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Grape and Wine Research and Development Corporation

Addressing fruit exposure and sunburn in Queensland wine grape vineyards

FINAL REPORT to

GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: RT 08/03-1

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GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION

REGIONAL INNOVATION AND TECHNOLOGY ADOPTION (RITA) PROJECT

FINAL REPORT

PROJECT TITLE

Addressing fruit exposure and sunburn in Queensland wine grape vineyards

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Abstract

While Queensland wine industry development has relied upon adoption of viticultural practices from established winegrowing regions, such procedures are not necessarily best practice under local conditions. The wine grape growing regions of Queensland are climatically distinct from other Australian regions with relatively wet growing seasons, and at times with severe peak heat loads. Queensland also hosts the most northerly and some of the highest altitude vineyards in Australia, with higher ultra violet radiation exposure than any other Australian grape growing region. Furthermore, fruit exposure may be exacerbated by regional management practices (e.g. leaf plucking, shoot thinning) used to minimise risk of fungal infection (e.g. botrytis, bunch rots). The Queensland wine industry had identified fruit exposure management as a critical issue to be addressed.

We set up demonstration sites to show the impacts of canopy management options on exposure of Chardonnay and Shiraz over the 2009/10 vintage in the Granite Belt, South Burnett and Scenic Rim. Demonstrated options included sprawl, VSP, fruit zone leaf removal at pea size and véraison (easterly or both sides of canopy), bird netting, or commercial sunscreen products (calcium carbonate or kaolin clay). Differences in fruit exposure, grape and wine quality were noted. Growers inspected the demonstration sites prior to harvest and provided feedback on fruit quality. Fruit was harvested, analysed and wines made and analysed, and results presented and discussed at the 2010 Queensland Viticulture Seminar. At this seminar / workshop, industry participants were also able to conduct sensory evaluation of the wines to determine any impacts of alternative management practices on wines produced, to supplement their evaluation of fruit quality prior to harvest.

Conclusions from this project were confounded by problematic seasonal conditions with diverse severe events including frost, hail, heat and water stress and fungal disease pressures. Recommendations from this study are that while they may be useful in cooler seasons, in hotter seasons practices such as leaf plucking and shoot thinning are not advised due to potential to exacerbate overexposure and sunburn of fruit.

Executive summary

Demonstration sites were established in Queensland's Granite Belt, South Burnett and Scenic Rim regions to illustrate the impacts of canopy management options on exposure of Chardonnay and Shiraz over the 2009/10 vintage. Demonstrated options included sprawl, VSP, fruit zone leaf removal at pea size and véraison (easterly or both sides of canopy), bird netting, or commercial sunscreen products (calcium carbonate or kaolin clay). Differences in fruit exposure, grape and wine quality were noted. Growers inspected the demonstration sites prior to harvest and provided feedback on fruit quality. Fruit was harvested, analysed and wines made and analysed, and results presented and discussed at the 2010 Queensland Viticulture Seminar. At this seminar / workshop, industry participants were also able to conduct sensory evaluation of the wines to determine any impacts of alternative management practices on wines produced, to supplement their evaluation of fruit quality prior to harvest.

Conclusions from this project were confounded by problematic seasonal conditions with diverse severe events including frost, hail, heat and water stress and fungal disease pressures. Differences were noted in exposure and sunburn of the Chardonnay grapes prior to harvest, although only marginal differences were seen in the measures of fruit and wine quality of either variety. We are wary of making inferences from this study over a difficult season where site and seasonal factors confounded differences due to imposed management practices.

Notwithstanding the difficulties of the season, some findings are worthy of noting:

- overhead canopy appears to be important in limiting exposure of grape bunches
- in the South Burnett and Granite Belt, marked sunburn was seen on fruit on the easterly side of the canopy, likely due to higher morning exposure due to afternoon cloud cover typical of the regions
- bunch zone leaf removal resulted in high visible light and UV radiation in the canopy, causing sunburnt fruit higher in brown pigments (Chardonnay) and lower in anthocyanins (Shiraz)
- the treatments only led to subtle if any impacts on wine sensory profiles.
- using a calcium-based sunscreen product did not result in elevated wine calcium levels.

The 'take home' messages from this project point to the importance of limiting exposure of Chardonnay in a climate such as Queensland in a hot season such as season 2009/10 was. Exposure in the 2009/10 season resulted in berry sunburn, loss of acidity and development of overripe and cooked flavours, increase in berry total phenolics and potential for browning. Similar impacts were seen in the Shiraz, and additionally the higher exposure treatments led to lowering of anthocyanins.

It is not recommended in hotter seasons to use management practices such as leaf plucking and shoot thinning. Such practices increase vineyard costs and may induce deleterious impacts on fruit quality. Bird netting does not appear to be damaging to fruit in this season however and may actually assist in protecting fruit from exposure, while commercial sunscreens are not necessarily beneficial where fruit is highly exposed.

In cooler seasons and in seasons of high disease risk these treatments, particularly leaf and shoot removal, may be advantageous to fruit ripening and quality.

We plan to follow up with demonstration trials over several future seasons, in vineyard sites with lower intrinsic variability and lower risk of unfavourable events. The first follow-up demonstration / trial is scheduled for the 2010/2011 season with the support of GWRDC Grass Roots Regional Development funding.

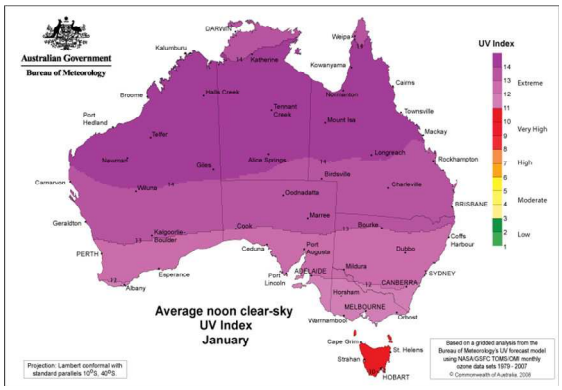
Background

The Queensland wine industry is relatively new, and its development has relied on the adoption of a number of viticultural practices typically used in more established wine growing regions. While successful in other regions, these techniques have not necessarily proven to be best practice for viticulture in Queensland. Moreover, the wine grape growing regions of Queensland are climatically distinct from the majority of other Australian wine growing regions. Queensland has relatively wet growing seasons, often with severe peak heat loads. Queensland also hosts the most northerly and some of the highest altitude vineyards in Australia, which are therefore subject to high ultra violet (UV) radiation exposure, higher than any other grape growing region in Australia. This may be demonstrated by reference to UV Indices from Australian regions. The UV index is measured in capital and regional cities by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). From recorded data ARPANSA has developed models showing predicted maximum daily levels of UV radiation for each city (see http://www.arpansa.gov.au/uvindex/models/index.cfm). ARPANZA also provides data for actual recorded daily maximum UV index for the last five years. Table 1 summarises this data into an average maximum daily index for the growing season. However these recordings have been made in cities that are at sea level. The Granite Belt region is 800 to 1000m above sea level. ARPANSA have advised us that "at altitudes of 1000m there is an approximate increase in UV index of 14%."

Table 1 Summary of UV index (average daily max) for the growing season

	Brisbane	Perth	Adelaide	Newcastle	Melbourne	Kingston
Oct	8.6	7.6	6.9	7.2	6.5	5.3
Nov	9.9	9.4	8.8	8.6	7.8	6.7
Dec	11.0	10.4	10.2	9.5	8.7	8.7
Jan	11.3	10.6	10.5	10.0	9.9	9.3
Feb	10.8	10.3	9.7	8.6	8.5	8.1
Mar	9.1	7.5	7.6	7.0	7.1	5.6
Average	**10.1**	**9.3**	**9.0**	**8.5**	**8.1**	**7.3**

This may be reinforced by consideration of averaged monthly UV Index maps provided by the Bureau of Meteorology. Figure1 shows Queensland winegrowing regions have higher UV exposure. The UV index altitude multiplier applies equally to all areas; therefore Queensland winegrowing regions generally have higher UV exposure than other Australian winegrowing regions of similar altitude.



Furthermore, fruit exposure may be exacerbated by regional vineyard management practices which are often chosen to minimise the risk of fungal infection in a wet growing season. For example VSP trellising, shoot thinning and leaf removal are widely practiced, particularly in the Granite Belt. These practices increase the risk of fruit sunburn (Spayd *et al.* 2002) which may be detrimental to fruit quality.

Figure 1. Averaged UV index for January
(http://www.bom.gov.au/jsp/ncc/climate_averages/uv-index/index.jsp).

A survey conducted by the Queensland DPI&F (including Tony Hassall from the team for this proposal) after the very dry 2006/07 growing season showed serious fruit sunburn throughout the Granite Belt region due to inadequate canopy cover, exacerbated in a number of vineyards by leaf plucking and also due to leaf senescence caused by drought.

Consequently the Queensland wine industry has identified fruit exposure management as a critical issue that needs to be addressed to help move the industry forward. In this project we sought to extend the current knowledge on fruit exposure management, value-adding to a key demonstration site already established in the Queensland as well as establishing new demonstration sites. There exists a large body of Australian research studying the effects of light exposure (including some research on the impacts of ultra violet radiation) on wine grape quality (Downey *et al.* 2004; Ristic *et al.* 2007; Steel and Keller 2000, Haselgrove *et al.* 2000). In particular, sun exposure in white wine grapes may result in increased phenolic concentration (Macaulay and Morris, 1993), and berry shrivel and browning (Spayd *et al.* 2002). However that research was carried out in regions with a lower UV index than vineyards in Queensland, thus findings may not be fully applicable to the Queensland wine industry. Furthermore those studies were not supported by direct UV dosimetry measurements as conducted in the demonstration site in this project.

Prior to this project commencing a pilot study is was conducted in the 2008/9 season, designed to display both the impact of exposure of Chardonnay by leaf removal at different times of the growing season and with different levels of exposure, and the effect of commercial horticultural sunscreening products on reducing berry sunburn. This pilot site on the Granite Belt was the focus of an informal on-site educational session for grape growers and winemakers in February 2009. The pilot study informed this proposed project, and results were presented and discussed at the 2009 Queensland Viticulture Seminar. The current project was essentially launched by the 2009 Queensland Viticulture Seminar. With its theme of fruit exposure management and a range of talks by national and international experts as well as discussion of pilot trial results, this seminar inspired wider participation within the wine industry of Queensland and also Northern NSW grape growers.

Project Aims and Performance targets

This project addressed key priorities identified in the Queensland Wine Industry Association's Strategic Plan. The primary purpose of this project, through demonstration of alternative canopy management approaches, was to determine whether current vineyard canopy management practices are optimal for wine grape production in Queensland, or if there are alternate practices better suited to regional conditions. The project included vineyard demonstration sites on the Granite Belt, the South Burnett, and the Scenic Rim. Various canopy management and fruit exposure techniques were applied to demonstrate the impacts of these on wine grape quality. These treatments enabled comparison of fruit quality from VSP and sprawl trellises, and also from vines subjected to leaf plucking treatments. Demonstrations also included trials of fruit exposure management using commercial screening products based on kaolin clay and calcium carbonate, and bird net.

Chardonnay and Shiraz were selected for the trial as they are the most common white and red wine grape varieties in Queensland. The Granite Belt demonstration site also formed the basis of a trial in which a number of canopy parameters were compared, including measurements of bunch zone visible and UV light and temperature. Data was recorded both during the season and at harvest, measuring vine performance and key juice quality indicators. To fully analyse the effect of viticultural practices on the end product, small lot wines were made from the various treatments and subjected to analytical characterisation and sensory evaluation. In particular, as the impacts of sun screening products on wine quality are not well understood, preparation of wines from these treatments was conducted help regional winemakers better assess their impacts on wine quality. The data taken included vine measures (leaf area, shoot number, yield per vine, bunches per vine) fruit measures (bunch weight, berry weight, berry size, total soluble solids, titratable acidity, pH, and levels of malic acid, anthocyanins, tannins and total phenolics), wine composition (ethanol, titratable acidity, pH) ethanol levels and sensory profiling analysis.

