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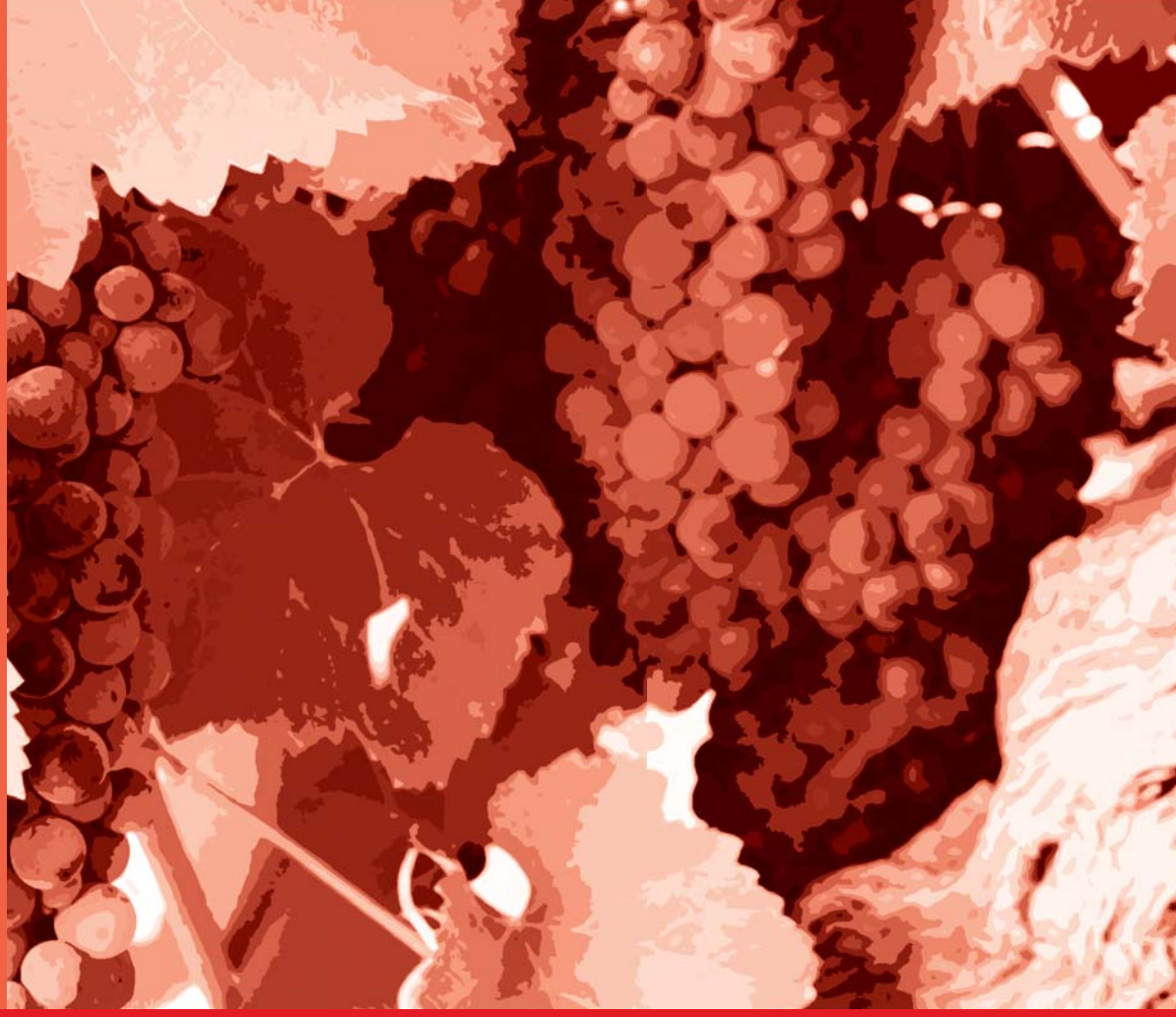

VITICARE ON FARM TRIALS

Manual 2.6 - Canopy Management

Managing cropping levels to improve grape quality

Modifying trellising systems to improve grape quality

Cooperative
Research Centre
for
Viticulture

Core Participants

About the CRCV

The Cooperative Research Centre for Viticulture is a joint venture between Australia's viticulture industry and leading research and education organisations. It promotes cooperative scientific research to accelerate quality viticultural management from vine to palate. Australian grapegrowers and winemakers are key stakeholders in the CRCV, contributing levies matched by the Commonwealth Government and invested by the Grape and Wine Research and Development Corporation in the Centre.

For more information about the CRCV, please visit www.crcv.com.au.

Disclaimer

Acknowledgments

The following growers have been directly involved in participatory on-farm trials and without them this manual would not exist.

Mal Barclay
Stuart Barclay, Tumbarumba Wines
Lachlan Campbell, Coolongatta Estate
Juliet Cullen, Excellsior Peak Vineyard
Dan Dujic
Cathy Gairns, Courabyra Vineyard
Ryan Johnstone, Warramate Vineyard
Jeff King, Warangesda Vineyard
Vincent Lackey, Ray Monde Vineyard
Simon Locke, Kyeamba Creek Vineyard
John Manfield, Panton Hill Vineyard
Gary Robinson, Minninya VIneyard
Peter Royal, Barters Vineyard
Graham Smith, Bradfield Park

The following people have made the development of this manual possible:

Ms Lee Bartlett, South Australian Research and Development Institute, Adelaide, South Australia (Manual 2.5)
Mr David Braybrook, VitiSolutions, Victoria
Ms Jo-Anne Deretic, Australian Quarantine Inspection Services, Melbourne, Victoria
Mr Marcus Everett, Southcorp, Mildura, Victoria (Manual 2.1)
Dr DeAnn Glenn, Grape and Wine Research and Development Corporation, Adelaide, South Australia
Mr Ian Goodwin, Department of Primary Industries, Tatura, Victoria (Manual 2.3, Manuals 3.1-3.3, editing)
Mr Shayne Hackett, NSW Agriculture, Wagga Wagga, New South Wales (Manual 2.2, 2.3, 2.6)
Mr Chris Haywood, NSW Agriculture, Gosford, New South Wales (Manual 2.4, 2.6)
Mr Graham Hepworth, Statistical Consulting Centre, University of Melbourne, Victoria (Manual 1)
Ms Vanessa Hood, Department to Primary Industries, Box Hill, Victoria
Dr Daryl Joyce, Department of Primary Industries, Knoxfield, Victoria (Manual 1, Manuals 2.1-2.6, editing)
Ms Natalie Laukart, Department of Primary Industries, Knoxfield, Victoria (Manual 1, 2.4, 2.6, Manuals 2.1-2.6, 3.1-3.3, editing)
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Dr Michael Treeby, CSIRO (Manual 2.2)
Mr Ashley Wheaton, Melbourne University, Dookie College, Victoria (Manual 2.1, 2.3, 2.5, Manuals 3.1 - 3.3, editing)
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Introduction

Introduction

The Cooperative Research Centre for Viticulture has conducted On Farm Trials since 1999. The initial trials were conducted in eight regions (Port Phillip, North East Victoria, Central Victoria, Adelaide Hills, Riverland, South West Slopes, Riverina and Hunter Valley) and provided Australian growers with the ability to formally assess and validate new science and technology. The trials were conducted over four growing seasons and helped growers to solve problems in their vineyards and improve their management practices.

