Swan Hill Wine Region Grape Growers Assoc. Inc.

Australian Government

Grape and Wine Research and Development Corporation

Benchmarking winegrape quality in the Swan Hill region for the 2005 vintage



FINAL REPORT to

GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: RT 04/13-3

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Research Organisation: Scholefield Robinson HORTICULTURAL SERVICES

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Scholefield Robinson
HORTICULTURAL SERVICES

BENCHMARKING WINEGRAPE QUALITY IN THE SWAN HILL REGION FOR THE 2005 VINTAGE

GWRDC Project Number RT 04/13-3

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This report details results of the project "Benchmarking Winegrape Quality In The Swan Hill Region For The 2005 Vintage", which was conducted over the 2004-05 vintage and reported to the Swan Hill Region Grape Growers Association in July 2005.

Acknowledgements

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Summary

A benchmarking study was conducted in Shiraz blocks in the Swan Hill district during the 2005 vintage, providing a comprehensive set of crop measurements against which growers can compare their individual crop management, fruit quality and economic returns.

Some participating growers hoped that the study would reveal aspects of their crop or management that most influenced quality. Instead it highlighted the complexity of grape production, and uniqueness of each site. The benchmarks enabled participants to see clearly that vine blocks must be managed according to the individual needs of a particular block in a particular season.

Contrary to suggestions that smaller berries produce more flavour components per kg, there were no significant correlations between berry weight and quality (colour, phenolics, pH or TA). There was also no significant correlation between crop load and harvest date, or between harvest date and fruit quality.

Fruit from heavier crops had lower phenolics, colour and baumé. Vines pruned to leave more buds had higher bunch numbers and lower phenolics and baumé, although this had not been observed in previous years benchmarking studies.

Fruit quality was not reflected in gross returns. Return was a consequence of bunch number and weight, and varied 3-fold across the sites. Water use also varied 3-fold, and revenue generated ($/ML) from water used varied 6-fold.

Participating growers had hoped that grapes would be made into wine, to provide a clearer link between management, berry components and wine quality. While winemaking would be a costly addition, it would enhance the value of further benchmarking studies.

Participating growers were encouraged to reflect on where their fruit was ranked for each variable measured in the benchmarking study, to support any management decisions. Towards maximising their crop potential, the Swan Hill growers were able to identify those parameters that would provide the greatest benefit to economic returns and crop quality.

Introduction

During the 2002-03 and 2003-3004 seasons, grape growers from the Swan Hill region formed a Shiraz Benchmarking Group and participated in RITA-funded GWRDC projects to benchmark their fruit.

Collation of data from each participating grower had allowed individuals to see how specific blocks on their vineyards had performed when compared against the averages of the region.

In December 2004, the Swan Hill grape growers approached Scholefield Robinson regarding continuing the benchmarking study. Scholefield Robinson had undertaken similar benchmarking at 80 sites across Sunraysia and the Riverland in 2003-04 and was able to include the Swan Hill growers in their 2004-05 program.

The agreed aims of the 2005 benchmarking study were:

- To provide Shiraz growers with information on fruit composition and vineyard attributes that will help them manage their vineyards in future to achieve a desired outcome.
- To provide growers with information on returns per hectare, megalitres of water used per hectare, and returns per megalitre so that they can manage their inputs to optimise their outcome in the vineyard.
- To provide growers with a context of performance by benchmarking a number of growers and comparing outcomes. It is important that growers know where in the spectrum they sit on a number of performance indicators.

The study was subsidised by the Grape and Wine Research and Development Corporation (GWRDC). Participating vineyard managers each contributed $100 for each patch they included in the study, to cover costs of travel to and from sites, sampling, laboratory analyses of fruit, data collation and the benchmarking report.

This report describes the methods used for collecting and collating the 2005 Swan Hill data, and the results and conclusions of the study. The results of the benchmarking study were reported to the Swan Hill growers in July 2005.

Materials and Methods

Site selection

Eleven commercial vineyards participated in the 2004-2005 Swan Hill benchmarking study. To protect their privacy, the vineyards are not listed.

Fifteen shiraz blocks from the 11 vineyards were included in the study. In addition to these 15 blocks, five Cabernet Sauvignon and three Merlot blocks were assessed.

Sampling and site data

At harvest, participants sampled 50 bunches per patch, according to a protocol provided by Scholefield Robinson. Participants also provided site and crop details for each patch.

Canopy scores were measured by Scholefield Robinsons during the 2004-05 season.

Laboratory analysis

Laboratory analysis of grape composition was conducted at laboratories of Vine Science (Red Cliffs) and Mildura Fruit Juices (Mildura).