The project utilised the combined resources of the project participants and other industry stakeholders to achieve the maximum benefit for the Queensland wine industry. The project was designed to disseminate findings via a number of seminars, field days and workshops presented to industry, including guest speakers specialising in grape exposure and grape and wine quality. In addition to on-site inspection of the demonstrations of impacts of different fruit exposure, photographs, descriptions and comparisons were disseminated via workshops, seminars and sensory evaluation sessions. This was supplemented by an occasional technical bulletin providing up to date summaries of outcomes and recommendations to growers that could implement in their own enterprises. Conference, seminar and workshop presentations have been listed in Appendix 1.

The key focus of this study was to demonstrate effects, determine any economic cost/benefit and optimum timing for canopy management approaches in three Queensland regions.

The intended outputs from this project included:

- conduct of industry-based seminars at the start and end of the project *(completed – see section on performance targets below)*
- demonstration of effect of alternative practices at each demonstration site during the 2009 and 2010 winegrowing seasons (grower vineyard walks) *(completed – see section on performance targets below)*
- publication of quarterly technical bulletins to QWIA members *(occasional reports and bulletins were prepared, disseminated and discussed at various meetings with industry personnel)*

- conduct of sensory evaluation sessions to demonstrate differential fruit exposure effects on the wines produced *(completed – wines evaluated by judges at the RASQ Wine Show Toowoomba on 6 June 2010 and by industry on 23 June 2010)*
- reporting of findings to the Queensland wine industry, GWRDC and the broader Australian wine industry in the form of a written report *(refers to this report, and in addition other publications and presentations as listed in Appendix 1)*
- stimulation of further investigation into optimising grape and wine production in the Queensland wine industry, such as investigating other vineyard management and wine production options (*this project has led to follow up extension work funded by the GWRDC Grass Roots Regional Development program for 2010/2011.*

Performance targets

February 2009: conduct Granite Belt vineyard walk showcasing pilot Chardonnay exposure study (*Completed in a vineyard in the Granite Belt*.)

June 2009: deliver to the Queensland wine industry a Queensland Viticulture Seminar focussing on fruit exposure, UV light and canopy management, featuring expert guest speakers, and delivery of findings of the pilot Chardonnay fruit exposure trial *(completed – we conducted preparatory education and discussion with growers via the Queensland Viticulture Seminar with the theme "how much sunlight is enough" 17 June 2009 - seminar programme attached in Appendix 4).*

October 2009 to January 2010: set up vineyard demonstration sites on exposure of Chardonnay and Shiraz in the Granite Belt, South Burnett and Scenic Rim regions, and collect trial data. (*Completed in vineyards in the Granite Belt (Sirromet St Judes), the South Burnett (Clovely) and the Scenic Rim (Ironbark Ridge).*

March 2010: conduct vineyard walks in Granite Belt and South Burnett showcasing Chardonnay and Shiraz exposure studies, and collect trial data from Granite Belt site. *Completed – Scenic Rim vineyard walk 10/01/2010, South Burnett vineyard walk 3/2/2010 (handout in Appendix 5), Granite Belt vineyard walk 10/2/2010 (handout in Appendix 6).*

February to May 2010: conduct chemical analyses on fruit from Granite Belt exposure studies and produce small lot wines from this fruit *(completed – findings discussed below)*

June 2010: present regional tasting forum with key regional winemakers assessing impacts of high exposure and different canopy treatments *(completed – wines evaluated by industry participants at a session of the Queensland Viticulture Seminar on 23 June 2010)*

June 2010: deliver DPI&F Winter seminar detailing results of local exposure studies. This is a key annual technical seminar for the QLD wine industry where the latest information on viticulture and winemaking is presented annually *(completed – presentation of findings and discussion with growers via the Queensland Viticulture Seminar with the theme "sustainable vineyard management" 23 June 2010 - seminar programme attached in Appendix 4).*

July 2010: ascertain which of the applied treatments, if any, is the more beneficial to fruit and wine quality, publish and promulgate results (*completed - preliminary results have been delivered via seminars, workshops and conferences as listed in Appendix 1 - further journal and newsletter publications are currently being prepared*).

Methods

Three commercial Queensland vineyards were chosen as demonstration sites in the Granite Belt (Sirromet St Judes), the South Burnett (Clovely) and the Scenic Rim (Ironbark Ridge). At each site, panels of each variety were subjected to the following treatments:

LP - Leaf plucked on the eastern side only at pea size
HP - Leaf plucked on both sides of the vine at pea size
SS - Shoot thinned at pea size to 1 shoot per 10cm
C – Control
LV - Leaf plucked on the eastern side only at véraison
HV - Leaf plucked both sides at véraison
BN - Bird net was placed over the vine at véraison
Parasol ($CaCO_3$) – product was sprayed over fruit zone at véraison
Surround (kaolin clay, based on kaolinite - $Al_2Si_2O_5(OH)_4$) - product was sprayed over fruit zone at véraison

Single demonstration panels for each treatment were prepared at the South Burnett and Scenic Rim, while several replicate panels were prepared at the Granite Belt demonstration site to allow replication to improve the validity of vine and fruit measures as well as provide sufficient quantities for making wine from each treatment.

Growers inspected the sites in their regions prior to harvest, and fruit from the Granite Belt site was harvested, chemically analysed and processed into wine for sensory assessment. Vine measures were recorded at véraison, including shoot number and shoot length. Leaf area was measured using the method derived by Winter and Whiting (2004). Vine and fruit measures were performed at harvest, including bunch number per vine, yield (kg per vine), bunch weight and berry weight. Grape and wine analyses and winemaking were conducted in the laboratories and winery of the Queensland College of Wine Tourism.

Where not otherwise referenced, analytical measurements were conducted by standard methods as described in Iland *et al.* (2004). Total soluble solids were measured by refractometry and hydrometry, titratable acidity by titration, pH with a TPS AQUA-pH pH meter. Malic acid was measured using an enzymic test (Vintessential), anthocyanins by the AWRI Industry Standard Method (2006), tannins using the MCP (methyl cellulose precipitable) tannin assay (AWRI Industry Standard Method 2007) and phenolics by UV - visible spectrophotometry.

Small lot wines were made under standardised conditions from all treatments. Wine composition: ethanol was measured by ebulliometry, TA by titration and pH using a TPS AQUA-pH pH meter. Colour and phenolic measures were determined by UV-visible spectrophotometry. Wines sensory profiles were determined evaluated by the 2010 RASQ Wine Show judges. Where appropriate results are reported as mean ± standard deviation.

Findings were discussed with the Queensland wine industry and wines made available for sensory assessment by participants in the Queensland Viticulture Seminar in June 2010.

It should be noted that during the 2009/2010 growing season several difficulties impacted upon this project. Firstly the season was very advanced compared to previous seasons, leading to earlier than anticipated harvest dates and the need to reschedule preparative activities and vineyard walks etc. Secondly, the Granite Belt demonstration / trial block showed considerable variability at harvest, with a degree of vine defoliation by (a) hail storms in November 2009 (see http://www.bom.gov.au/climate/mwr/qld/mwr-qld-200911.pdf and http://www.abc.net.au/news/stories/2009/11/14/2742765.htm) as well as frost events late in 2009, and (b) very hot conditions which prevailed between véraison and harvest (Stanthorpe MJT 2010 = 28.9°C; 2009 = 26.9°C; 2008 = 24.7°C; mean 1938-2009 = 27.4°C;

www.bom.gov.au). Thirdly, late season water stress and disease pressures impacted on the results of this trial.

It is hoped to repeat this trial over several future seasons on a more uniform site to assess the impacts of these treatments in varying seasonal conditions. The first follow-up demonstration / trial is scheduled for the 2010/2011 season with the support of GWRDC Grass Roots Regional Development funding.

Results and Discussion

Grower feedback

Growers were invited to visit the demonstration sites prior to harvest and to give their opinions as to the appearance of fruit and general vine health. The overall impression of growers was that worst sunburn was seen in fruit with little canopy or leaf cover (the leaf removal and shoot thinned treatments). Little difference in severity of sunburn was seen between pea size and véraison leaf removal treatments. In the South Burnett and Granite Belt sites, the severity of sunburn was equal or greater on fruit situated on the more easterly side of the canopy, anecdotal evidence suggesting this may be due to afternoon cloud cover typical in the region.

Overhanging foliage appeared to give protection from sunburn in all treatments in all demonstration sites, with fruit from the control and bird netted vines having the greatest amount of leaf cover and the lowest degree of sunburn.

Those who tasted fruit commented on better acid and flavour balance on unexposed fruit, with more exposed and sunburnt fruit showing overripe and 'cooked' fruit flavours and lack of acidity.

Light exposure monitoring

Granite Belt site measurements of ambient light in the bunch zone at véraison (Fig. 2) showed highest exposure in leaf-plucked treatments; data for the vertical plane showing low light penetration in most treatments with healthy canopy, except the sprawl which had little overhead cover. Shiraz netted vines had lowest overall light penetration while leaf plucked, shoot thinned and sprawl treatments showing the highest. In the Chardonnay, heavy leaf plucked vines showed highest light penetration, with control and LV having the lowest.

Dosimetric measurement of bunch zone UV radiation in the Shiraz (Fig. 3) indicated highest UV exposure in the high plucked treatments as well as slight increases in sunscreen treatments (likely due to greater reflection of UV radiation onto the dosimeters). The lowest UV exposure was seen in the control, netted and sprawl canopies. Interestingly while the sprawl treatment showed higher visible light penetration and bunch zone temperatures (see below) the UV exposure was found to be less than in other treatments.

Bunch zone temperatures were recorded in the Shiraz block from véraison until harvest. Data for 1pm bunch temperatures (Fig. 4), a typical day (Fig. 5) and the hottest day of the season (Stanthorpe maximum 35.5 ℃, Fig. 6) indicated that the highest temperatures were in the bunch zone of the shoot thinned vines, followed by sprawl and netted vines. Lowest temperatures were found in the control and lightly leaf plucked vines.