In 2004 the On Farm Trials project expanded to cover more than 20 viticultural trials primarily in the Riverina, Riverland and Sunraysia regions. Rather than focusing on individual grower issues, the CRCV team has worked with regional grower groups to determine regional issues. The trials are still conducted on a participant growers' property but a team of people are involved to learn from the trial and to share the workload.

This booklet is part of a series that draws on knowledge gained from this experience in developing and delivering On Farm Trials.

Conducting a trial in your vineyard is not easy and is not a decision that should be made lightly. Although trials can be an excellent method for refining management practices, improving quality or looking for solutions to problems, there are many practical considerations involved in conducting a trial.

On Farm Trials can lead to management improvements in a number of areas. The information in this booklet will guide you through the various protocols involved with setting up On Farm Trials that aim to manage cropping levels to improve grape quality and modify trellising systems to improve grape quality.

Managing Cropping Levels to Improve Grape Quality

Aims

This trial aims to:

- Manage crop loads to accelerate maturity
- Perform bunch thinning to compare yield with quality and/or ripening speed
- Compare different pruning techniques
- Investigate methods of reducing canopy density by shoot thinning
- Investigate methods of reducing canopy vigour by increasing bud numbers using sacrificial canes (kicker canes) while retaining yields to appropriate levels

Important Points to Know

Many of the canopy management techniques used to manipulate crop levels involve the use of increased bud numbers to reduce vegetative growth. Whilst this is an effective measure to reduce vine vigour, retaining more buds at pruning generally leads to increased cropping levels and shoot crowding.

A vine has a range of cropping capacities determined by leaf area, age, nutrition, water and climate. The ripening date is determined genetically by Growing Degree-Days (GDD). Growing Degree-Days is the sum of the average daily temperature above 10°C during the vine growth period. An earlier ripening date can be achieved by management practices including adjusting crop load, to a limited extent. As a crop is increased beyond vine capacity the first effect is delayed maturity. Further successive increases in crop can result in low sugar, "water-berries", sunburn and drying of the tips of clusters, reduced vine growth and storage, and poor fruit-bud formation. Overcropped vines (ie vines that have a very large crop and insufficient foliage) cannot produce enough sugar to feed all bunches, therefore fruit needs a long time to ripen or may never reach adequate ripeness. While high cropping levels can have an influence on grape composition, the effects of overcropping are also experienced for more than one season as the vine's capacity for future growth is reduced. Reducing crop levels will increase speed of maturity and sugar content, but not the quantity of aromas in the remaining bunches.

Pruning
The general principle of pruning is that the more nodes that are left on spurs or canes the more potential yield. If too many buds are retained at pruning, there is a decrease in the proportion of shoots that reach productivity and an increase in short, weak and poorly performing shoots.

A couple of 'rules of thumb' are listed here:

- Retain 30 to 40 buds per kg of pruning weight.
- Shoot and vine spacing affects the amount of light on leaves and resulting sugar production. Therefore, 15 shoots per meter of single canopy is recommended for controlled hand-pruned canopies. Higher numbers may apply for hedged vines.
- To achieve 40 buds/kg of pruning weight and 15 shoots/m on rich soils the canopy must be divided to enable adequate spacing of shoots.
- To avoid shading in vertical trellis systems the canopy height should be equal to or less than the row width (Smart, 1995).

Sacrificial canes
The use of sacrificial canes has the ability of increasing bud numbers to de-vigourate vines without increasing crop loads. Vines are spur-pruned with one or two additional canes retained and wrapped along a foliage wire. Canes are removed at or prior to veraison; in case of bad fruit set they can be left on (Clancy, 2001).

Shoot thinning
Shoot thinning, as well as bunch thinning, is a tool that can manipulate the balance of vegetative and fruitful growth. Thinning has the role of managing canopy density and hence shoot and bunch exposure to light. The higher the ratio of exposed leaves to shaded leaves, the better. Thinning also helps avoid short shoots that produce an under-ripe crop, since they have a low leaf area to fruit ratio.

Bunch thinning
The principles of bunch thinning are to increase the leaf area to fruit ratio (optimal between 6 and 15 cm2 per gram of fruit (Smart and Robinson, 1991) which can lead to better sugar accumulation and ripening speed. Bunch thinning is generally seen as a tool to prevent over-cropping and adapt yield to vine capacity and seasonal climate, and to encourage higher level of quality within a given yield. Timing of bunch thinning varies greatly, usually from pre-bloom to just before harvest. However, to avoid an increase in berry size and therefore quality in red varieties, the best time for bunch thinning is veraison to remove unripe bunches. This also decreases the variability within the crop.

Positive and Negative Aspects

It is important to determine the risks associated with different cropping levels at the proposed site. These risks must be weighed up against the potential benefits that a particular treatment may impart. Some risks may preclude trialing treatments on a particular site. At other sites, it may be sufficient to monitor a potential risk and have a contingency plan in place to deal with it if it occurs. The positive and negative aspects of managing cropping levels in vineyards are listed below. These may be used as a guide to risks that may develop.

