VINEYARD MANAGEMENT EFFECTS ON WINE QUALITY OF PINOT NOIR



FINAL REPORT to
GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: **GWR Ph06/03**

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Disclaimer: The reader is referred to the publication, in due course, of the PhD thesis of Mrs Fiona Kerslake. This thesis is likely to be available electronically through the library of the University of Tasmania. This GWRDC final report may be of assistance to you but the authors and their employer do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaim all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

TABLE OF CONTENTS

Abstract: 1

Executive summary: 1

Background: 2

Project Aims and Performance targets: 2

Method: 3

Results/Discussion: 4

Outcome/Conclusion: 5

Recommendations: 5

Appendix 1: Communication: 6

Appendix 2: Intellectual Property: 7

Appendix 3: References 7

Appendix 4: Staff 8

Appendix 5: 8

Appendix 6: Budget reconciliation 9

Abstract:

The primary objective of the current study was to research commercial vineyard management techniques, winter pruning, bunch thinning, leaf removal and shoot trimming, on cool climate Pinot Noir wine composition. The study utilised a small scale winery and used standard winemaking protocol to link viticultural management and fruit composition with wine chemistry. The main outcomes of the study were the over-riding influence of climate variability in Tasmania and the need for grape growers to adapt management practices within each season. In warmer years, high cost inputs may not be necessary to improve wine composition, however in more marginal years, practices such as bunch thinning and leaf removal may be beneficial.

Executive summary:

Trials for the study included treatments of manipulation of node number through winter pruning, bunch thinning, leaf removal or shoot trimming. The overall outcome of all trials conducted for this study was the over-riding effect of the variable climate in Tasmania. Most variables for fruit and wine composition showed highly significant differences between seasons and these were greater than the effects of vineyard management practice treatments applied.

Mean February temperatures (MFT) and annual rainfall varied widely across the three seasons of the study (2005/06, 2006/07 and 2007/08) indicating that these variables may play a more significant role than mean January temperature (MJT), despite MJT being commonly used to delineate wine growing regions. 2006/07 experienced the highest MFT and lowest rainfall and was the season in which the highest levels of fruit anthocyanins were found. In addition 2006/07, showed the least treatment differences for fruit and wine composition variables across all trials.

The influence of temperature at flowering and temperature during ripening may well prove to be the make or break times of the season. Vineyard management practices need to be adapted to work within the confines of the climate for any given season. Results from this report should be considered in conjunction with climate variables for each season and then management practices should be modified to work within these climatic boundaries.

As a brief example, the study indicated that in seasons with higher MFT, grape anthocyanins are most likely to be higher. In these years (e.g. 2006/07), a higher crop load resulting from winter pruning levels was able to be sustained without large detrimental effects on grape and wine composition. However, in seasons with lower MFT (e.g. 2005/06 and 2007/08), practices such as bunch thinning and leaf removal improved fruit and wine composition. Further analyses will be conducted on the wines from these trials to investigate the ageing progress of the wines as a result of vineyard management practices.

For other varieties, such as Cabernet Sauvignon, a detrimental effect on wine composition has been associated with increased yields (Chapman et al. 2004) and this effect was expected to be seen in Pinot Noir. However, significant yield increases in this study for Pinot Noir as a result of management practices (winter pruning, bunch thinning) only produced significant decreases in wine composition variables, such as SO_2 corrected wine colour density, in the seasons of cooler MFT. Results also suggest that leaf removal may only be of benefit in cool seasons.

Further research into climatic modeling of cool climates would be beneficial for cool climate grape growers. The current study indicates that management practices could be based on MFT, however February is too late for most management decisions to be made. Further research utilising historical data to build predictive models would assist grape growers in making more informed management decisions and hopefully reduce the input costs into crops each year. Further research into the contribution of individual anthocyanins to wine colour would also prove

valuable as some treatment effects were noted in the current study, such as decreasing shoot length by summer shoot trimming reducing peonidin content but not affecting the other four anthocyanins in Pinot Noir. Reducing yield by bunch thinning increased individual anthocyanin content, whereas reducing yield by winter pruning had no effect and the timing of the bunch thinning produced a varied response amongst the five anthocyanins.