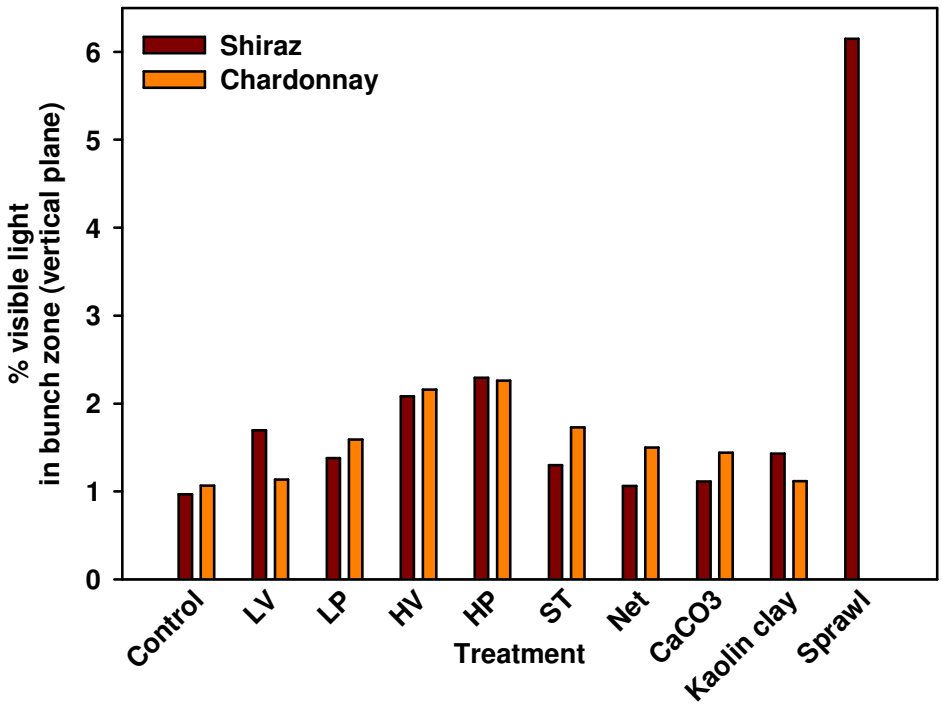


Figure 2. Visible light penetration into the bunch zone at the Granite Belt site

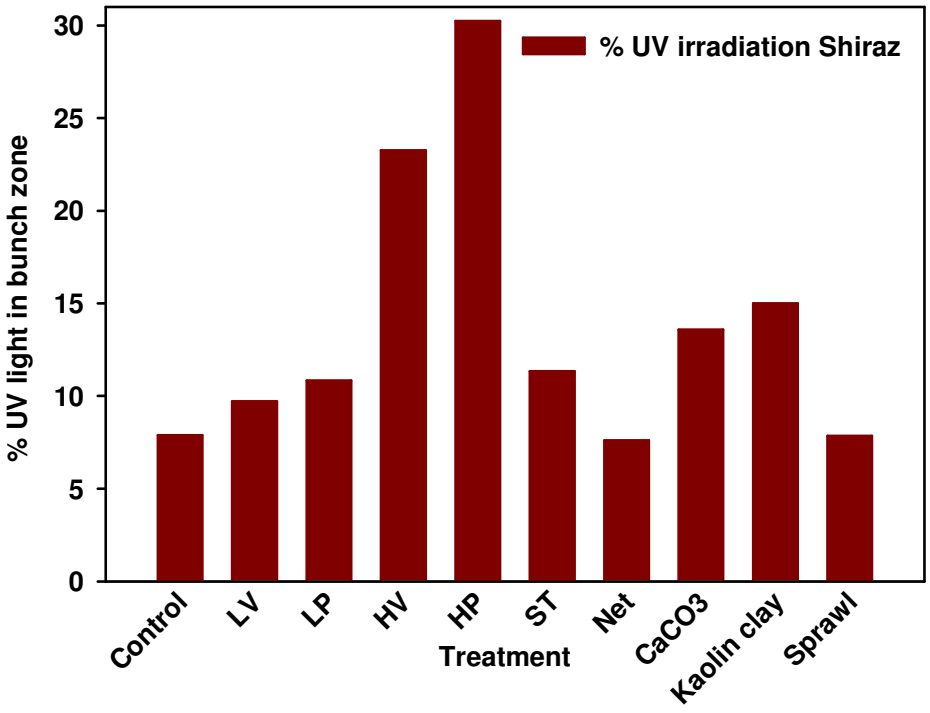


Figure 3. Mid season ultraviolet radiation exposure (summed over 24 h) in the Shiraz bunch zone at the Granite Belt site

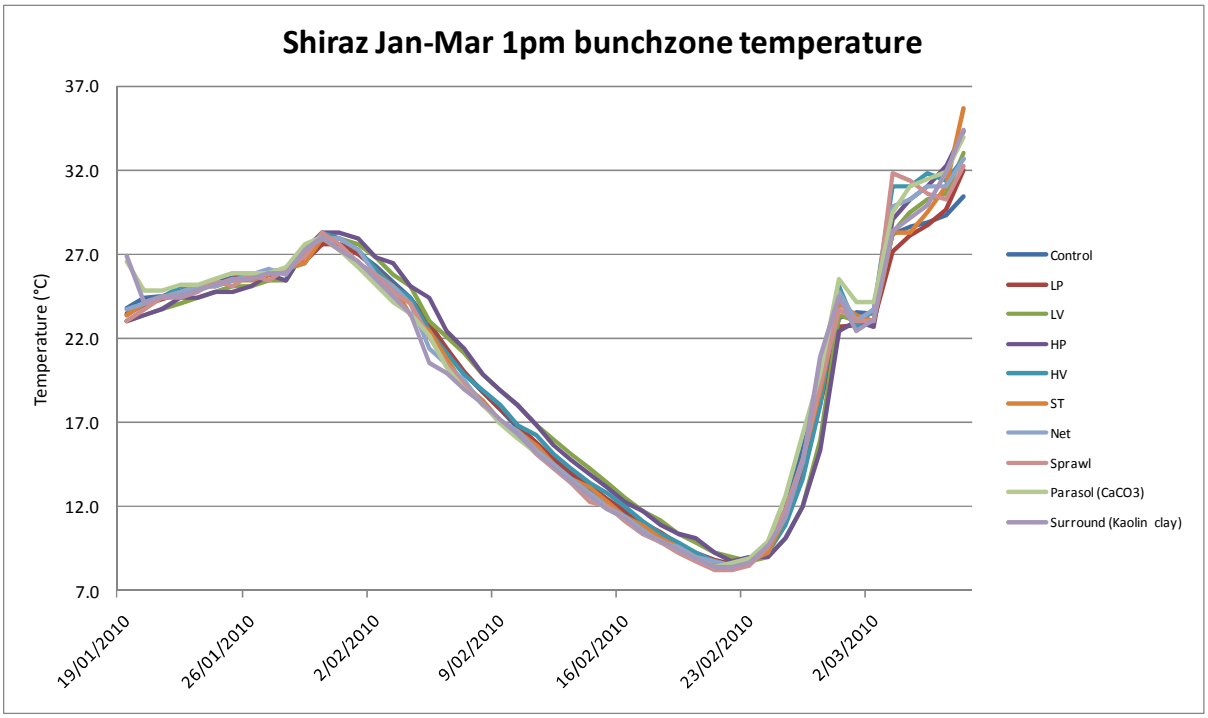


Figure 4 Shiraz 1pm bunchzone temperatures at the Granite Belt site during the trial

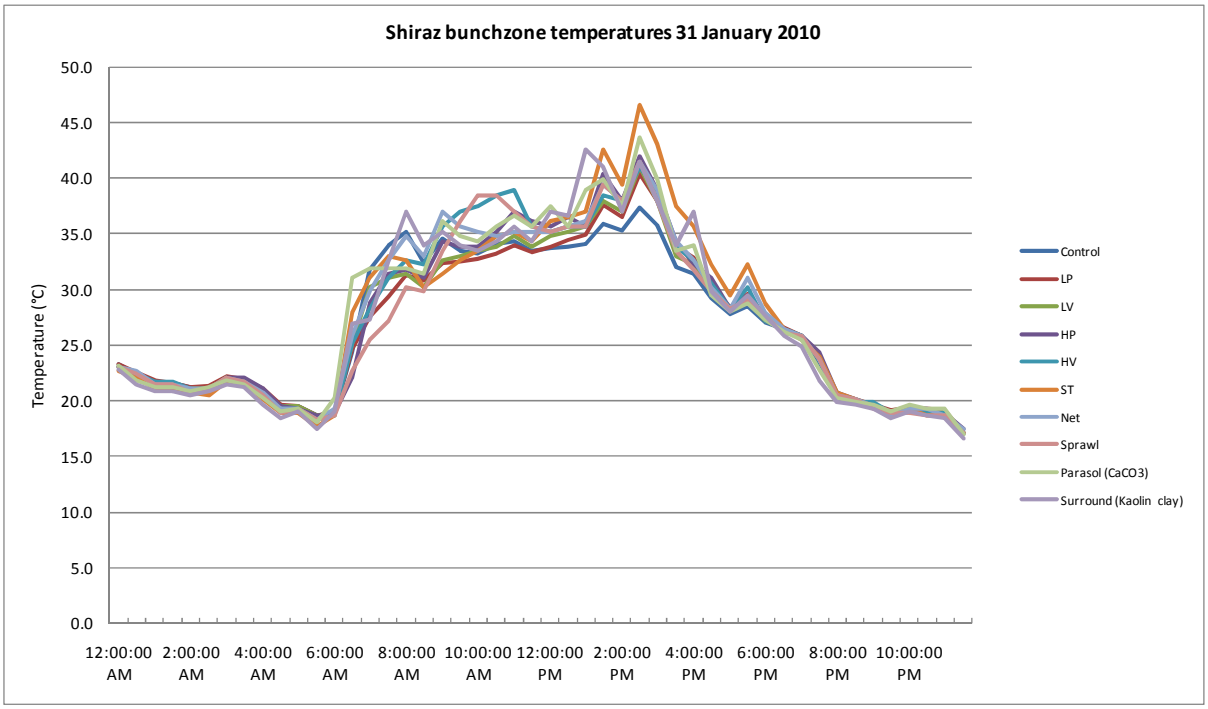


Figure 5. Shiraz bunchzone temperatures over a typical day

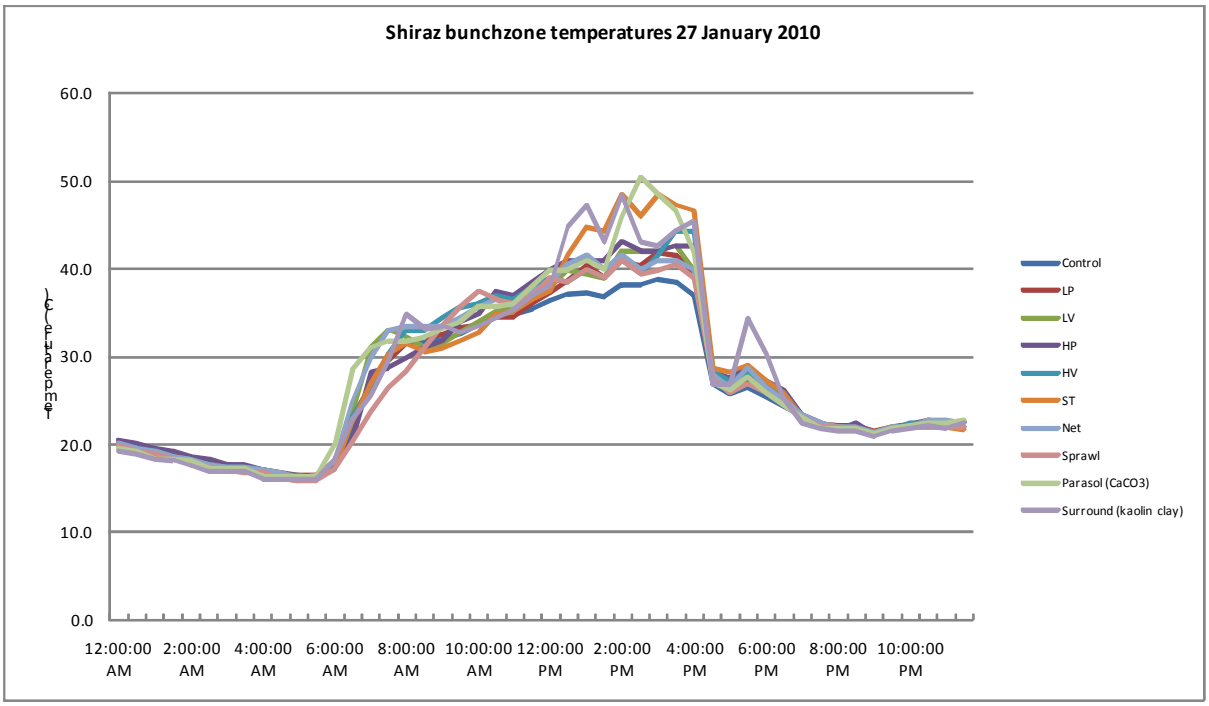


Figure 6. Shiraz bunchzone temperatures on the season's hottest day (27/1/2010).