Winter Pruning
Positives of winter pruning in vineyards include:

- Pruning can be used to regulate yield
- Generally the more nodes are left on spurs or canes the more potential yield

Negatives of winter pruning in vineyards include:

- Effects of pruning are often only visible after 2 - 3 years
- Yield does not increase in direct proportion to bud numbers

Sacrificial Canes
Positives of using sacrificial canes in vineyards include:

- Best results when retaining 8 - 10 canes per vine
- Beneficial in hail-prone areas or where areas prone to fungal diseases
- Versatile method: when set is good, they can be either completely or partially removed and when set is bad they can be retained

Negatives of using sacrificial canes in vineyards include:

- Cost: hand removal is labour intensive and time consuming

Shoot Thinning
Positives of shoot thinning in vineyards include:

- Reduced risk of pests and diseases
- By managing shoot density, leaves will perform better, ripening and colour will benefit due to open canopy (cool climate only)
- Removal of short shoots is an advantage because their leaf to fruit ratio is low, which in turn affects the quality
- Open canopy can improve spray application

Negatives of shoot thinning in vineyards include:

- The growth rate of the remaining shoots generally increases, which can lead to lower fruit-set, in turn stimulating shoot growth even more and reducing sun exposure
- There are no fall-back buds in case of bad set
- Open canopy can cause sunburn in bunches in hot climate regions

Bunch Thinning
Positives of bunch thinning in vineyards include:

- Post fruit-set thinning can reduce the susceptibility of bunches to Botrytis since it reduces the compactness of bunches
- Bunch thinning is an effective method of reducing yield, when removal occurs before veraison
- Veraison thinning has the greatest effect on the final yield
- Bunch thinning is useful when yields are higher than expected and if pruning and yield assessments have been miscalculated
- Bunch thinning is useful to increase the uniformity of the ripening of the crop after veraison

Negatives of bunch thinning in vineyards include:

- The vine will compensate for post fruit-set thinning
- An increase in berry and bunch mass generally results in smaller yield reductions
- Calculate yield loss versus quality bonus (eg: 50% of bunch thinning will result in a 16-30% increase in brix or colour) (Iland et al. 1995 and Dry et al. 1999)
- High costs are involved in bunch removal (hand removal is labour intensive)
- Bunch thinning will show no improvements in aromas

In light of these issues, some questions worth considering are:

- Which risks are important at your site?
- Which risks would not prevent the trial proceeding but should be monitored?
- What plans need to be put in place to reduce the impact of any risks occurring?

Cost Benefit Analysis

In order to determine the financial viability of a canopy management program, a cost/benefit analysis should be completed to relate the monetary requirements of thinning or different pruning techniques to a production basis. The risks associated with a cropping program in vineyards must be weighed up against the benefits. However, it must also be remembered that fruit quality benefits may only be realised over a minimum of three years, which may justify the commitment to canopy management program.

Before You Get Started

The following requirements will help you prepare for this trial:

- Secateurs
- Leather gloves
- Buckets
- Scales

Site Suitability

Canopy

- Vine not younger than 3 years
- Difficulty in achieving maturity (Brix)
- Insufficient productivity/quality
- High vegetative growth
- Quality issues (poor colour)
- Winery restriction in cropping levels
- Pest and/or disease issues

Potential Treatments

There are several different ways to conduct trials for cropping levels management:

1) Pruning
a) Altering cropping levels by pruning to different bud numbers in winter
b) Timing of pruning
2) Sacrificial Canes
a) Single sacrificial cane per vine
b) Two sacrificial canes per vine
c) Nil sacrificial canes (Control)
d) Sacrificial canes not removed
3) Shoot thinning
a) Remove non-bearers
b) Remove shoots bearing only small bunches
c) Un-thinned
4) Bunch thinning:
a) Partial bunch removal when berries are pea-size
b) Partial bunch removal at veraison
c) 50% bunches removed
d) 25% bunches removed
e) Un-thinned

Measurements and Monitoring

There are numerous measurements that are applicable to a cropping level trial. Unfortunately, there is no single set of measurements that are applicable to all trials. The correct measurements can only be selected once the objectives of the trial have been clearly defined. The following is a list of potential measurements.

Measurements	Time*	Difficulty*
Bunch sampling (after spray)	1	A/B
Vine vigour - shoot length	3	A
Leaf number	3	A
Pest and disease damage	1	A
Disease visual assessment	1	A
Brix/Baumé	1	A
pH	1	B
Titratable acidity	1	C
Colour	2	C
Yield	2	A
Pruning weights	2	A
Vine growth stages (phenology)	1	A

**Time is where 1 = few minutes per replicate, 2 = 15 minutes per replicate, 3 = >30 minutes per replicate; Difficulty is where A = easy, no laboratory skills and/or measurement equipment required, B = some laboratory skills and/or measurement equipment required, and C = laboratory skills and/or sophisticated measurement equipment required. Refer to complete Table 2.2 in Section #2: Trial Design and Variability.*

Trial Timelines

Trials involving canopy management should be run for a minimum of three years. The impact of bunch and shoot thinning as well as sacrificial canes on quality for example is difficult to measure in short term trials. The time required to carry out the treatments (for example, pruning or bunch thinning) will be approximately 0.5 day. Samples taken at harvest could take approximately 0.5 day for quality parameters.

The below table indicates when measurements or samples suggested are to be taken by shaded areas. See the measurement manual in this series for more information about measurement protocols.

	Dormancy	Bud burst	Shoots 10 cm	Flowering	50% capfall	Berry set	Berries pea-size	Bunch closure	Veraison	Harvest	Post-harvesty
Pruning weight											
Vine growth stage (phenology)											
Shoot length											
Yield											
Bunch sampling											
Quality											
Botrytis assessment											

Trial Design

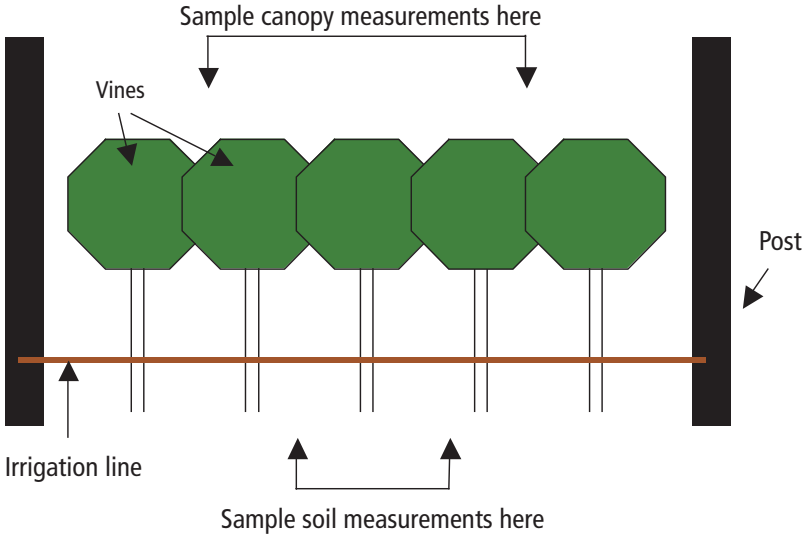
Treatments will need to be replicated within the trial area at least 6 to 8 times; more if the area is not very uniform. One of the treatments should be a control, which will often be current practice. It is advised not to have more than 3 or 4 treatments, to allow enough time for management of the trial. Plots (or experimental units) can be different shapes and sizes, but a common plot in a canopy management trial consists of three rows by three panels of vines. The middle panel is used for taking measurements (for example, Row 5 Panel 5). Buffering is important to identify clear treatment areas and to avoid contamination between treatment areas. Buffer zones are marked as panels with grid-lines in the designs shown on the following page.