Leaf removal and winter pruning trials from this study have led to the author conducting further research into the efficacy of these management practices for sparkling wine production. The author will also be attending the International Cool Climate Symposium in 2010 and the Australian Wine Industry Technical Conference in 2010 to disseminate final results from the current study. A minimum of three journal papers will arise from this research from the final thesis. The author is also working with Wine Industry Tasmania to work on a Pinot Noir canopy management strategy for Tasmanian grape growers.

The author would like to thank Tamar Ridge Estates, the Australian Postgraduate Award (APA) and the Tasmanian Institute of Agricultural Research (TIAR) for part-funding the stipend for this scholarship. The author would also like to thank Tamar Ridge Estates for providing an operational budget and in-kind support for this project.

Background:

Canopy management is a well-researched area with well known reviews such as Jackson and Lombard (1993) widely cited. However, less work has been done with cool climate varieties, in particular Pinot Noir, in Australia. Recent studies published by Heazlewood and co-workers (Dr Heazlewood, now Dr Jones, is a supervisor of the current study) have looked at pollination and fruit set for Pinot Noir in Tasmania, as well as the impact of pruning severity on yield and fruit composition. However, there is still a need to further investigate common commercial practices in the vineyard and how these practices affect wine composition and not just the resulting grape composition. The current study therefore relates directly to the objectives of the GWRDC's Program 3: *Grapes for purpose*.

There is continuing debate as to the best vineyard management practices to manipulate yield in Pinot Noir and whether higher yields equate to lower quality (Jackson 1987). Juice composition has often been studied (Sommer and Clingeleffer 1993, Reynolds et al. 1994, Reynolds et al. 1996) as a proxy for wine quality, but there are few published reports on measured quality attributes for wine (Sinton et al. 1978). The current study utilised a small scale winemaking facility at a commercial vineyard in Tasmania to enable wines to be made from vineyard treatments to evaluate the effect on wine composition. Common commercial vineyard management techniques of winter pruning, bunch thinning, leaf removal and shoot trimming were investigated and fruit and wine composition analysed.

Project Aims and Performance targets:

During the first season of this study, a range of field trials were established to identify potential areas for future, more focussed experimentation. Included were various aspects of the assumed yield/quality relationship such as differing winter pruning severities, shoot thinning, bunch thinning, leaf removal and different trellising types. For the 2005/06 vintage a temporary facility at Tamar Ridge Estates was used for micro-vinification and 250 different wine lots were prepared from these trials. This temporary facility was then upgraded for the 2007 vintage as the result of a grant from the Tasmanian Department of Economic Development.

The reduction or increase in shoot trimming lengths appeared to give interesting results at the time of applying for funding from the GWRDC. Visual observation indicated that wine colour was improved as shoot lengths were increased. The original GWRDC funding application requested funding for C^{14} tracer studies to investigate this result, but as a result of increased costs for HPLC analysis, C^{14} tracer studies were not carried out. HPLC analyses were $1500 for 2006/07 and $2000 for 2007/08 and in 2007/08, funds were also acquired from TIAR to cover the extra costs. The results from the HPLC analyses of all trials proved very interesting and the contribution of the individual anthocyanins to total wine colour and stability warrants further investigation.

Method:

The current study evaluated the commercial vineyard management practices of winter pruning, bunch thinning, leaf removal and shoot trimming. A commercial Pinot Noir clone 114 vineyard block at Tamar Ridge Estates' Kayena vineyard in the Tamar Valley, Tasmania was used for all trials. The block was on a Scott Henry trellis system. At the same property is the small scale winemaking facility, a joint venture between TIAR and Tamar Ridge Estates.

