆ After one to two leaves have opened on the new shoot it is advisable to go back through the block to re-graft where necessary. You may be able to regraft using the chip bud method (prior to bark slip) or the T-bud method post-bark slip. Both methods use dormant wood from a cold store.
- ◆ In the second and third year, there may be a potential overcropping situation where old vines with a diminished amount of fruiting wood suddenly have a lot of fruiting wood. Overcropping can throw a vine out of balance, leading to uneven/poor budburst in the next season and subsequent difficulty in developing spur positions and

permanent cordons (as well as a possible reduction in fruit quality). This situation is very difficult to recover from. Shoot thinning and bunch thinning can be used to reduce the crop in the first two years and help the vine achieve balance.

- ◆ If a vine is not balanced, the number of nodes left at pruning can help in increasing or decreasing vine vigour. The rule of thumb is that 30-40 nodes are required for every kg of pruning weight removed from the grapevine⁵.
- ◆ On lower vigoured sites, it may be necessary to hand-pick in the first bearing year to allow the graft union to fully strengthen, and avoid substantial union breakage, as a result of mechanical harvesting.
- ◆ If a graft has failed and the vine has died, it will need to be replaced with a grafted rootling. New vines have different management needs, which will need to be considered. Other issues include herbicide effects on young vines, which may warrant vine guarding, and the potentially damaging effect of machine harvesting on the young vines. The block may need to be hand picked or young vines staked prior to machine harvesting.

DIAGNOSTIC TESTING FACILITIES

WAITE DIAGNOSTICS

University of Adelaide
Waite campus
Phone: 08 8303 7426
Email: nhabili@waite.adelaide.edu.au

KNOXFIELD

Department of Primary Industries
Institute for Horticultural Development
Knoxfield
Phone: 03 9210 9222

⁵ See the Board's publication "Young Vine Management".

RECOMMENDED READING

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ISBN 0 9750882 2 X