Design 1 gives an example of a trial layout in which the treatments are three rates of bunch thinning plus a control (no bunch thinning). The trial has 4 treatments and 6 replications, arranged in a randomised block design, with the blocks being rows (or, more strictly, groups of 3 adjacent rows).

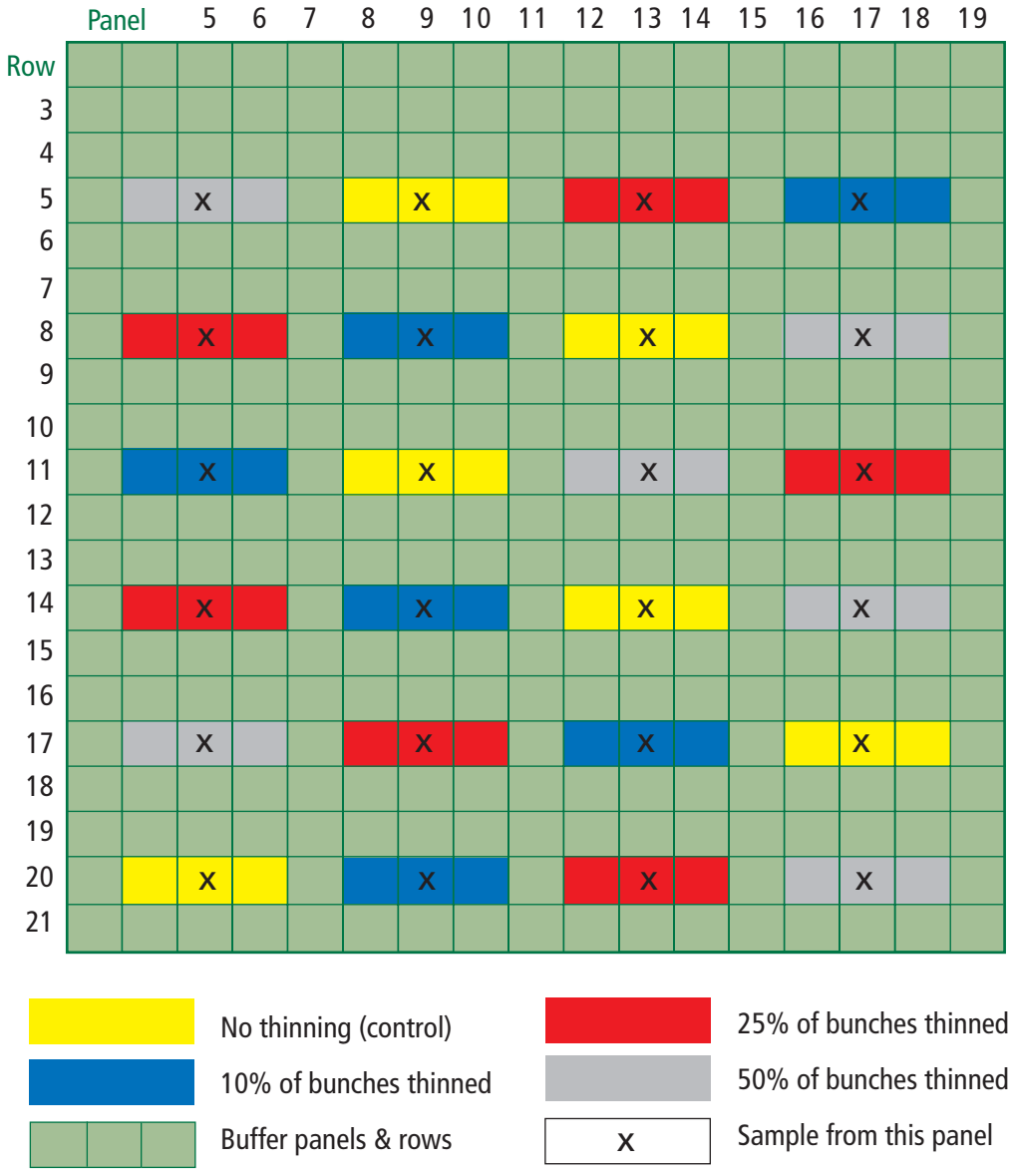
Design 2 gives an example of a trial layout in which the treatments are two shoot thinning options plus a control (no thinning). It uses rows as experimental units as opposed to panels. This can make management of the trial (i.e. mechanical thinning) a little easier. When using rows as experimental units, it is normally anticipated that a maximum of three treatments are trialed due to the potential workload expected. This trial has 3 treatments and 6 replications, again arranged in a randomised block design, with the blocks being groups of 3 adjacent experimental units.

When taking vine measurements, the following approach is recommended: only sample the middle vine in panels marked with an X (Design 1 and Design 2). If there are more than 3 vines per panel, only sample from the middle vines of the above-mentioned panels (see Figure 1). These recommendations are to ensure there is no contamination between plots; in some situations they may be waived provided such contamination is not a possibility. The approach described here also guarantees objectivity in the sampling, thus preventing the experimenter's bias from jeopardizing the results. Sample from the whole vine for pruning weights, mean cane weights, yield and quality parameters, and sample six shoots per vine for shoot length (see Design 1).