Data analysis

The data were compared by ranking, analysed by drawing correlations between each pair of variables, and by using principle components analysis to account for variation in the data. The terms R^2 and *P*-value appear in this report to describe the significance of results from a statistical perspective. A simple explanation of these terms is provided in section 0 on page 5.

Benchmarking

Results from each property were compared, to provide some benchmarks for the Swan Hill district and for the 2005 season.

The growers were provided with graphs flagging their individual vineyard results among the larger data set from Swan Hill. Results from Sunraysia vineyards were also included in graphs provided to the Swan Hill growers, to provide a larger pool against which individual blocks could be compared.

Table 1: Details provided participating vineyard managers, measured or calculated.

Variable	*Unit*	*Method for calculating or scoring the variable*
Site details provided by participating vineyard managers		
Variety	type	Shiraz, Merlot or Cabernet Sauvignon
Area	hectares	Size of the patch being studied
Planting distances	metres	Distance between vines and rows, to calculate vines/ha.
Rootstock	type	
Irrigation system	type	
Vine age	years	
Winery		Winery to which the fruit will be sold
Pruning methods	1-5 scale	1 refers to hard pruning leaving few buds and a score of '5' refers to minimally pruned vines.
Provided after harvest by participating vineyard managers		
Harvest date	date	From weighbridge docket
Yield 2003-04	tonnes/ha	Tonne/ha harvested in previous vintage
Yield 2004-05	tonne/ha	Tonne/ha harvested in current vintage
Price	$/tonne	As valued by the winery
Water use	ML/ha	Water applications up until harvest
Assessed or measured at harvest		
Bunch weight	grams	Average of 50 bunches sampled randomly from across the vineyard at harvest, reflecting the range in bunch sizes.
Bunch number per metre	bunches/m	Derived from bunch weight, yield and vine spacing
Berry weight	grams	Average of 500 berries taken from the 50 bunch sample
Leaf area per linear metre of row	m^2/m	Estimated by throwing a plastic Perspex sheet with grid marks over the canopy in 10 randomly selected parts of the patch, to approximate photosynthetic area of the canopy.
Canopy score	1-10 scale	A relative score of bunch exposure and canopy vigour.
Colour	mg/g	Measured using a modified Iland method and UV-vis spectrophotometer at Vine Sciences
Baumé	°Be	Measured by digital bench refractometer (±0.2 Brix) at Vine Sciences.
Phenolics	μmol/g	Measured by UV-vis spectrophotometer at Vine Sciences
pH		Measured at Mildura Fruit Juices
Titratable acidity (TA)	grams	Measured at Mildura Fruit Juices
Juice extraction	% juice yield	Weight of juice relative to grapes when ½kg grapes is subjected to a standardized crushing pressure to extract the juice.
Crop load	kg/m^2	Balance of fruit to canopy, derived from tonne/ha ÷ leaf area (m^2) per hectare (eliminating influence of planting density).
QIN score	1-100	A single value derived from colour, baumé, pH and TA. Higher scores are better. Designed as a relative index of berry composition that will remain consistent irrespective of grading by particular wineries, which fluctuates with demand and supply.
Returns per hectare	$/ha	Refers to gross revenue/ha
Returns per megalitre	$/ML	
Growing degree days		((Max + min daily temp - 10) ÷ 2) × days in growing season.

Statistics explained

Data from this benchmarking study was compared using standard statistical correlations.

Correlations between the parameters were explored as a way of confirming whether there were relationships between different variables, for example between pruning method and colour, or harvest date and pH or baumé.

Two terms, R^2 and *P*-value, are often used by statisticians to describe certainty of a relationship between variables. As these terms may be unfamiliar to readers, we offer the following explanations to assist with understanding the results.

R^2 value

An R^2 value tells us the strength of the relationship between two variables.

- An R^2 value that is close to 1 indicates that there is a very strong positive relationship between two variables. As one increases, so does the other. An example might be the strong positive relationship between increasing temperatures and increasing vine growth.
- An R^2 value that is close to -1 indicates that there is a very strong negative relationship between two variables. As one increases, the other decreases. An example might be the strong negative relationship between increasing salinity and decreasing vine growth.

An R^2 value that is close to zero, whether it be a negative or positive value, indicates that there is very little relationship between the two variables.

P-value

P-values describe the probability that an observation was not due to chance but was due to a true relationship between two variables, ie that one variable had an influence on the other.