The winter pruning trial consisted of four different treatments of 10, 20, 30 or 40 nodes per vine retained at winter pruning over three seasons. The bunch thinning trial consisted of a time by extent factorial design. Four different times of bunch thinning (fruit set, pea sized fruit, beginning of veraison and end of veraison) and two different extents of bunch thinning (20% of bunches or 40% of bunches) were carried out over the three seasons.

Leaf removal for the 2005/06 trial design was similar to the bunch thinning trial design with four different times of leaf removal (fruit set, pea sized fruit, beginning of veraison and end of veraison) and two different extents of leaf removal (20% of mature leaves or 40% of mature leaves). As removing 40% of leaves in this season reduced grape anthocyanins compared to removing 20% of leaves, the trial design was modified to investigate the contribution of three different sections of leaves along the shoot (basal, middle or apical four leaves) compared to removing no leaves at all.

The shoot trimming trial investigated the effect of changing the trimming height of vines at summer pruning time. Vines in the commercial vineyard used were annually trimmed around veraison to around 12 nodes per shoot on the upper shoots. Lower shoots were often trimmed back as they grew back up through the Scott Henry canopy or left. This trial trimmed upper shoots to a length of 6, 12 or 22 nodes per shoot and then trimmed lower shoots to 12 nodes per shoot. In the 2006/07 season, an additional treatment of 12 nodes per upper shoot and 6 nodes per lower shoot was added.

Basic fruit composition (sugar, pH and titratable acidity) was analysed in the micro-winery laboratory. AWRI wet chemistry methods were used for grape anthocyanin and phenolic analyses (AWRI 2006).

For all treatments in all trials, there were four replicates of each treatment, with each plot being made into individual wines. A standard protocol of winemaking was adopted in consultation with Tamar Ridge Estates staff Dr Andrew Pirie and Matt Lowe and also Dr Richard Smart and Reuben Wells. This standard protocol included a standard amount of time on skins during fermentation.

The original Somers wine analyses (Somers and Evans 1977) adapted by Iland (2000) were used in the first year of wine composition analysis and in subsequent years, the recent modification by Mercurio et al. (2007) was followed.

Results/Discussion:

The winter pruning trial manipulated node number per vine from 10 to 40 nodes and produced a significant variation in yield per vine. These yield effects were not evident in all of the fruit and wine composition variables, indicating that for this site there may be an upper yield limit above 40 nodes per vine beyond which detrimental fruit and wine composition could be seen. Seasonal influences were far more pronounced than treatment effects. The cooler season of 2007/08 produced lower SO_2 corrected wine colour density as node number retained per vine increased, however other wine composition variables, such as total anthocyanins and phenolics, SO_2 resistant pigment and total pigment were unaffected by treatments. This indicates that in cooler years, young wines may be affected by heavier crop loads and further wine analyses of these experimental wines in the future will provide information as to how these wines develop as they age.

The bunch thinning trial examined the effect of removing either 20% or 40% of bunches from vines at four different times throughout the season, at fruit set, pea size berries, veraison or the end of veraison. The timing of bunch thinning affected sugar, acid and pH of grapes in different ways each season. This is another indication of the seasonal variability mentioned earlier that is experienced in Tasmania. Young wines showed no treatment effects for SO_2 corrected wine colour density, however new wines from 2007/08 (cooler than 2006/07) showed significant increases in total anthocyanins, phenolics, total pigment and SO_2 resistant pigments.

The practice of leaf removal is commonly undertaken in Tasmania to promote colour development in the grapes. For the 2005/06 season, a trial was conducted removing 20% or 40% of mature leaves at four different times throughout the season, at fruit set, pea size berries, veraison or the end of veraison. Sugar, acid and pH were unaffected by these treatments, however the removal of 40% leaves decreased grape anthocyanins when compared to removal of 20% of leaves, but both treatments were still higher than removing no leaves at all. A modification of the trial design was then carried out to investigate if the removal of different sections of leaves along shoots influenced fruit and wine composition.