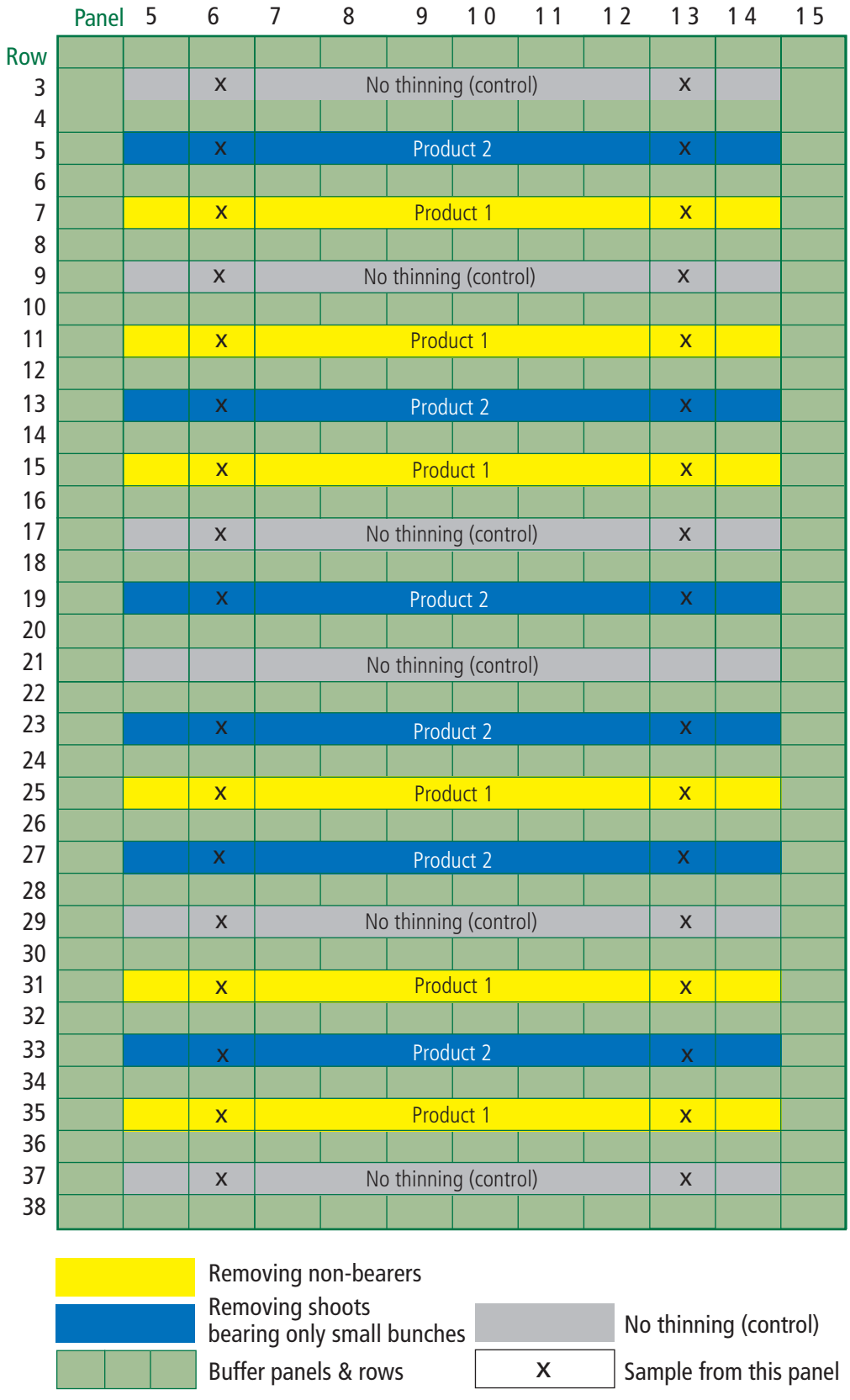
Figure 1: A diagrammatic explanation of where, within a panel, measurements can be taken.



Design 1: An example of a randomised block design that could be used to test various bunch-thinning rates.



Design 2: An example of a trial design to test different shoot thinning options (for example, removing non-bearers, removing shoots bearing only small bunches) using rows as experimental units.



Modifying Trellising Systems to Improve Grape Quality

Aims

The aims of this trial are to:

- Determine the effects of modifying the trellising system to increase bunch and leaf exposure (canopy surface area) and manage grape yield
- Improve a dense canopy

Important Points to Know

A method to improve a dense canopy is to modify the trellising system. This can most often be done without having to replant the vineyard. However, other canopy management regimes need to be applied in collaboration with improving the trellis system.

Modified trellising systems are able to provide:

- Increased leaf exposure
- Decreased canopy density
- Improved bunch exposure
- Better spray penetration
- Lower incidence of pest and disease
- Improved yield

Some of the common trellising systems include:

1. Vertical shoot positioning (VSP)
2. U or lyre trellis
3. Geneva Double Curtain (GDC)
4. Scott Henry (SH)
5. Minimally pruned (MP)
6. Smart Dyson

For further information on trellising systems please refer to Smart and Robinson (1991), Coombe and Dry (1988) and Jackson (2001).

Positive and Negative Aspects

It is important to determine the risks associated with comparing different trellising systems at the proposed site. These risks must be weighed against the potential benefits that a particular treatment may impart. Some risks may preclude trialing treatments on a particular site. At other sites, it may be sufficient to monitor a potential risk and have a contingency plan in place to deal with it if it occurs. The positives and negatives of modifying the trellis systems in vineyards are listed below. These may be used as a guide to risks that may develop.

Considerations to bear in mind when deciding what trellis system to choose include:

- Vigour (causing shade and therefore less fruitfulness)
- Balanced vine growth to potential fruit production and quality
- Environmental factors such as temperature, rainfall and soil type which will have a bearing on trellis selection
- Economic considerations in relation to the total investment and subsequent management in further years

Positives and negatives of Vertical Shoot Positioning (VSP), Lyre, GDC, Scott Henry, and minimally pruned trellis system can be found below, adapted from Jacobs (2002) and Smart and Robinson (1991).

Vertical Shoot Positioning
Positives of VSP in the vineyard include:

- Relatively easy to establish
- Suited to mechanisation since the fruit is found in one zone only
- Allows for fruit exposure to fruit (cool climates)
- Vertically upward growing shoots are competitive with the majority of vinifera vines

Negatives of VSP in the vineyard include:

- Fruit can become crowded
- Higher disease incidence in over vigorous sites
- Fruit exposure to fruit can lead to sunburn (hot - climates)
- Possible poor fruit set due to upward growing shoots
- Prone to shade and is therefore unsuitable for high vigour varieties

Lyre Trellis System
Positives of the Lyre Trellis System in the vineyard include:

- Excellent canopy division
- Higher yields and good exposure inside the division
- Higher aeration due to the division
- Easy to hand harvest

Negatives of the Lyre Trellis System in the vineyard include:

- Machine harvesting is not possible because a machine design is not available
- More expensive to train and develop than other systems
- Not suited to many mechanised tasks

Geneva Double Curtain Trellis System

Positives of the Geneva Double Curtain Trellis System in the vineyard include:

- Downward shoot positioning causes desired shoot de-vigouration
- Excellent fruit exposure giving rise to improvements in fruit composition and wine quality (Cool Climates)
- Easily machine harvested and machine pruned

Negatives of the Geneva Double Curtain Trellis System in the vineyard include:

- The need to vertically shoot position downwards can be difficult
- Fruit exposure can be excessive (especially in warm to hot climates)
- Often requires bunch thinning due to excessive yield

Scott Henry Trellis System

Positives of the Scott Henry Trellis System in the vineyard include:

- Less disease incidence due to open canopy
- Suited to mechanisation
- Downward growth is de-vigourised assisting the leaf/vine balance
- Allows for greater fruit exposure to sun (cool-climate)

Negatives of the Scott Henry Trellis System in the vineyard include:

- Economically more expensive due to wire construction and vine training
- Labour intensive in relation to folding canes down and lifting up
- Can crop too high on vigorous sites causing late ripening and lower yield
- Fruit exposure to sun can lead to sunburn (hot climates)

Minimally Pruned Trellis Systems

Positives of Minimally Pruned Trellis Systems in the vineyard include:

- Easy to machine harvest
- Total labour required for this system is very low
- Fruit exposure can be increased and canopy density reduced
- Trellis costs are minimal

Negatives of Minimally Pruned Trellis Systems in the vineyard include:

- Delays in ripening with higher yields possible in cool, humid climates
- Some shoots can grow vigorously leading to shading of the canopy
- Possible increased disease due to dense canopy
- Fruit zone is spread over the whole vine making harvesting difficult

In light of these issues, some questions worth considering are:

- Which of these risks are important at your site?
- Which of these risks would not prevent the trial proceeding but should be monitored?
- What plans need to be put in place to reduce the impact of any risks occurring?

Cost Benefit Analysis

In order to determine the financial viability of a vine trellising comparison, a cost/benefit analysis should be completed to relate the monetary requirement of changing the trellis system to a production basis. The risks associated with a change in vine trellis system used in vineyards must be weighed up against the benefits. This will justify the commitment to an irrigation program in the long term.

Before You Get Started

The resources required for the trial are:

- Secateurs
- Trellis posts
- Trellis wire
- Leather gloves

Site Suitability

- Vine not younger than three years
- Difficulty in achieving maturity (Brix)
- Quality issues (poor colour)
- Dense canopies
- Over/under cropping

Potential Treatments

Modifying the trellis by converting to another trellising type:

1) Vertical shoot positioning (VSP)
2) U or Lyre trellis
3) Te Kauwhata Two Tier (TK2T)
4) Scott Henry (SH)
5) Minimally pruned (MP)
6) Smart Dyson
7) Current practice (control)

Measurements and Monitoring

There are numerous measurements that are applicable to a vine trellising comparison trial. Unfortunately there is no single set of measurements that are applicable to all trials. The correct measurements can only be selected once the trial's objectives have been clearly defined. The following is a list of potential measurements.

The following table includes potential measurements for this type of trial, their time involvement, and difficulty.

Measurements	Time*	Difficulty*
Vine vigour - shoot length	3	A
Baumé	1	A
pH	1	B
Titratable acidity	1	C
Colour (anthocyanin)	2	C
Yield	2	A
Pruning weight	2	A
Bud fruitfulness	1	A
Cane maturation	1	A
Vine growth stages (phenology)	1	A

**Time is where 1 = few minutes per replicate, 2 = 15 minutes per replicate, 3 = >30 minutes per replicate; Difficulty is where A = easy, no laboratory skills and/or measurement equipment required, B = some laboratory skills and/or measurement equipment required, and C = laboratory skills and/or sophisticated measurement equipment required. Refer to complete Table 2.2 in Section #2: Trial Design and Variability.*

Trial Timelines

Trials involving a change in the vine trellis system should be run for at least three years to ensure maximum benefits are achieved by the impact of pruning to the new trellis system. The time required to carry out the treatments such as pruning would be 1.0 day. Taking measurements at harvest would be .5 day for bunch sampling for quality parameters. The time required for shoot length, pruning weights and bud fruitfulness would be approximately .5 day per measurement.

Shaded areas in the following table indicate when measurements or samples suggested above are to be taken. See the measurement manual in this series for more information about measurement protocols.

	Dormancy	Bud burst	Shoots 10 cm	Flowering	50% capfall	Berry set	Berries pea-size	Bunch closure	Veraison	Harvest	Post-harvesty
Bud fruitfulness	■										■
Cane maturation	■										■
Pruning weight	■										■
Vine vigour/ Shoot length			■	■	■	■	■	■	■	■	
Vine growth stage (phenology)		■	■	■	■	■	■	■	■	■	
Grape yield										■	
pH									■	■	
Baumé									■	■	
Titratable acidity									■	■	
Colour									■	■	

Trellis System Trial Designs

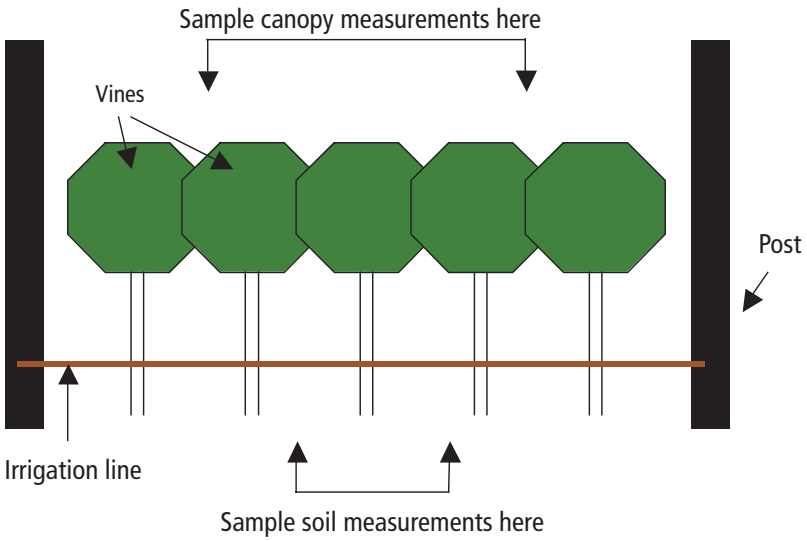
Treatments will need to be replicated within the trial area at least 6 to 8 times, more if the area is not very uniform. One of the treatments should be a control, which will often be current practice. It is advised not to have more than 3 or 4 treatments, to allow enough time for management of the trial. Plots (or experimental units) can be different shapes and sizes, but a common plot in a canopy management trial consists of three rows by three panels of vines. The middle panel is used for taking measurements (for example, Row 5 Panel 5). Buffering is important to identify clear treatment areas and to avoid contamination between treatment areas. Buffer zones are marked as panels with grid-lines in the designs shown on the following page.