- If the P-value is 0.001, this means there is only a 1 in a 1000 probability that the observed relationship is due to chance.
- If the P-value is 0.01, this means that there is a 1 in a 100 probability that the observed relationship is due to chance
- If the P-value is 0.05, there is a 5 in a 100 probability that the observed relationship is due to chance.
- If there is more than a 5 in 100 probability that the observation occurred by chance (this would be written as $P>0.05$) then statisticians usually say that the relationship between the two variables was ‘not significant’

Results

Table 2: Vineyard details, canopy measurements and berry composition recorded from Swan Hill shiraz blocks in 2004/05. (*Italicised values in brackets include the combined data set from Swan Hill and Sunraysia*).

Variable	*Lowest*		*Highest*		*Average*	
Gross Returns ($/ha)	$3,500	*($1,705)*	$14,082	*($24,419)*	$9,554	*($10,645)*
Water use (ML/hectare)	1.8	*(1.8)*	6	*(11.5)*	4.42	*(5.67)*
$ returns per megalitre	$697	*($173)*	$4,107	*($4,667)*	$2,356	*($2,166)*
Vines per hectare	1389	*(1244)*	2083	*(2083)*	1569	*(1632)*
Vine age (years)	6	*(5)*	30	*(30)*	11	*(9.35)*
Leaf area per linear metre of row (m2/m)	2.2	*(1.8)*	3.2	*(3.2)*	2.61	*(2.38)*
Canopy score (1-5)	4	*(4)*	7	*(7)*	5.39	*(5.11)*
Bunch weight (g)	74	*(64)*	118	*(144)*	96	*(102.6)*
Berry number	72	*(45)*	107	*(148)*	85.4	(*92.7)*
Berry weight (g)	0.71	*(0.71)*	1.39	*(1.46)*	1.14	*(1.13)*
Bunch number	76.4	*(38)*	161.1	*(199)*	120	*(110)*
Harvest date	1st March	*(9th Feb)*	28th April	*(28th April)*	18th March	*(16th March)*
Tonne/ha	11.45	*(7.09)*	23.47	*(29.17)*	17.1	*(17.56)*
Tonne/100m	3.3	*(1.95)*	8.2	*(9.77)*	5.7	*(5.52)*
Crop load (kg/m^2)	1	*(0.96)*	3	*(4.07)*	2.2	*(2.33)*
Colour (mg/g)	0.92	*(0.92)*	1.6	*(1.6)*	1.28	*(1.3)*
Phenolics (µmol/g)	0.88	*(0.88)*	1.36	*(1.36)*	1.1	*(1.1)*
Baumé (°Be)	13.3	*(13.1)*	15.6	*(15.6)*	14.3	*(14.0)*
pH	3.7	*(3)*	4.3	*(4.3)*	3.96	*(3.75)*
Titratable acidity (grams)	4	*(4)*	6.9	*(7.3)*	4.6	*(5.4)*
QIN	59	*(59)*	93	*(96)*	75	*(79)*
Juice extraction (%)	43	*(40)*	63	*(63)*	51.7	*(49.9)*

Data recorded from the Swan Hill shiraz blocks in 2004/05 are summarised in Table 2. showing the average and also the maximum and minimum values recorded from the Swan

Hill vineyards, but also the average maximum and minimum of the combined Sunraysia and Swan Hill regions.

The following charts, explanations and interpretations were provided to the Swan Hill grower group at an end-of-season workshop in 2005, and as an individual property report to each participant in the benchmarking study.

Shiraz berry characteristics

Colour

'Berry colour' was a measure of the pigment found in the skins of red grapes. It was measured using a calibrated spectrophotometer and expressed in milligrams of anthocyanin per gram of berry. Usually, higher levels of colour in the fruit of red varieties leads to higher wine quality after fermentation. Colour is one of the best indicators of wine quality that growers have at present.

Colour scores from Swan Hill shiraz blocks ranged from 0.92 to 1.6 mg/g, and averaged at 1.28 mg/g. When compared against the larger data set including Sunraysia, Swan Hill vineyards produced shiraz with the least and most colour.