In 2006/07 and 2007/08 no yield differences were seen and there was no response by acid and pH of the fruit. Total anthocyanin content of fruit was increased when removing the basal four leaves on the shoot in 2006/07, but did not have the same effect in 2007/08. Again the seasonal influence appears to be far greater than treatments applied and results indicate that in high anthocyanin years (perhaps years with higher mean February temperatures) then grape anthocyanins can be increased by leaf removal in the fruiting zone. However, in lower grape anthocyanin years (perhaps cooler mean February temperature years), leaf removal could be detrimental to anthocyanin accumulation as was observed in 2005/06 and 2007/08. Young wines from the high grape anthocyanin season of 2006/07 showed few treatment effects, and when these wines had aged for 12 months, only chemical age 1, chemical age 2 and SO_2 resistant pigments (pigmented polymers) showed significant differences, being that the removal of no leaves resulted in the highest values for these three variables

The trimming height of vines is most commonly a prescriptive height from year to year in commercial vineyards and is predominately dependant on the row width of a vineyard. A trial examining different trimming heights was carried out for this study as another method of manipulating the canopy size by changing the height of the canopy. For the 2005/06 season vines were trimmed to 6, 12 or 22 nodes on upper shoots and to around 12 nodes on lower shoots of a Scott Henry canopy. For the 2006/07 and 2007/08 seasons, an additional treatment was added of trimming upper shoots to 12 nodes and lower shoots to 6 nodes. Once again, seasonal variability was predominant over treatments applied. Yield and basic yield components were not affected by treatments. Reducing canopy height by trimming upper shoots to 6 nodes per shoot resulted in detrimental effects on fruit and wine composition, however reducing canopy height by

trimming lower shoots did not produce the same effects. This indicated a canopy exposure effect. The upper shoots are exposed to the sun for more time per day than lower shoots and as such decreasing the length of these upper shoots would have reduced the canopy exposure time per day and most likely reduced photosynthetic capability. It was interesting to note that the standard commercial practice for the vineyard, of 12 nodes per shoot on upper shoots, appeared to perform the best across fruit and wine composition and as the wines aged.

Outcome/Conclusion:

The current study has provided grape growers and winemakers in cool climates with valuable information about Pinot Noir management practices. This research will assist Pinot Noir growers in cool climates to understand in greater depth how each management practice may affect their vines in different seasons. Growers understand that Pinot Noir can be quite fickle, but this research will enable them to make more informed decisions as to the benefit of practices such as bunch thinning and leaf removal and then they will be able to weigh this up against the cost of these practices and the possible cost of yield reductions.

Results from the current study have been presented at a number of seminars, workshops, field days and through media interviews and a list to date can be found in Appendix 1.

Recommendations:

Results from this study have led to the author setting up similar trials for the purpose of sparkling wine production. The role of phenolics in base wines for sparkling will be investigated for Pinot Noir and Chardonnay and the manipulation of this by leaf removal. Further investigation into the role of the individual anthocyanins in wine colour is warranted and Pinot Noir, containing only five anthocyanins, lends itself to the initial investigation. Work on cool climate modeling and prediction would also prove useful as coupled with results from the current study, this would enable growers to make more informed decisions. In light of Australia's current wine industry status and oversupply occurring more commonly in warmer regions, then an increase in cool climate research for higher quality production is necessary as these are the regions in Australia where grapes are still commanding premium prices.

Appendix 1: Communication:

Communication of the outcomes of research is an important part of the GWRDC's activities. Outline how the outcomes of this project have been communicated during the project.

If any journal articles were written or published during the conduct of the project please list them and where possible include copies in the appendix.

If you believe further communication activities would enhance the uptake of this project's findings please identify them i.e. the conduct of field days, workshops or the production of brochures or identification guides.

The author is currently working with Wine Industry Tasmania on a canopy management handbook and the results from these trials will be widely disseminated through this publication. Along with poster presentations at the ICCS and AWITC and the author participation in a workshop at the AWITC, further dissemination will be possible.