Design 1 gives an example of a trial layout in which the treatments are two trellis types. The trial has 2 treatments and 8 replications, arranged in a randomised block design, with the blocks being rows (or, more strictly, groups of 3 adjacent rows).

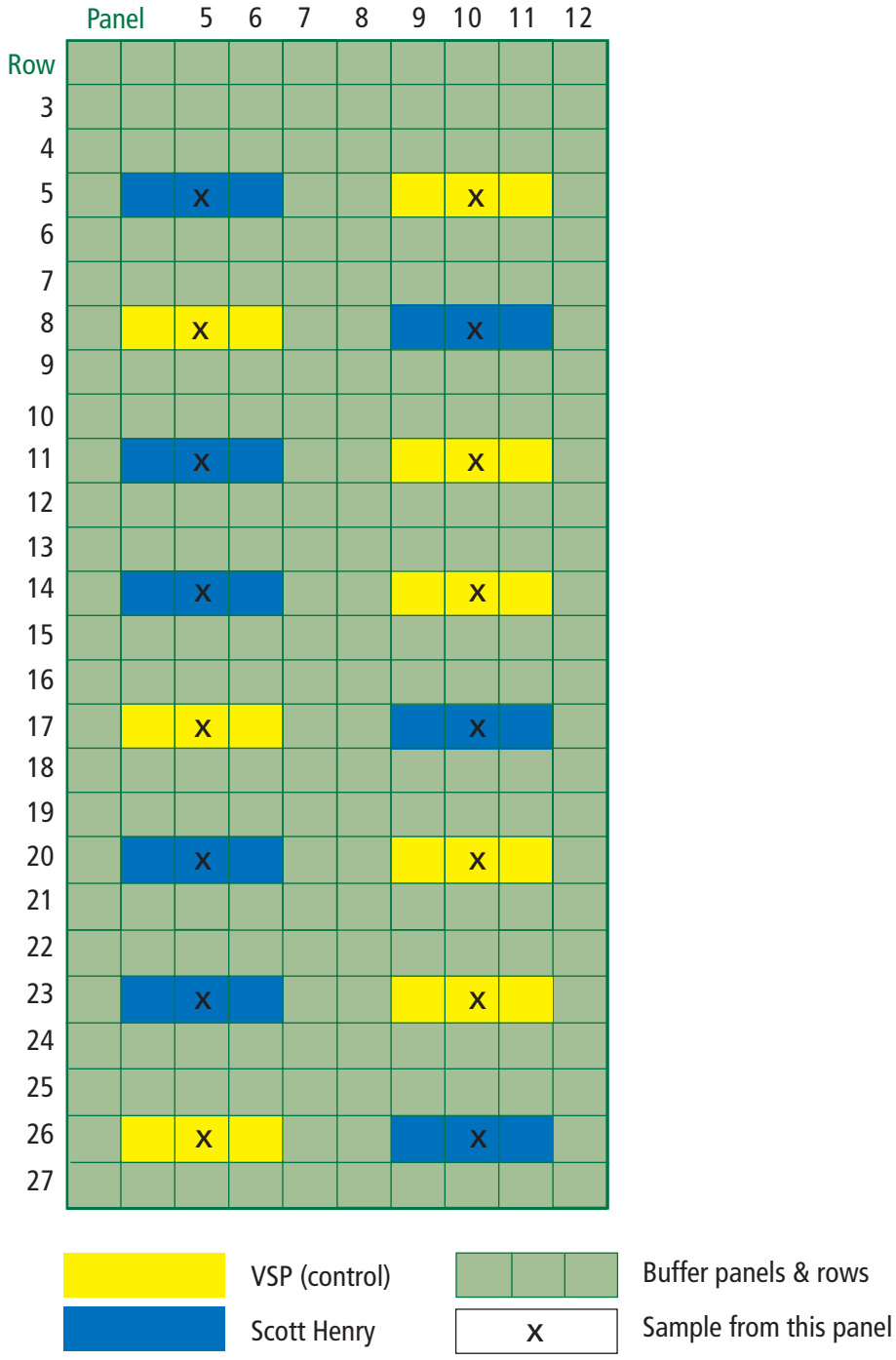
Design 2 gives an example of a trial layout in which the treatments are two trellis types. It uses rows as experimental units as opposed to panels. This can make management of the trial (i.e. re-working) a little easier. When using rows as experimental units, it is normally anticipated a maximum of three treatments are trialed due to the potential workload expected. This trial has 2 treatments and 6 replications, again arranged in a randomised block design, with the blocks being groups of 2 adjacent experimental units.

When taking vine measurements, the following approach is recommended: only sample the middle vine in panels marked with an X (Designs 1 and 2). If there are more than 3 vines per panel, only sample from the middle vines of the above-mentioned panels (see Figure 1). These recommendations are to ensure there is no contamination between plots; in some situations they may be waived provided such contamination is not a possibility. The approach described here also guarantees objectivity in the sampling, thus preventing the experimenter's bias from jeopardizing the results. Sample from the whole vine for pruning weights, yield and quality parameters, and sample six shoots per vine for shoot length (see Figure 1).