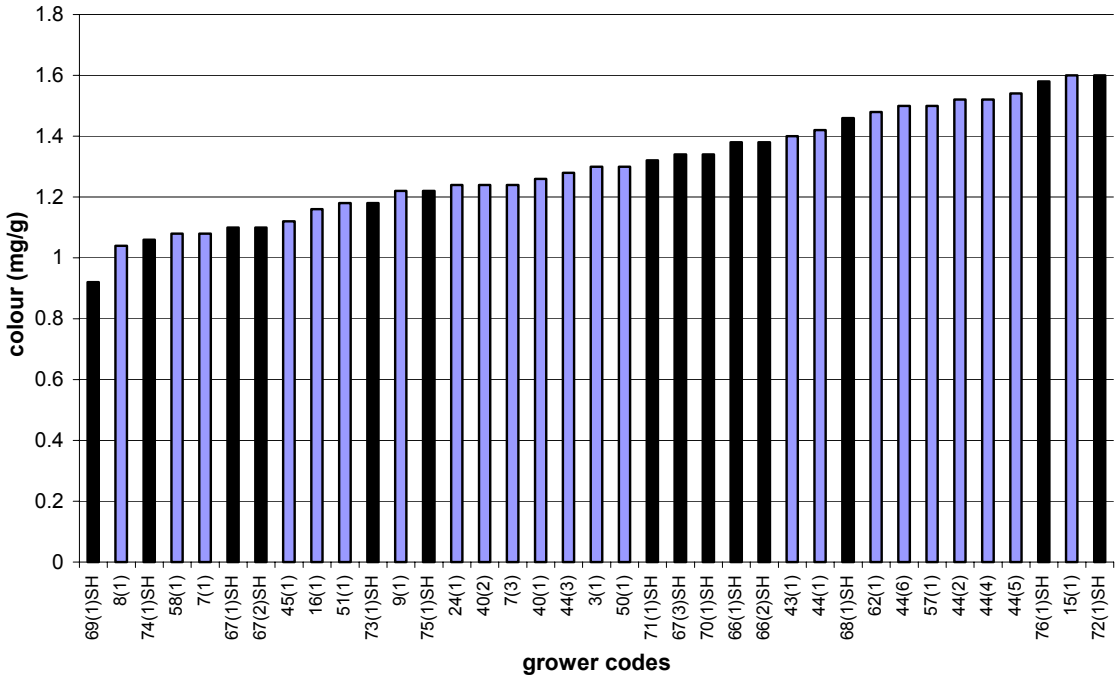


Figure 1: Colour scores from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Colour ranged from 0.92 to 1.6 mg/g, and averaged at 1.28 mg/g.

Phenolics

Phenolics are a large group of compounds present in grapes, that belong to a general group called secondary metabolites. Phenolics include tannins, anthocyanins (colour) and flavour compounds. The formation of phenolics in the grapes is therefore important for the winemaking process, and for development of colour intensity, aromas and flavours, and hence an indicator of quality.

Phenolics ranged from 0.88 to 1.36 μmol/g, and averaged at 1.09 μmol/g. Fruit from Swan Hill vineyards was represented at both the high and low end of the range.

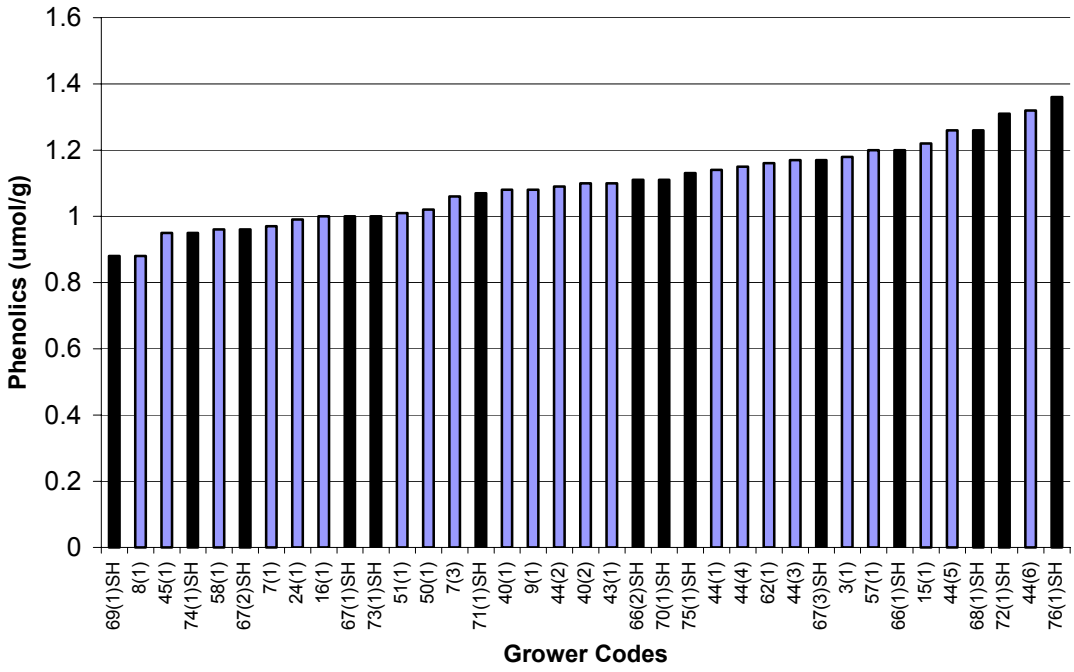


Figure 2: Phenolics scores from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Phenolics ranged from 0.88 to 1.36 μmol/g, and averaged at 1.09 μmol/g.