Vine measures and fruit analyses

Leaf areas assessed at véraison as expected showed a decrease in leaf area for all vines which had undergone leaf removal and shoot thinned vines as compared to controls, while netted vines and those with sunscreen products applied had slightly higher leaf areas. All treatments fell within recommendations for leaf area / fruit weight (Fig.7) i.e. 6 – 15 cm^2/g (Smart and Robinson 1991).

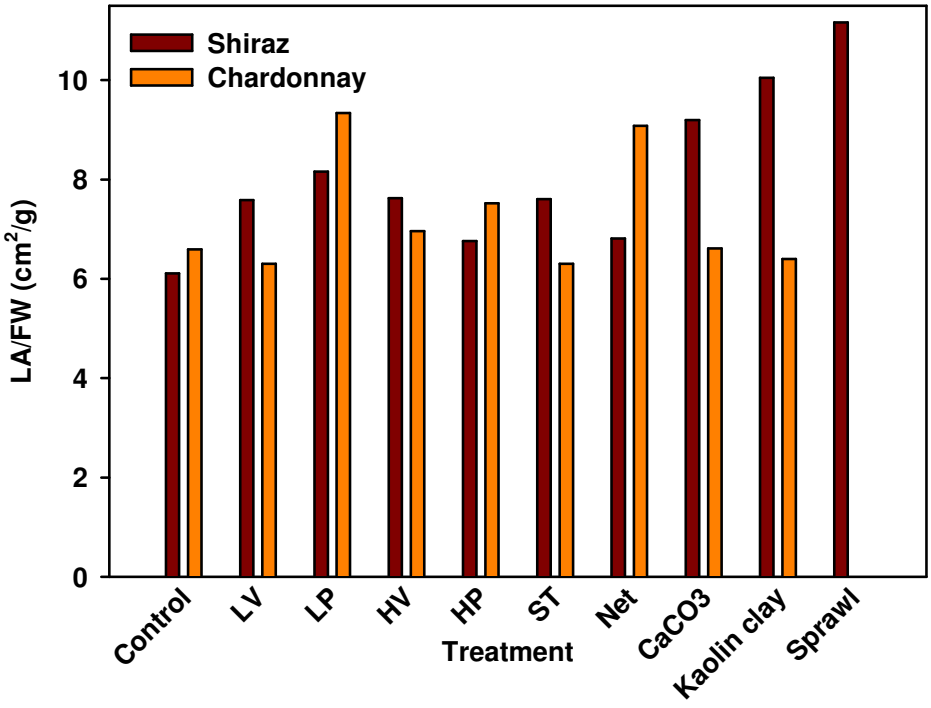


Figure 7. Leaf area / fruit weight (cm^2/g) for all treatments. Chardonnay mean 7.2 ± 1.2, Shiraz mean 8.1 ± 1.6).

Both varieties were harvested when the block in which the treatments were placed was deemed mature for commercial harvest.

At harvest bunch weights were assessed, with bunch from leaf removal treatments and from netted vines having lower harvest bunch weights than control vines, fruit from netted vines and those with sunscreen products applied having slightly heavier bunches.

Fruit analyses showed similar harvest yields and profiles of TSS (Fig. 8), pH (Fig. 9) and TA (Fig. 10). No marked trends seen between TSS, pH and TA for different treatments. TSS was in a narrow range for both varieties, 11.1 – 11.9 °Bé in the Chardonnay and 11.2 – 12.4°Bé in the Shiraz. In the Shiraz pH varied between from 3.86 to 3.99 with TA between 5.11 and 5.51 g/L. In the Chardonnay pH varied between 3.68 and 3.81 and with TA between 4.15 and 4.79 g/L. Fruit from all leaf removal and shoot thinned vines tended to be higher in pH and lower in TA than the control, with all but the vines with leaves removed from the eastern side at véraison also higher in TSS than the control. Results for the netted and sunscreen vines were varied.

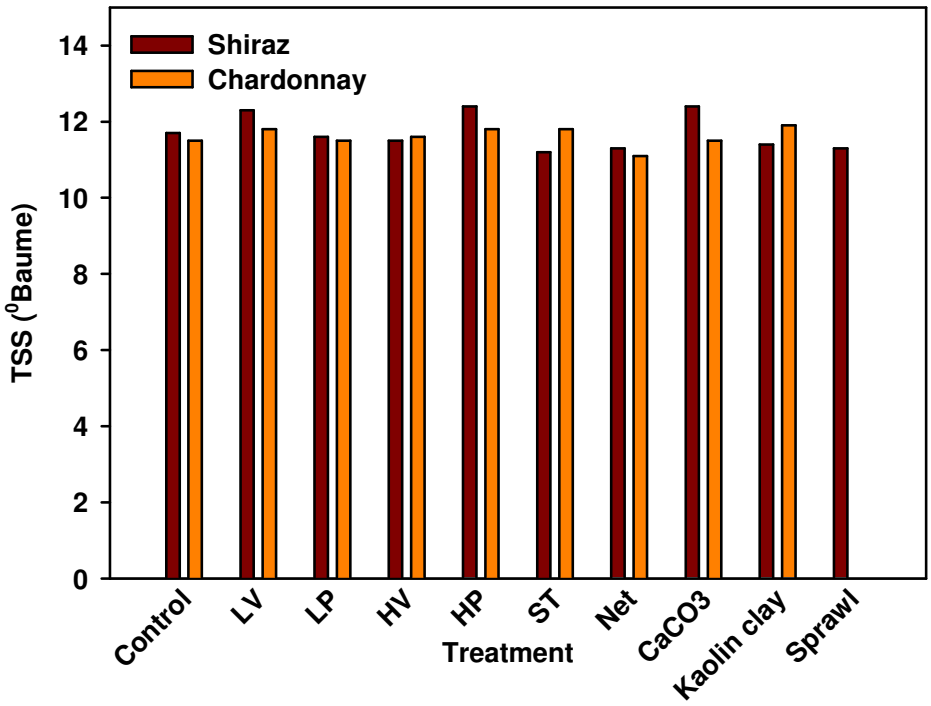


Figure 8. TSS at harvest

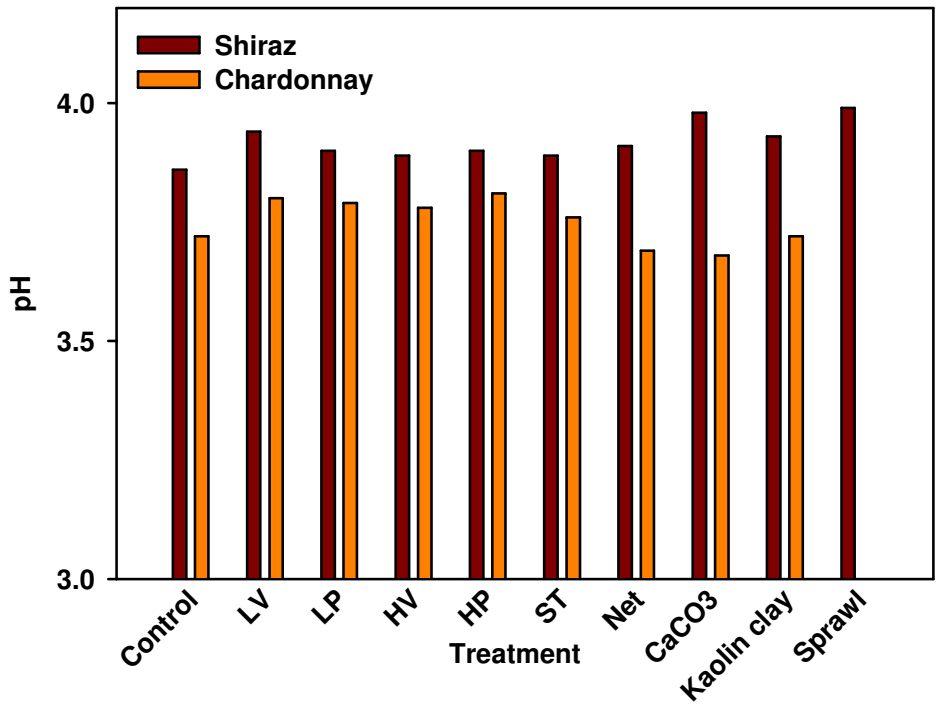


Figure 9. pH at harvest

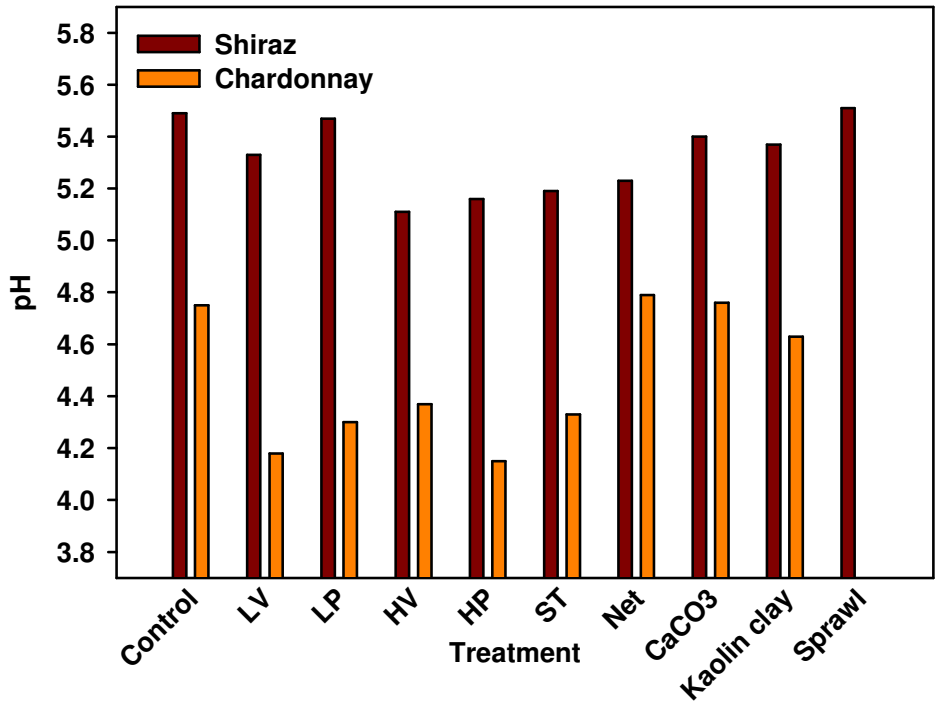


Figure 10. TA at harvest

Spectral measures were also carried out to assess juice total phenolics and brown pigments. Marginal differences were seen in Chardonnay phenolic profiles (Fig. 11) and Shiraz anthocyanins, tannins and phenolics (Fig. 12). The most severely leaf plucked treatments showed the highest levels of phenolics and brown pigments pre settling, followed by less severely leaf plucked treatments (eastern side leaf plucked).