Below is a list of output arising from the current study:

Kerslake, F, 'Informed pruning: working with the facts from the beginning', *Presentation to the TIAR-WIT Bud Dissection Workshop*, 20 May 2008, TIAR Mt Pleasant Laboratories, Propsect, 20 May (2008)

Chopping, F, 'Update: Grape and Wine Quality of Pinot Noir', *Presentation to the TIAR Tamar Ridge Field Day*, 23 January 2008, Tamar Ridge Vineyard, Tasmania, 23 January (2008)

Chopping, F and Jones, JE and Wilson, SJ and Smart, RE*, 'The effect of summer trimming height on Pinot Noir berry ripening in Tasmania', *Proceedings of the 13th Australian Wine Industry Technical Conference*, 29 July - 2 August 2007, Adelaide, South Australia (2007)

Chopping, F and Jones, JE and Wilson, SJ and Smart, R*, 'Vineyard management approaches affecting Pinot Noir wine quality in the Tamar Valley, Tasmania', *Proceedings of the 13th Australian Wine Industry Technical Conference*, 29 July - 2 August 2007, Adelaide, South Australia (2007)

Chopping, F, 'Vineyard management effects on wine quality of Pinot Noir', *Oral Presentation of major results of interest to date to the GWRDC Board on Monday 22nd October 2007*, Monday 22nd October 2007, Tamar Ridge Estates' micro-vinification facility (2007)

Chopping, F, 'Brief overview of the effect of management techniques on the grape quality of Pinot Noir', *Presentation to TIAR 10th anniversary celebration, Launceston, Tasmania, 28 November 2006* (2006)

Chopping, F, 'Effect of node number on Pinot Noir in the 2006 vintage', *Presentation to the Vineyards Association of Tasmania field day, Glenwood, Relbia, Tasmania, 9 November 2006* (2006)

Chopping, F, 'Initial results from trials investigating vineyard management effects on the grape quality of Pinot Noir', *Presentation to the Pinot Noir Forum annual meeting, Bicheno, Tasmania, 16 February 2006* (2006)

Chopping, F, 'Micro-vinification and results obtained to date on the effect of management techniques on the wine quality of Pinot Noir¿', *Presentation to the Vineyards Association of Tasmania Annual General Meeting 2006, St Helens, Tasmania, 22 July 2006* (2006)

Chopping, F, 'Overview and initial results of the effect of vineyard management techniques on the grape quality of Pinot Noir', *Presentation to GWRDC yield prediction workshop, Hobart, Tasmania, 5 June 2006* (2006)

Chopping, F, 'PhD overview investigating the effect of vineyard management techniques on the wine quality of Pinot Noir', *Presentation to TIAR/DPIWE as part of the seminar program, New Town, Tasmania, 19 May 2006* (2006)

Chopping, F, 'Initial trial setup and background investigating vineyard management effects on the wine quality of Pinot Noir', *Presentation to the Pinot Noir Forum field day, Tamar Ridge, Kayena, Tasmania, 2 December 2005* (2005)

Kerslake, FL, 'General observations about completing a viticultural PhD in Tasmania', *and specific observations about the yield and quality relationship of Pinot Noir in Northern Tasmania*, The Examiner Newspaper, Launceston, Tasmania, May (2009)

Kerslake, FL, 'General observations about completing a viticultural PhD in Tasmania and specific observations about the yield and quality relationship of Pinot Noir in Northern Tasmania', *The Country Hour*, ABC Radio, Launceston, Tasmania, 1 May 09 (2009)

Appendix 2: Intellectual Property:

Nil

Appendix 3: References

AWRI (2006) Determination of Total Anthocyanins (Colour) in Red Grape Berries. Cooperative Research Centre for Viticulture.

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Iland, P. (2000) *Chemical Analyses of Grapes and Wine: Techniques and Concepts,* edn.
Jackson, D. (1987) The Effect of Yield on Wine Quality. *Vinifera Wine Growers Journal,* 14, 144-146.

Jackson, D. I. & Lombard, P. B. (1993) Environmental and Management Practices Affecting Grape Composition and Wine Quality - a Review. *American Journal of Enology and Viticulture,* 44, 409-429.