Acidity (pH and titratable acidity -TA)

pH is a measure of the concentration of hydrogen ions in a solution. Strong acids will give up more hydrogen ions into solution, causing a drop in pH.

Titratable acidity (TA) is the measure of free and bound hydrogen ions. The two main acids present in wine grapes are malic and tartaric acid.

In wine, the values for TA and pH have no direct or predictable relationship.

In the 2005 season, TA in fruit from the Swan Hill growers was relatively low, possibly because samples were harvested late in the season. Correspondingly, pH levels in fruit from the Swan Hill sites tended to be high relative to the wider benchmark, including Sunraysia sites.

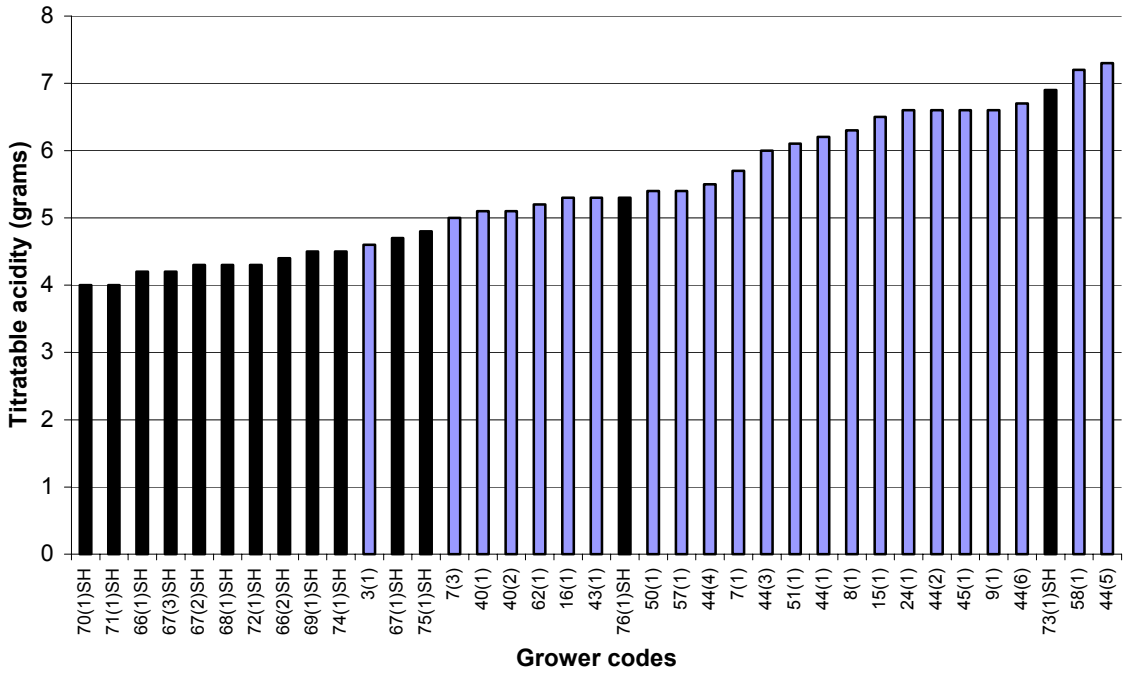


Figure 3: TA scores from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. TA from Swan Hill sites ranged from 4-6.9 g, averaging at 4.6 g.