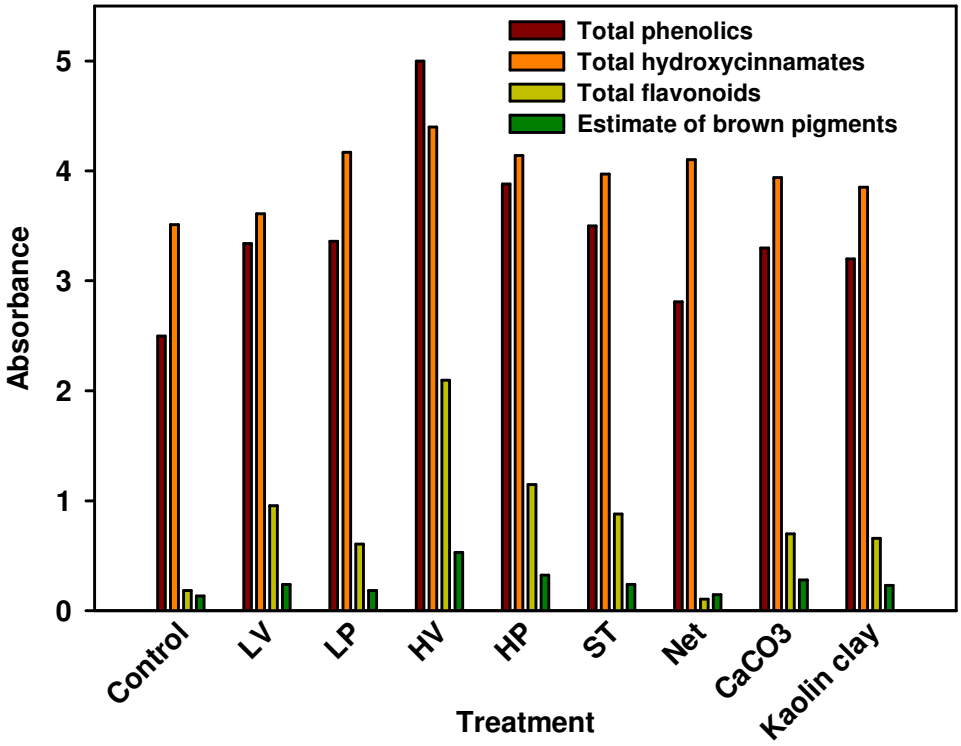


Figure 11. Chardonnay phenolics, hydroxycinnamates, flavonoids and brown pigments (unsettled juice).

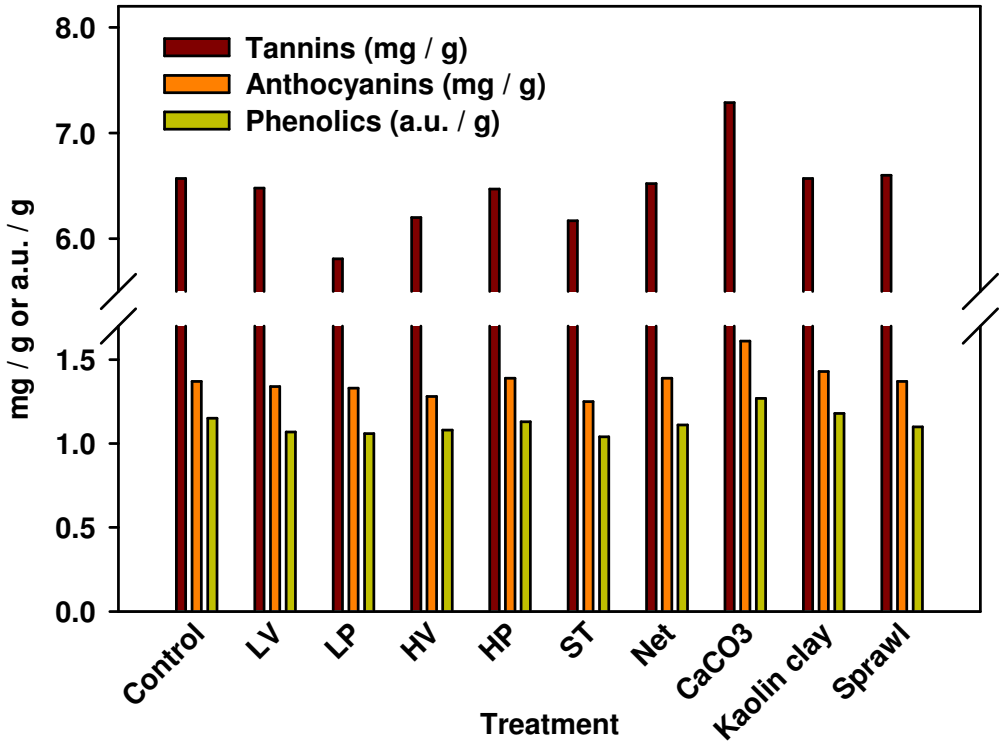


Figure 12. Shiraz tannins, anthocyanins and phenolics.

Although slight differences were seen in phenolic profiles, the wines had similar sensory profiles (see below). The more highly exposed Shiraz fruit had lower levels of anthocyanins, similar to the findings of others such as Haselgrove *et al.* (2000).

Wine measures

The resultant wines had similar profiles, which reflected the fruit used to prepare the wines. pH and TA profiles were similar as wines were acidified to constant TA prior to fermentation. The ferments for each variety went to similar levels of completion in terms of residual sugar and ethanol analyses.

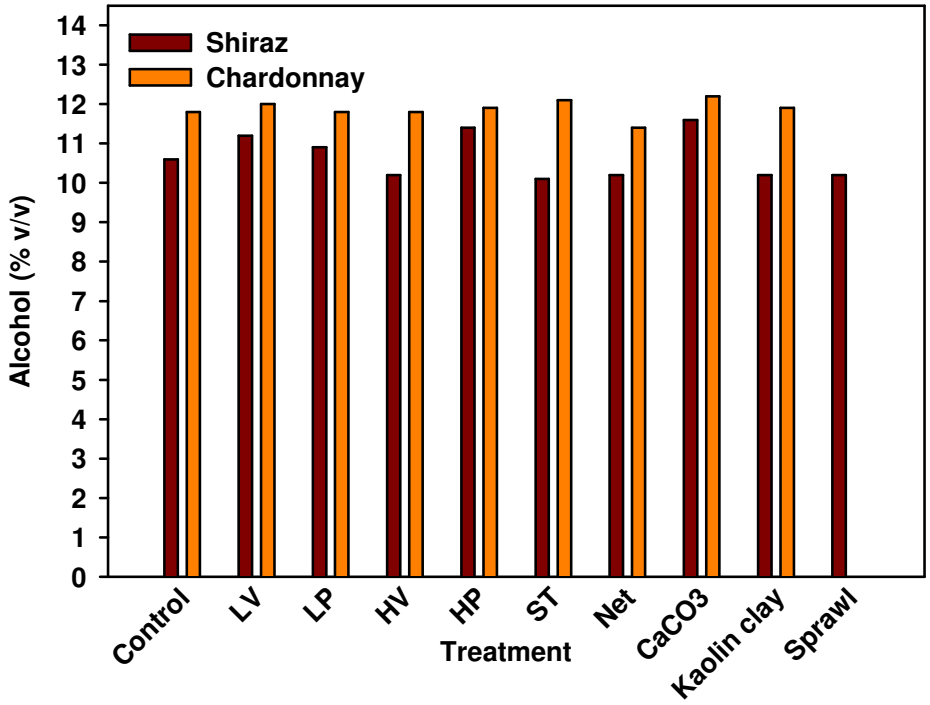


Figure 13. Alcohol levels of the wines produced.

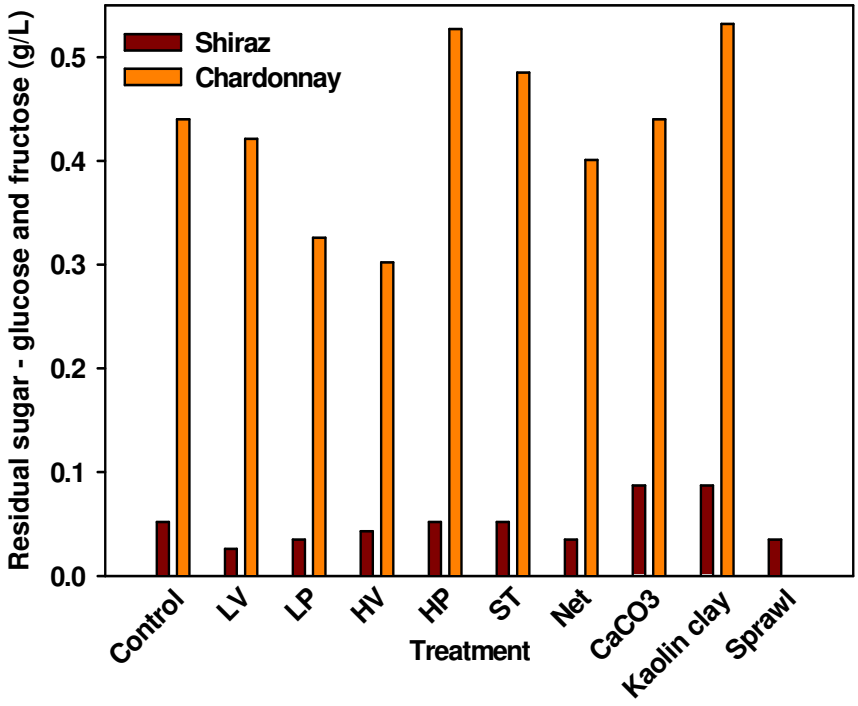


Figure 14. Residual sugar (glucose + fructose) levels of the wines produced.

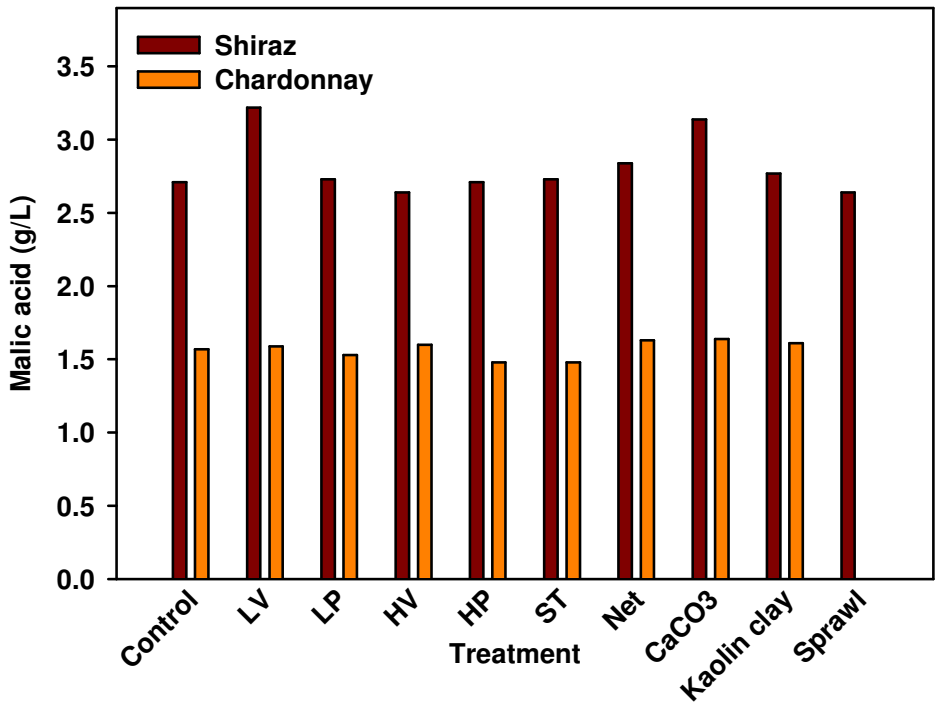


Figure 15. Malic acid levels of the wines produced.

The Chardonnay wine phenolic profiles were similar to those of the unsettled juice, although the levels were reduced by juice settling (data not shown) and during the winemaking processes.