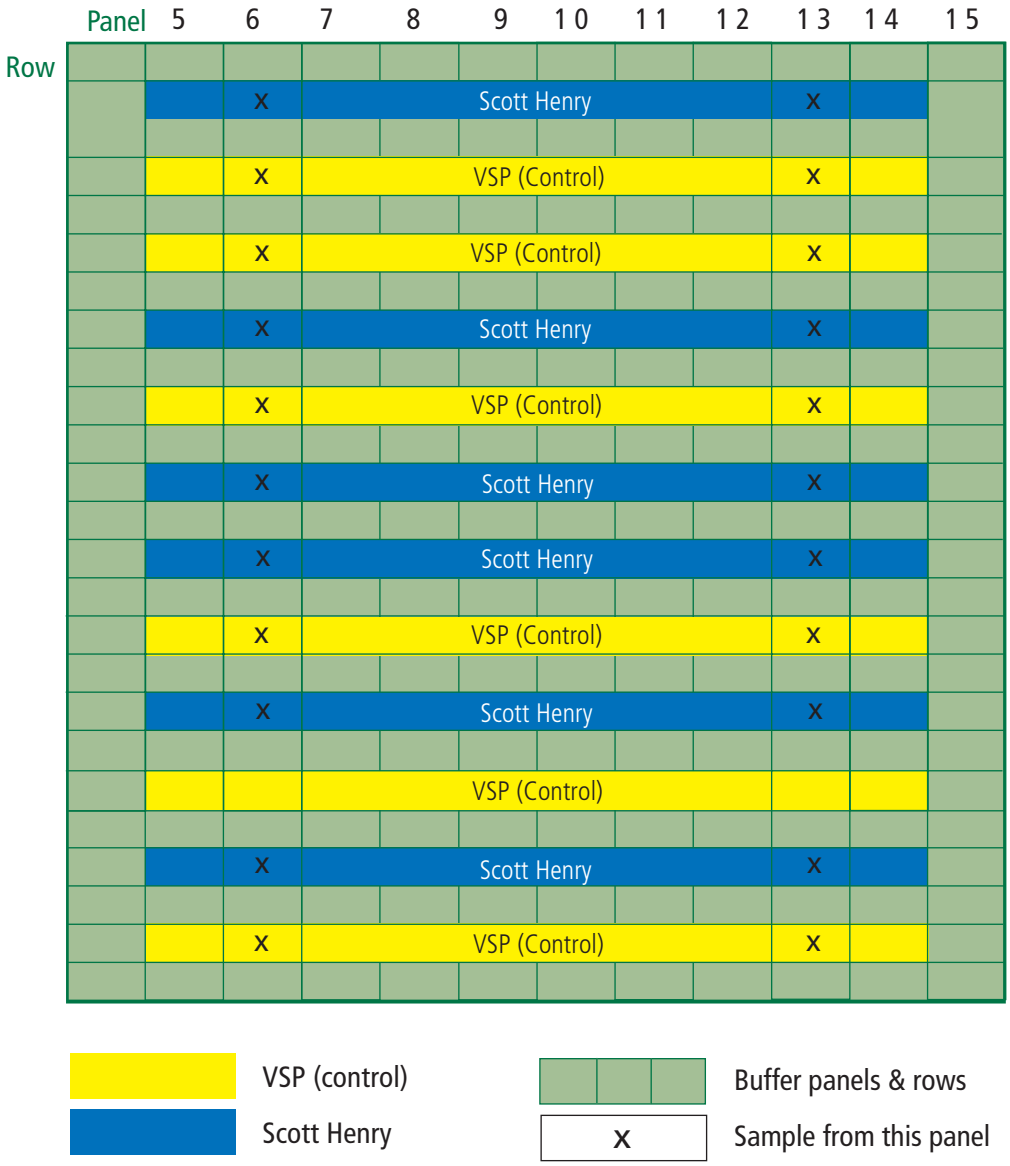
Figure 1: A diagrammatic explanation of where, within a panel, measurements can be taken.



Design 1: An example of a randomised block design that could be used to test different trellis types.



Design 2: An example of a trial design to test different trellis types using rows as experimental units.



Resources

Some useful resources for managing cropping levels trials include:

- Clancy T. (2001) Study the vineyard and market before selective bunch thinning. Australian Viticulture 5: 30 - 32
- Dry P.R., Loveys B.R., Iland P.G., Botting D.G., McCarthy M.G. and Stoll M. (1999) Vine manipulation to meet fruit specification. Proceedings of the 10th Australian Wine Technical Conference, AWRI
- Hedberg P. (2002) Pruning young vines - some useful tips. Australian Viticulture 5: 54 - 56
- Iland P. (1999) Bunch thinning requires testing. Australian Viticulture 3: 40 - 43
- Iland P., Gawel R., McCarthy M.G., Botting D.G., Giddings J., Coombe B.G. and Williams P.J. (1995) The glycolsyl-glucose assay - its application to assessing grape composition. Proceedings of the 9th Australian Wine Industry Technical Conference
- Jackson D. (2001) Monographs in cool climate viticulture - 1: Pruning and Training. (Daphne Brasells Associates Ltd and Lincoln University Press) pp 16-18, 25 - 29, 32 - 34
- Jordan D. (2001) Some key steps in preparation for pruning the vineyards. The Australian Grapegrower and Winemaker 448: 36 - 39
- Keller M. (2001) Principles to have in mind when deciding on a thinning strategy. Australian Viticulture 5: 27 - 29
- Laukart N. and Haywood C. (2003) Modifying trellising systems to improve grape quality In: Laukart N. and Joyce D.C. (edts) 'Participatory On-Farm Trials for Viticulture Manual.' (Cooperative Research Centre for Viticulture, Adelaide, S.A.)
- Ludvigsen K. (2002) Pruning: an essential part of every vineyard's operation. The Australian and New Zealand Grapegrower and Winemaker 460: 29 - 32
- Smart R. (1995) Two golden rules of viticulture. Australian and NZ Wine Industry Journal 10: 5
- Smart R. and Robinson M. (1991) Sunlight into Wine - a handbook for winegrape canopy management (Winetitles, S.A.) pp 40 - 66
- Tassie E. and Freeman B.M. (1992) Pruning In: Coombe B.G. and Dry P.R. (edts) 'Viticulture Volume 2 Practices' pp66 - 84
- Winter E. (2002) Winegrape Quality Management: Research to Practice, Training Manual. (Department of Primary Industries)

Resources

Some useful resources for modifying trellising levels trials include:

- Freeman B.M,, Tassie E. and Rebbechi M.D. (1992) Training and Trellising In: Coombe B.G. and Dry P.R. (edts) 'Viticulture Volume 2: Practices' (Winetitles, S.A.) pp 42 - 65
- Jackson D. (2001) Monographs in cool climate viticulture - 1: Pruning and Training. (Daphne Brassells Associates Ltd and Lincoln University Press) pp 35 - 55
- Jacobs A. (2002) What trellis system do I choose? The Australian and New Zealand Grapegrower and Winemaker 460: 34 - 37
- Hackett S. and Laukart N. (2003) Managing cropping levels to improve grape quality In: Laukart N. and Joyce D.C. (edts) 'Participatory On-Farm Trials for Viticulture Manual.' (Cooperative Research Centre for Viticulture, Adelaide, S.A.)
- MacMillan I. (2003) Problems with downward-oriented grapevine canopies. The Australian and New Zealand Grapegrower and Winemaker 468: 20 - 24
- Smart R.E. and Robinson M.D. (1991) 'Sunlight into Wine - A Handbook for Winegrape Canopy Management.' (Winetitles, Adelaide, S.A.)