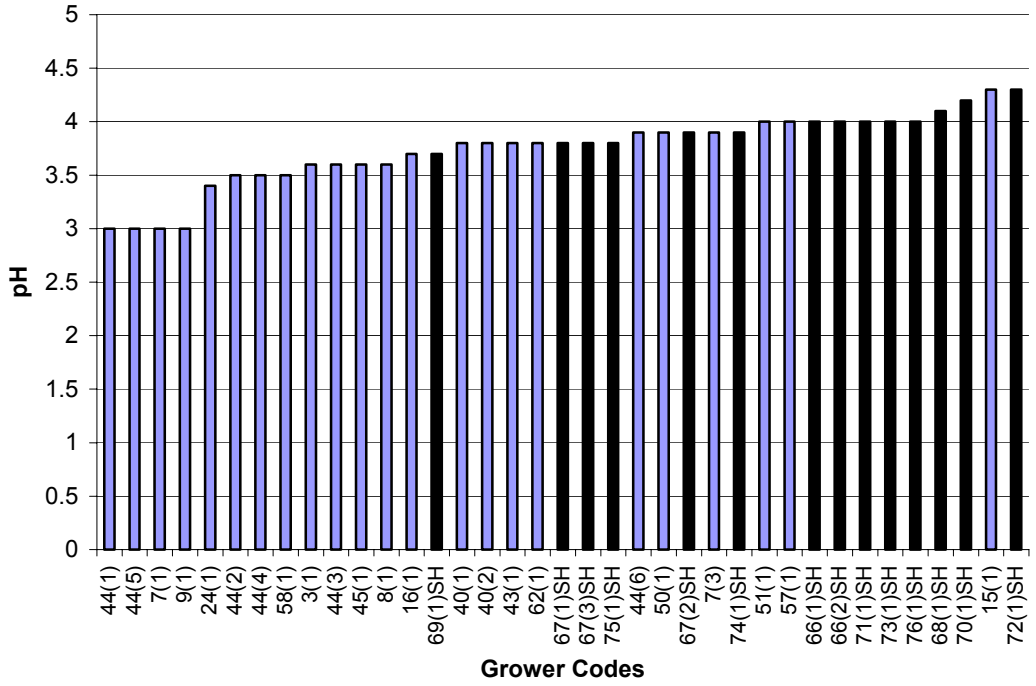


Figure 4: pH scores from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. pH from Swan Hill sites ranged from 3.7-4.3, averaging at 4.

Juice extraction

Although wineries purchase grapes, what they really purchase is grape juice plus essential colour and flavour components from the skins, to make wine. The amount of juice in each tonne of fruit may therefore become an important measure of vineyard performance from the wineries' perspective.

Juice extraction also helps us to assess the overall quality of the fruit. For example, a high QIN score may be partly attributed to the dehydration of the fruit on the vine and this will be reflected in a low juice extraction score. The method used to extract juice was to mimic what happens at the crusher in a winery. Juice extraction was calculated on the volume of juice divided by the gross weight of the sample. It is the relative ranking of the sample (benchmarking) against others in the group that is important, not the actual value measured.

Juice extracted from Swan Hill fruit ranged from 43% to 63%, and averaged at 52%.

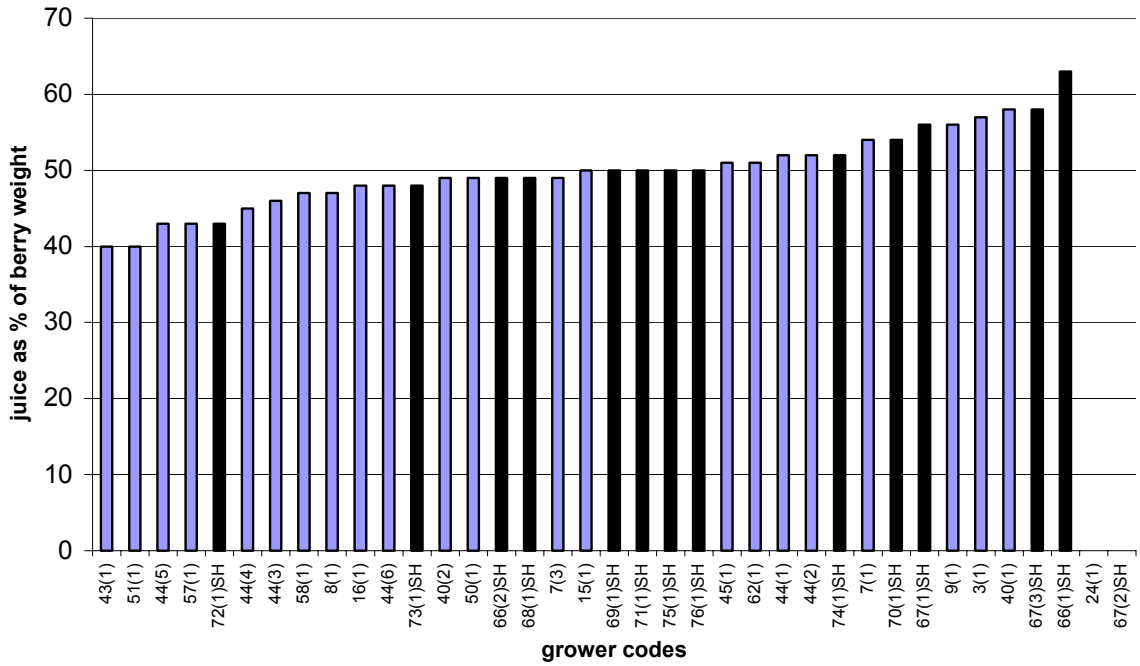


Figure 5: Juice extraction scores from Swan Hill Shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Juice extraction from Swan Hill sites ranged from 43% to 63%, averaging 52%.