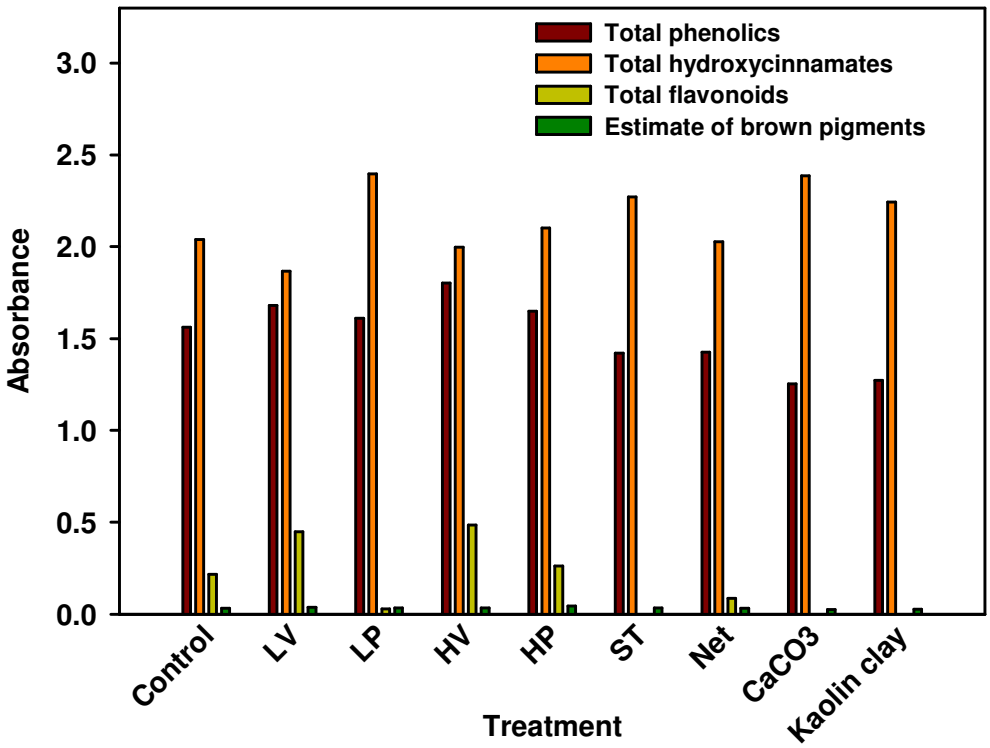


Figure 16. Chardonnay wine phenolics, hydroxycinnamates, flavonoids and brown pigments.

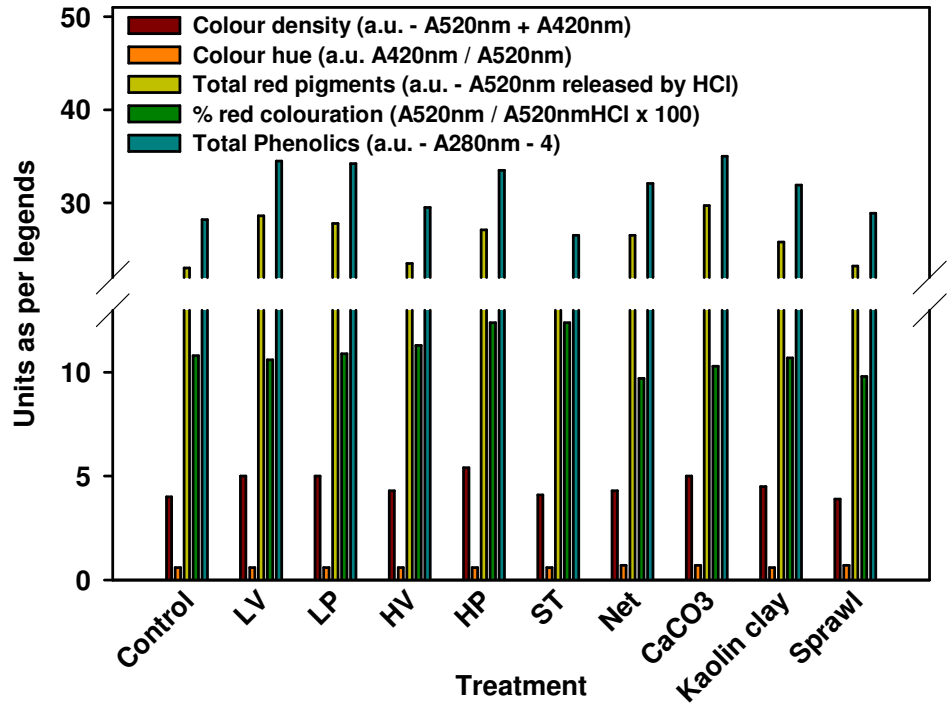


Figure 17. Shiraz wine colour density, hue, red pigments, % red colour and total phenolics.

Sensory analysis

For the Chardonnay (Fig. 18) similar trends were seen in all wine assessments. Controls had the lightest colour intensity, shoot thinned the most tropical and least herbaceous character, and netted vines the most citrus and least overripe aromas. Wines from sunscreen sprayed fruit showed the greatest astringency and bitterness (the latter along with control wines).

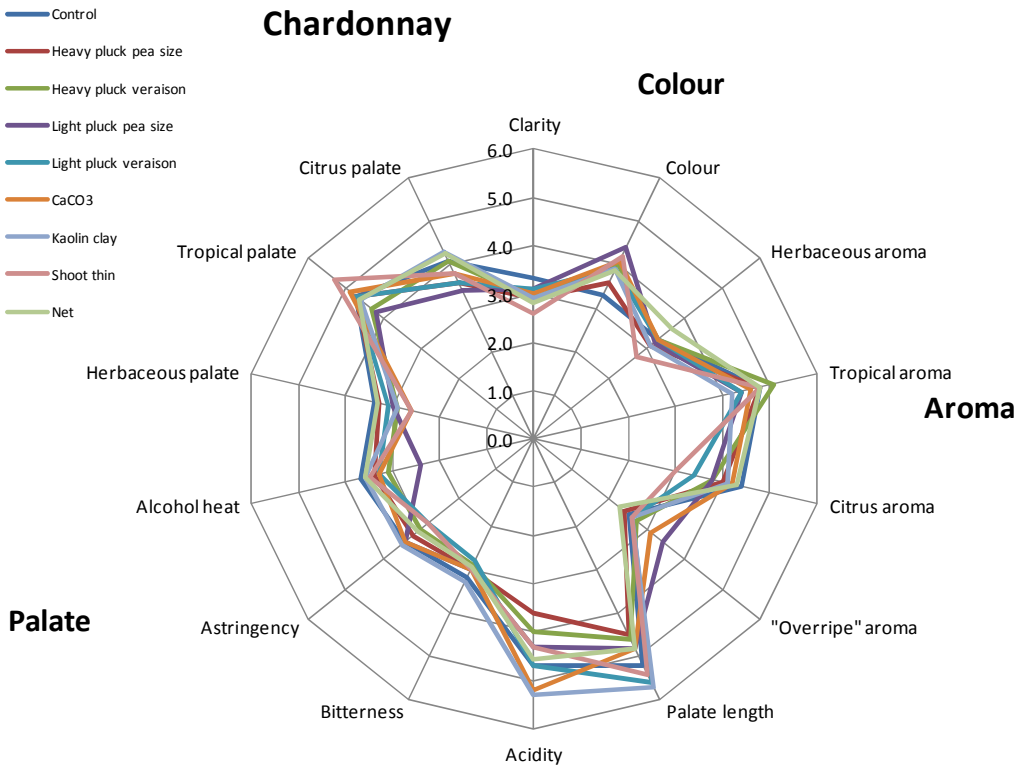


Figure 18. Chardonnay sensory profiles.

For the Shiraz (Fig. 19) again similar trends were seen in all wine assessments. The HP and LV were judged to be the most astringent. The control and kaolin clay treatments evidenced the greatest berry and dark fruit aromas, while the HP, LV and $CaCO_3$ treatments were perceived to have most red/berry fruit palate character. Wines from the kaolin clay treated fruit showed the greatest colour intensity.

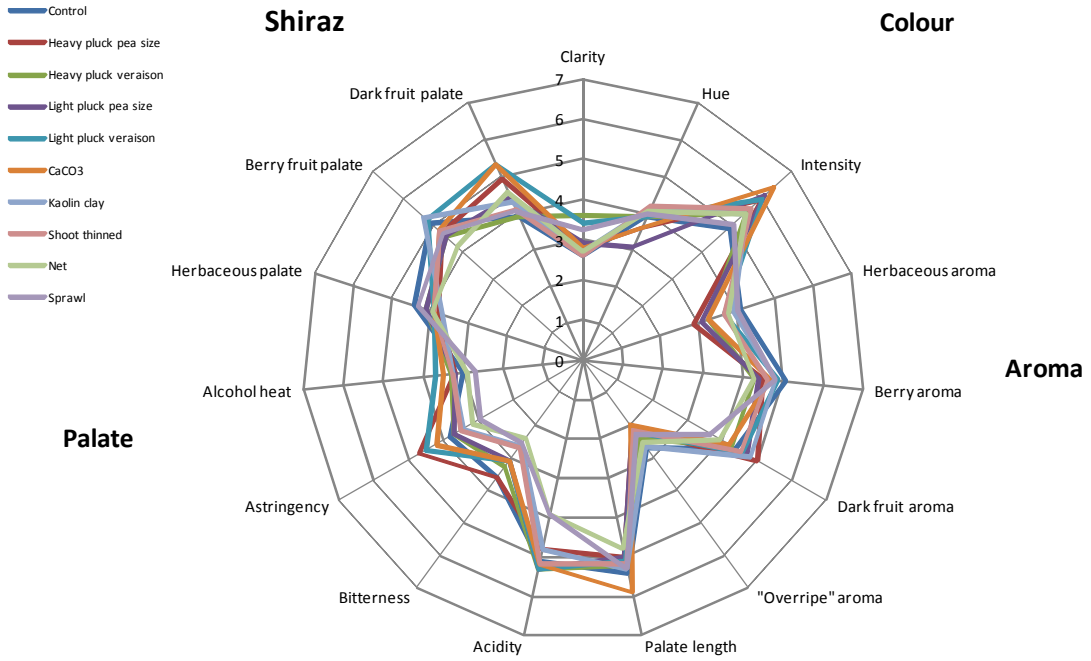


Figure 19. Shiraz sensory profiles.

Wine calcium levels

There has been some industry concern regarding the use of sunscreen products potentially leading to high calcium levels in wine. We measured the calcium levels in the wines, using a Shimadzu Atomic Absorption Spectrophotometer.

Results are shown in Figure 20. In the figure, lines have been drawn to represent the mean values for Shiraz (56.0 ± 4.8 ppm) and Chardonnay (37.1 ± 3.4 ppm). The calcium values for the sunscreen products were very close to the mean values (Parasol [$CaCO_3$] 36.7 ppm in Chardonnay, 55.9 ppm in Shiraz; Surround [kaolin clay - $Al_2Si_2O_5(OH)_4$] 35.3 ppm in Chardonnay, 50.5 ppm in Shiraz. Thus it can be seen that use of the calcium carbonate based sunscreen product (Parasol) did not result in higher wine calcium levels.

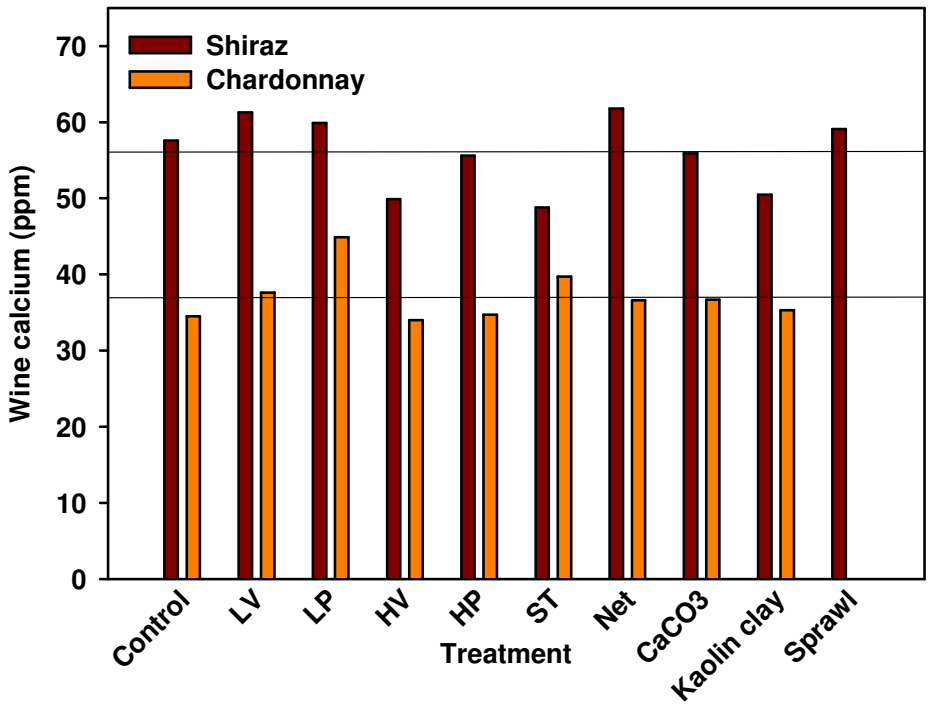


Figure 20. Chardonnay and Shiraz wine calcium levels.