Mercurio, M. D., Dambergs, R. G., Herderich, M. J. & Smith, P. A. (2007) High Throughput Analysis of Red Wine and Grape Phenolics-Adaptation and Validation of Methyl Cellulose Precipitable Tannin Assay and Modified Somers Color Assay to a Rapid 96 Well Plate Format. *Journal of agricultural and food chemistry,* 55, 4651-4657.

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Somers, T. C. & Evans, M. E. (1977) Spectral Evaluation of Young Red Wines: Anthocyanin Equilibria, Total Phenolics, Free and Molecular So_2, "Chemical Age". *Journal of the Science of Food and Agriculture,* 28, 279-287.

Sommer, K. J. & Clingeleffer, P. R. (1993) Comparison of Leaf Area Development, Leaf Physiology, Berry Maturation, Juice Quality, and Fruit Yield of Minimal and Cane Pruned Cabernet Sauvignon Grapevines. In Pool, R. M. (Ed.) *Second Nelson J. Shaulis Grape Symposium.* Fredonia, New York, New York State Agricultural Experiment Station.

Appendix 4: Staff

List all staff that have been engaged on the project.

- Ms Fiona Kerslake — PhD candidate, TIAR
- Dr Joanna Jones — PhD supervisor, TIAR
- Dr Dugald Close — PhD supervisor, TIAR
- Dr Richard Smart — Research supervisor, Smart Viticulture
- Dr Robert Dambergs — Research supervisor, TIAR/AWRI
- Dr Stephen Wilson — Former PhD supervisor, TIAR
- Mr Paul Townsend — Viticulturist, Tamar Ridge Estates
- Dr Andrew Pirie — CEO and Chief Winemaker, Tamar Ridge Estates
- Mr Matt Lowe — Former winemakers, Tamar Ridge Estates
- Mr Reuben Wells — PhD candidate, TIAR
- Mr Michael Humphrey — Vineyard manager, Tamar Ridge Estates
- Mrs Dorothy Humphrey — Vineyard manager, Tamar Ridge Estates

Appendix 5:

Nil

Appendix 6: Budget reconciliation

END OF PROJECT FINANCIAL STATEMENT

Statement of Receipts and Expenditure

At the conclusion of each Project, the GWRDC requires a Statement of Receipts and Expenditure of GWRDC funds received in relation to the Project.

Project Title:	Vineyard management effects on wine quality of Pinot Noir

GWRDC Project Number	Project Start Date	Project End Date
W0015946	29.8.2005	17.11.2009

Financial Year (e.g. 2006/07)	**(a)** ***Funds brought forward from previous year***	**(b)** **#Approved GWRDC Budget (full year)**	**(c)** **Total budget available** *(a)+(b)*	**(d)** **Actual expenditure ($)**	**(e)** **Difference ($)** *(c)-(d)*
Year 1: 2006/07	–	2500	2500	2500	0
Year 2: 2007/08	0	2500	2500	3000	-500
Year 3: 20__/__					
Year 4: 20__/__					
Year 5: 20__/__					
TOTAL		5000		5500	

* "Funds brought forward" refers to any unspent GWRDC funds from the previous year and approved by the GWRDC to be spent the following year (i.e. column *(e)* from previous year).
# "Approved GWRDC Budget" is the funding amount specified in the Project Agreement, including any approved Variations after Project commencement.

Was funding expended as approved in the Project Agreement? Yes ☐ No ☒

*If **NO**, please provide reasons:*

Costs for HPLC analyses increased and as such it was decided to forgo the C^{14} analysis in favour of the HPLC analyses to provide a fuller picture as to colour in Pinot Noir, rather than expand into the physiological responses.

Has the cash and/or in-kind funding from Contributing Agencies been received and applied to the Project as approved in the Project Agreement? Yes ☒ No ☐

*If **NO,** please provide reasons:*

I hereby certify that this statement is true and accurate.

Signature of duly authorised representative ……

……	……..	……
Name:	*Title:*	*Date:*