Baumé

Baumé of fruit from the Swan Hill sites is high, indicative of well ripened fruit and concentrating of sugars.

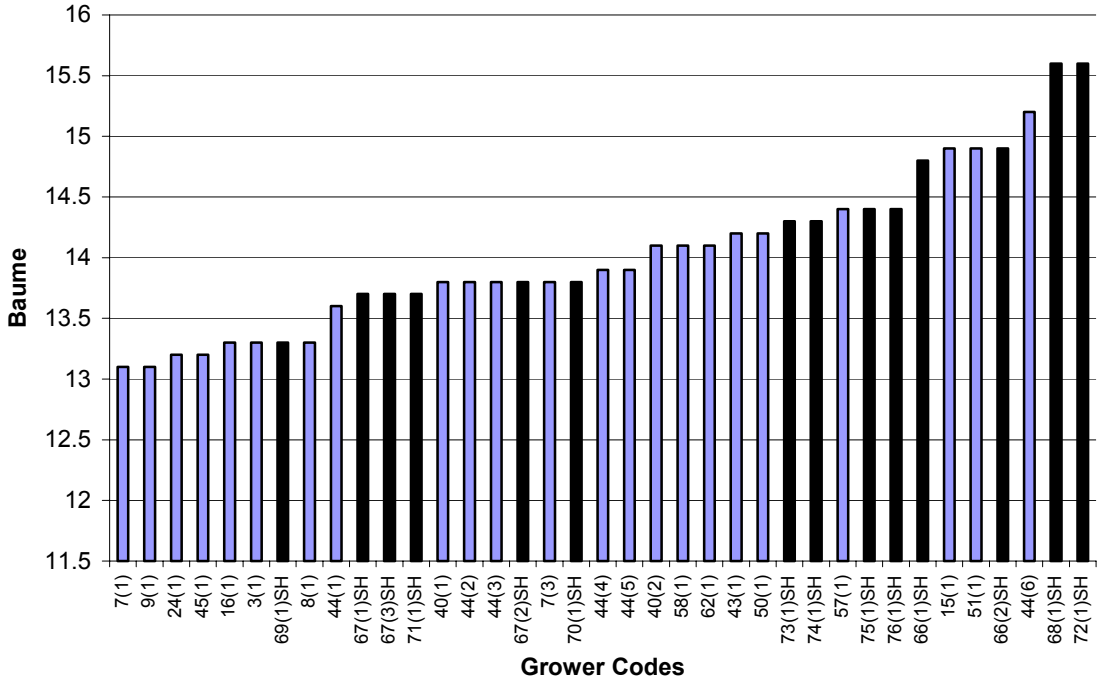


Figure 6: Baumé scores from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Baumé from Swan Hill sites ranged from 13.3 – 15.6, averaging 14.3.

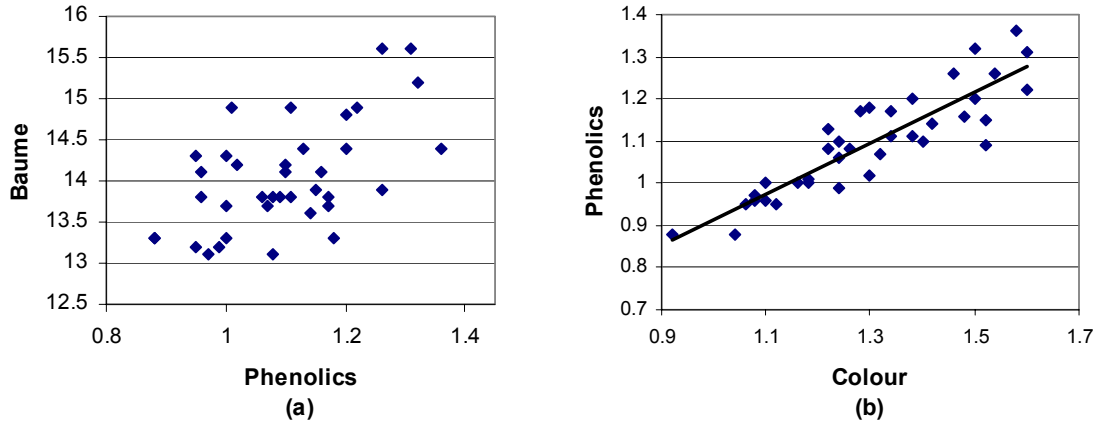


Figure 7: Correlations between (a) baumé and phenolics (R^2 = 0.588, *P* < 0.001) and (b) colour and phenolics (R^2 = 0.889, *P* = <0.001).