Conclusions

It was difficult to make solid conclusions from this work, due to problematic seasonal conditions which included diverse severe weather events. Determining differences between treatments was complicated by high intrinsic vineyard variability due to early season frost and hail, and also late season defoliation due to water stress and fungal disease pressure. Canopies of the various treatments did not have obvious differences due to the inherent lack of uniformity across all vines leading to Inconsistent additional fruit exposure. Differences were noted in exposure and sunburn of the Chardonnay grapes prior to harvest, although only marginal differences were seen in the measures of fruit and wine quality of either variety. We are wary of making inferences from this study over a difficult season where site and seasonal factors overwhelmed differences due to imposed management practices. Notwithstanding the difficulties of the season, findings of some note were made as follows.

Overhead canopy appears to be important in limiting exposure of grape bunches. While this was not specifically a studied component, where it occurred, loss of overhead canopy by hail, frost or general leaf senescence resulted in more highly exposed and sunburnt fruit. In the South Burnett and Granite Belt sites, marked sunburn was seen on fruit on the easterly side of the canopy, likely due to higher morning exposure due to afternoon cloud cover typical of the regions.

Bunch zone leaf removal resulted in high visible light and UV radiation in canopy, leading to sunburnt fruit which was higher in brown pigments (Chardonnay) and lower in anthocyanins (Shiraz). The treatments only led to subtle if any impacts on wine sensory profiles. Finally, using a calcium-based sunscreen product did not result in elevated wine calcium levels.

We plan to follow up with demonstration trials over several future seasons, in vineyard sites with lower intrinsic variability and lower risk of unfavourable events. The first follow-up demonstration / trial is scheduled for the 2010/2011 season with the support of GWRDC Grass Roots Regional Development funding.

Recommendations

The 'take home' messages from this project point to the importance of limiting exposure of Chardonnay in a climate such as Queensland in a hot season such as season 2009/10 was. Exposure in the 2009/10 season resulted in berry sunburn, loss of acidity and development of overripe and cooked flavours, increase in berry total phenolics and potential for browning. Similar impacts were seen in the Shiraz, and additionally the higher exposure treatments led to lowering of anthocyanins, affecting the red wine colour.

In hotter seasons, practices such as leaf plucking and shoot thinning are not advised, being an increased cost to vineyard management with potential deleterious impacts on fruit quality. Bird netting does not appear to be damaging to fruit in this season however and may actually assist in protecting fruit from exposure, while commercial sunscreens are not necessarily beneficial where fruit is highly exposed. In cooler seasons and in seasons of high disease risk these treatments, particularly leaf and shoot removal, may be advantageous to fruit ripening and quality.

Achievement of anticipated outcomes

Benefits of this project, as anticipated in the application include the following.

Economic

- short term comparison of the advantages and disadvantages of current regional canopy management and alternative practices *(some valuable comparisons were made, although problems inherent to the season and variability on one site indicate that further trials are needed to clarify possible findings)*
- showcasing to industry of low input vineyard management options which are easily implemented and economically viable for a variety of situations and climates *(some valuable comparisons were made; follow up work will provide better conditions for assessment of possible benefits)*
- provision of best practice canopy management advice to growers leading to maximisation of grape and wine quality thus increased wine economic value *(some valuable comparisons were made; follow up work will provide better conditions for assessment of possible benefits)*
- the path to adoption of findings is assured through involvement of industry personnel in the project as well as provision of vineyard sites and case studies *(in addition to a follow up project via GWRDC Regional Development funding, various growers are trialling the alternative management practices on their own vineyards)*

Environmental

- if proven to be of economic benefit, best practice canopy management resulting in faster grape ripening while reducing disease incidence will result in reduced chemical and water inputs *(more conclusive trials will enable this objective to be achieved)*

Social

- targeted investigation carried out for the Queensland wine industry will result in increased grape and wine quality and recognition for the state *(as above, more conclusive trials will enable this objective to be achieved)*
- enhancement of ongoing collaborations between key research, extension and education providers (USQ, DEEDI and QCWT), the State Government, QWIA, regional wine industry associations and commercial vineyards and wineries *(closer working and collaborative arrangements have resulted from this project).*

- this enhanced collaboration will strengthen relationships to enhance cooperative and strategic regional leadership and promotion of activities prioritised by QWIA for future benefit of the Queensland wine industry *(closer working and collaborative arrangements have resulted from this project).*
- adoption of findings leading to improved fruit and wine quality will enhance recognition of and promotion of the Queensland wine industry *(the work has stimulated further local interest and understanding of the benefits of research; the state profile is being raised through presentation at national and international conferences, and publications to be submitted to national and international journals).*
- transfer of findings to other regions of similar climatic situation, such as New England, will strengthen relationships between regions to mutual benefit *(New England wine industry practitioners participated in the 2010 Queensland Viticulture seminar and there is now regular exchange of attendance at workshops and activities on both sides of the state border.)*

Acknowledgements

This work utilised the facilities of the University of Southern Queensland and the Queensland College of Wine Tourism. We would also like to thank Sirromet, Clovely and Ironbark Ridge for provision of vineyard demonstration sites, the RASQ Wine Show judging panel, USQ Senior Technician Mr K Larsen and Bachelor of Technology (Wine) students for assisting with picking, processing grapes and monitoring ferments, and Alfio Parisi (USQ) for advice on UV dosimetry.

Appendix 1: Communication

Results from the study have been presented to the Queensland wine industry as follows:

1. Vineyard walk in the Granite Belt, February 2009, prior to harvest.
2. Kennedy, U. J., Learmonth, R. P., Hassall, T. and Harris, M. (2009) “Influence of bunch exposure on Chardonnay fruit and wine quality”. Queensland Viticulture Seminar, Stanthorpe QLD 17 June 2009.
3. Vineyard walks in the South Burnett, Scenic Rim and Granite Belt, prior to the 2010 harvest.
4. Kennedy, U. J., Learmonth, R. P., Deegenaars, M., Rhymer, D. J. and Hassall, T. (2010) “Addressing fruit exposure in Queensland winegrape vineyards over the 2009/2010 vintage”. Queensland Viticulture Seminar, 23 June 2010.
5. The Queensland Viticulture Seminar, 23 June 2010 included a post-seminar workshop where industry participants could evaluate the wines.

Results have also been disseminated to Queensland and wider audiences as follows:

6. Kennedy U. J. (2010) Addressing exposure of Chardonnay in Queensland Vineyards – Part 1. Australian Viticulture, 14, 50-1.
7. Kennedy U. J. and Learmonth, R. P. (2010) Addressing exposure of Chardonnay in Queensland Vineyards – Part 2. Australian Viticulture 14, 66-8.
8. Kennedy, U. J., Rhymer, D. J., Parisi. A.V. and Learmonth, R.P. (2010) “Describing the ultra violet light radiation environment of the grape bunch”. 14th Australian Wine Industry Technical Conference, Adelaide, July 2010. Poster 150.
9. Kennedy, U. J., Hassall, T., Deegenaars, M., Rhymer, D. J. and Learmonth, R.P. (2010) “Influence of Bunch Exposure in a Commercial Queensland Vineyard on Chardonnay and Shiraz Fruit and Wine Quality”. 14th Australian Wine Industry Technical Conference, Adelaide, July 2010, Poster 152.

Appendix 2: References

Downey, M.O., Harvey, J.S. and Robinson, S.P. (2004) The effect of bunch shading on berry development and flavonoid accumulation in Shiraz grapes. Aust J Grape & Wine Res 10, 55-73.

Haselgrove, L., Botting, D., van heeswijck, R., Hoj, P.B., Dry, P.R., Ford, C. and Iland, P.G. (2000). Canopy microclimate and berry composition: the effect of bunch exposure on the phenolic composition of *Vitis vinifera* L cv. Shiraz grape berries. Aust J Grape & Wine Res 6 (2), 141-149.

Iland, P, Bruer, N, Edwards, G, Weeks, S, Wilkes, E, 2004, Chemical analysis of grapes and wine: techniques and concepts, Patrick Iland Wine Promotions Pty Ltd, Adelaide.

Macauley, L. E. and Morris, J. R. (1993) Influence of cluster exposure and winemaking processes on monoterpenes and wine olfactory evaluation of Golden Muscat. American J Enology & Viticulture 44 (2)198-204.

Ristic, R., Downey, M.O., Iland, P.G., Bindon, K., Francis, I.L., Herderich, M. and Robinson, S (2007) Exclusion of sunlight from Shiraz grapes alters wine colour, tannin and sensory properties. Aust J Grape & Wine Res 13, 53-65.

Smart R. and Robinson M. (1991) Sunlight into wine. A handbook for winegrape canopy management. Winetitles, Adelaide.

Spayd, S.E., Tarara, J.M., Mee, D.L., and Ferguson, J.C. (2002) Separation of sunlight and temperature effects on the composition of *Vitis vinifera* cv. Merlot berries. American J Enology & Viticulture 53 (3) 171-182.

Steel, C.C. and Keller, M. (2000) Influence of UV-B irradiation on the carotenoid content of *Vitis vinifera* tissues. Biochemical Society Transactions (28) 883 – 885.

Winter, E. and Whiting, J. (2004) Using leaf area to crop weight to determine vine balance. Australian Viticulture Jan/Feb 2004, 70-73.

Appendix 3: Key Staff and Industry Collaborators

Centre for Systems Biology, University of Southern Queensland

- Ursula Kennedy
- A/Prof Robert Learmonth

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

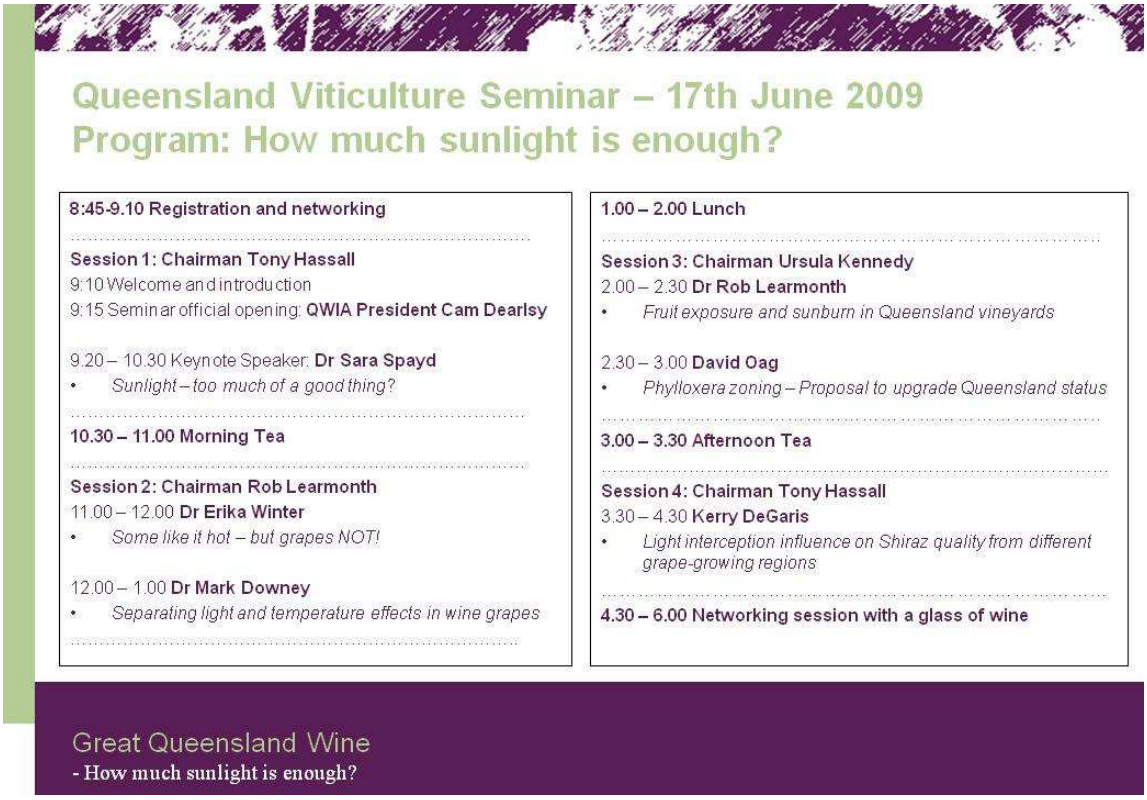
- Tony Hassall
- David Brown
- Mark Deegenaars

Key industry collaborators

- Dylan Rhymer, Ballandean Estate

Appendix 4: Queensland Viticulture seminar programmes

17 June 2009 – project initiation seminar



Queensland Viticulture Seminar – 17th June 2009
Program: How much sunlight is enough?

8:45-9.10 Registration and networking

Session 1: Chairman Tony Hassall
9:10 Welcome and introduction
9:15 Seminar official opening: **QWIA President Cam Dearlsy**

9.20 – 10.30 Keynote Speaker: **Dr Sara Spayd**
- *Sunlight – too much of a good thing?*

10.30 – 11.00 Morning Tea

Session 2: Chairman Rob Learmonth
11.00 – 12.00 **Dr Erika Winter**
- *Some like it hot – but grapes NOT!*

12.00 – 1.00 **Dr Mark Downey**
- *Separating light and temperature effects in wine grapes*

1.00 – 2.00 Lunch

Session 3: Chairman Ursula Kennedy
2.00 – 2.30 **Dr Rob Learmonth**
- *Fruit exposure and sunburn in Queensland vineyards*

2.30 – 3.00 **David Oag**
- *Phylloxera zoning – Proposal to upgrade Queensland status*

3.00 – 3.30 Afternoon Tea

Session 4: Chairman Tony Hassall
3.30 – 4.30 **Kerry DeGaris**
- *Light interception influence on Shiraz quality from different grape-growing regions*

4.30 – 6.00 Networking session with a glass of wine

Great Queensland Wine
- How much sunlight is enough?

23 June 2010 – project completion seminar and sensory workshop

Queensland Viticulture Seminar – 23rd June 2010
Program: Sustainable Vineyard Management

8:45-9.10 Registration and networking

Session 1: Chairperson Rob Learmonth
9:10 Welcome and introduction
9:15 Seminar official opening:
QWIA President Leeanne Gangemi

9.20 – 10.30 Keynote Speaker: **Louisa Rose**
- *Viognier and other 'V' Varieties – what's next?*

10.30 – 11.00 Morning Tea

Session 2: Chairperson Mark Deegenaars
11.00 – 11.50 **Marcel Essling**
- *The latest agrochemical update with a focus on best practice Botrytis management*

11.50 – 12.30 **Ursula Kennedy**
- *Addressing fruit exposure in Queensland winegrape vineyards over the 2009/2010 vintage*

12.30 – 1.40 Lunch and networking

Session 3: Chairperson Dave Brown
1.40 – 2.10 **Peter Stewart**
- *Double-pruned Shiraz in the South Burnett*

2.10 – 2.40 **Doug Baddeley**
- *Bunchzone temperature research in the Scenic Rim*

2.40 – 3.00 **Rob Learmonth**
- *Queensland alternative varieties – plantings and prospects*

3.00 – 3.20 **Michelle Cozzi**
- *Queensland alternative varieties – the Strange Bird experience*

3.20 – 3.35 Afternoon Tea

Session 4: Chairperson Ursula Kennedy
3.35 – 4.30 *Assessing Chardonnay and Shiraz canopy management trial wines*

4.30 – 6.00 Networking session with a glass of wine

Great Queensland Wine
- Sustainable Vineyard Management

Appendix 5: South Burnett bunch exposure trial - Field day handout 3/2/2010

By Ursula Kennedy, Rob Learmonth, and Tony Hassall

Introduction

As part of the GWRDC-funded RITA Project Rt08/03-1 "Addressing fruit exposure in Queensland winegrape vineyards," a trial was conducted on Chardonnay and Shiraz grapes in the South Burnett to look at the effects of various bunch exposure treatments.

Methods

Panels of each variety were subjected to the following treatments:
LP - Leaf plucked on the eastern side only at pea size
HP - Leaf plucked on both sides of the vine at pea size
SS - Shoot thinned at pea size to 1 shoot per 10cm
C - Control
LV - Leaf plucked on the eastern side only at véraison
HV - Leaf plucked both sides at véraison
BN- Bird net was placed over the vine at véraison
Parasol ($CaCO_3$) – Product was sprayed over fruit at véraison
Kaolin (clay) - Product was sprayed over fruit at véraison

Grapes were assessed visually and photographed at harvest date for signs of sunburn.

Observations Chardonnay 22/1/10

LP - Significant sunburn observed on eastern (plucked) side, western (unplucked) side not sunburned

HP - Some sunburn both sides. Most serious sunburn was where shoots were pointing upwards. Where shoots overhang they appeared to provide a sun umbrella effect.

SS - Lower yield due to crop thinned, thinning was labour intensive.

More sunburn than control. More fruit is exposed. Possibly more sunburn on the eastern side.

C - Good leaf cover, very little sunburn either side. Most of the fruit is shaded.

LV - Western (unplucked) side very little sunburn. Significant sunburn on (plucked) eastern side.

HV - Significant sunburn both sides, possibly worse on the eastern side.

BN - Similar to control, very little sunburn.

Parasol ($CaCO_3$) (crop harvested - inconclusive) Product was somewhat blotchy, still some sunburn observed

Kaolin (clay) (crop harvested - inconclusive) More even coverage than parasol

Take home messages:

- Leaf plucking is not advisable on Chardonnay in this climate.
- No difference observed in the level of sunburn due to timing of leaf plucking
- Eastern side exposure was at least as bad as western side exposure in this case.
- Shoot thinning is costly and probably not beneficial in this vineyard
- Upright training such as VSP may not be advisable in this climate for white varieties. Shoot overhang can protect even exposed fruit from serious damage.

Appendix 6: Granite Belt bunch exposure trial Field day handout 10/2/2010

By Ursula Kennedy, Rob Learmonth and Tony Hassall

Introduction

As part of the GWRDC-funded RITA Project Rt08/03-1 "Addressing fruit exposure in Queensland wine grape vineyards," a trial was conducted on Chardonnay and Shiraz grapes in the Granite Belt to look at the effects of various bunch exposure treatments. Demonstration sites were also set up on vineyards at the Scenic Rim and south Burnett.

At today's walk will look at the Chardonnay component of this trial. Below you will also find some observations from the Chardonnay trial harvested at the South Burnett in January, 2010.

Background to the trial

The wine grape growing regions of Queensland are climatically distinct from the majority of other Australian wine growing regions. Queensland has relatively wet growing seasons, often with severe peak heat loads. Queensland also hosts the most northerly and some of the highest altitude vineyards in Australia, which are therefore subject to high ultra violet (UV) radiation exposure, higher than any other grape growing region in Australia.

Therefore the primary purpose of this project is to assess whether a number of currently utilised vineyard canopy management practices are optimal for wine grape production in Queensland, or to show if there are other practices better suited to the regional conditions. The project included vineyard demonstration sites on the South Burnett, and the Scenic Rim, with a replicated trial at the Granite Belt.

Chardonnay and Shiraz were used in the trial as they are the most common white and red wine grape varieties in Queensland. The canopy management and fruit exposure techniques were applied to demonstrate the impacts of these on wine grape quality, including comparison of VSP un-manipulated vines to VSP vines having been leaf plucked, shoot thinned, bird netted and some with a commercial sun screening product ($CaCO_3$ and kaolin clay) applied. Additional features of the trial carried out in the Granite Belt site have included measurements of bunch zone visible and UV light and temperature, while small lot wines are to be produced from these treatments to assess impacts on wine sensory characteristics and stability issues.

Methods

Panels of each variety were subjected to the following treatments:
LP - Leaf plucked on the eastern side only at pea size
HP - Leaf plucked on both sides of the vine at pea size
SS - Shoot thinned at pea size to 1 shoot per 10cm
C - Control
LV - Leaf plucked on the eastern side only at véraison
HV - Leaf plucked both sides at véraison
BN- Bird net was placed over the vine at véraison
Parasol ($CaCO_3$) – Product was sprayed over fruit zone at véraison
Surround (kaolin clay) - Product was sprayed over fruit zone at véraison

Observations from the Granite Belt trial – Chardonnay – 10/02/10

Your activity is to observe the different treatments and provide your assessment of the visual fruit and canopy condition. This fruit is to be harvested on 11/02/10 and analysed for chemical parameters including TSS, pH, titratable acidity and phenolics. Small lot wines will also be produced for further chemical and sensorial assessment, and the results of these will be presented at the DPI&F Winter Wine Grape seminar later in 2010.

You may wish to comment on overall vine health, leaf health, canopy density and fruit exposure, fruit damage (sunburn, rot, split or other), fruit sensorial assessment (ripeness, flavour, seed ripeness, skin thickness etc), berry size and turgidity/shrivel, and any other considerations you deem important such as presence of spray deposits.

LP

HP

SS

C

LV

HV

BN

Parasol ($CaCO_3$)

Kaolin (clay)

Some observations from the South Burnett trial – Chardonnay - 22/1/10

LP - Significant sunburn observed on eastern (plucked) side, western (unplucked) side not sunburned

HP - Some sunburn both sides. Most serious sunburn was where shoots were pointing upwards. Where shoots overhang they appeared to provide a sun umbrella effect.

SS - Lower yield due to crop thinned, thinning was labour intensive.
More sunburn than control. More fruit is exposed. Possibly more sunburn on the eastern side.

C - Good leaf cover, very little sunburn either side. Most of the fruit is shaded.

LV - Western (unplucked) side very little sunburn. Significant sunburn on (plucked) eastern side.

HV - Significant sunburn both sides, possibly worse on the eastern side.

BN - Similar to control, very little sunburn.

Parasol ($CaCO_3$) (crop harvested - inconclusive) Product was somewhat blotchy, still some sunburn observed

Kaolin (clay) (crop harvested - inconclusive) More even coverage than parasol

Take home messages from the South Burnett:

- Leaf plucking is not advisable on Chardonnay in this climate.
- No difference observed in the level of sunburn due to timing of leaf plucking
- Eastern side exposure was at least as bad as western side exposure in this case.
- Shoot thinning is costly and probably not beneficial in this vineyard
- Upright training such as VSP may not be advisable in this climate for white varieties. Shoot overhang can protect even exposed fruit from serious damage.