Comparisons between baumé and phenolics and between colour and phenolics are plotted in Figure 7, illustrating the relationship between these variables[1]. As sugar increases in the fruit, so do phenolics. As phenolics increase in fruit, so does colour.

Quality Indicator Number (QIN) score

Fruit quality is variously determined by measuring Baumé, colour, pH, acid and phenolics.

Scholefield Robinson has combined the first four of these factors into a single index called QIN, to provide a relative but objective measure of quality on a scale from 1-100. The higher the QIN score, the higher the quality.

Evaluating the potential for a quality index (QIN) is the focus of a current 2-year research project being undertaken by Scholefield Robinson, funded by AusIndustry. The project aims to provide a more accurate calculation of the QIN score using the measured components of berry composition.

The Swan Hill QIN scores are distributed across a wide range, from 59 - 93, averaging at 75.

Swan Hill Site 76 was only slightly behind Sunraysia site 44. Site 44 has consistently out-performed all vineyards during the five years that the benchmarking project has run for.

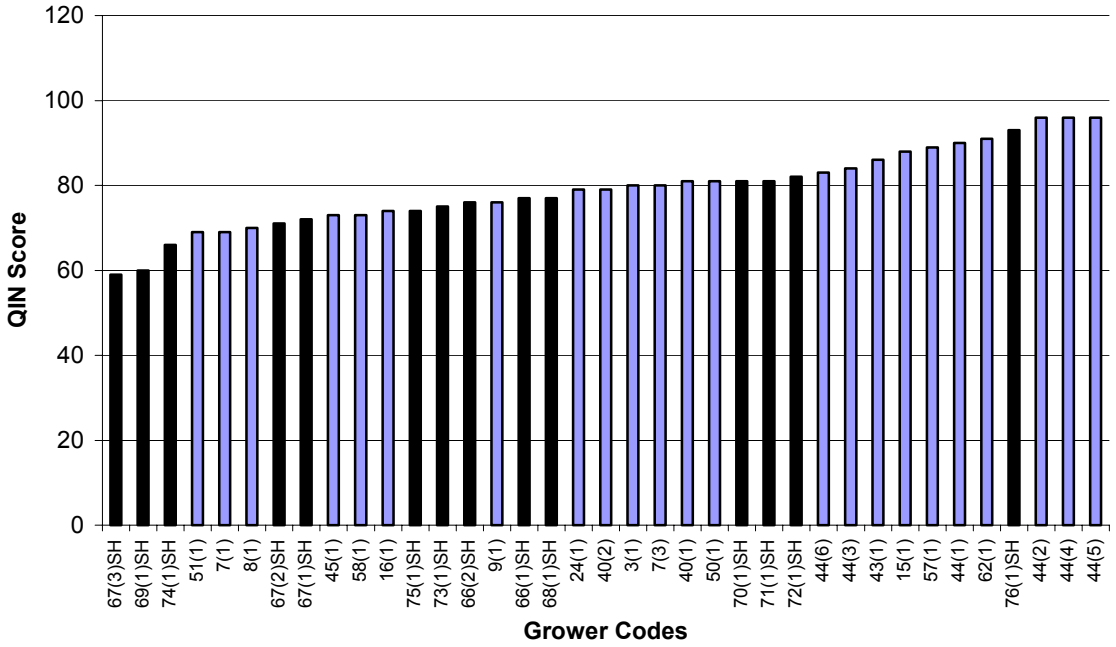


Figure 8: QIN scores from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. QIN from Swan Hill sites ranged from 59 - 93, averaging at 75.

[1] See page 5 for an explanation of R^2 value and *P*-value.

Shiraz crop and canopy characteristics

Yield and Crop Load

Swan Hill vineyards were evenly distributed based on their shiraz yields (tonne/ha) across a wide range, from 11 to 23 tonnes/ha, and averaging 17 tonnes/ha.

Because of variation in vine ages and canopy sizes, comparison of yield cannot meaningfully be correlated against quality. Crop load describes the weight of crop produced by the leaf area, rather than ground area, and as such is a more valuable measure of vine productivity to compare against quality parameters.

Crop load is calculated by combining leaf area figures with total tonnes per hectare and is expressed as kilograms of fruit produced per square metre of canopy (kg/m^2).

A comparison between the rankings of site codes in the yield chart and the crop load chart shows that there is some shift in the apparent production based on crop load rather than tonne/ha.

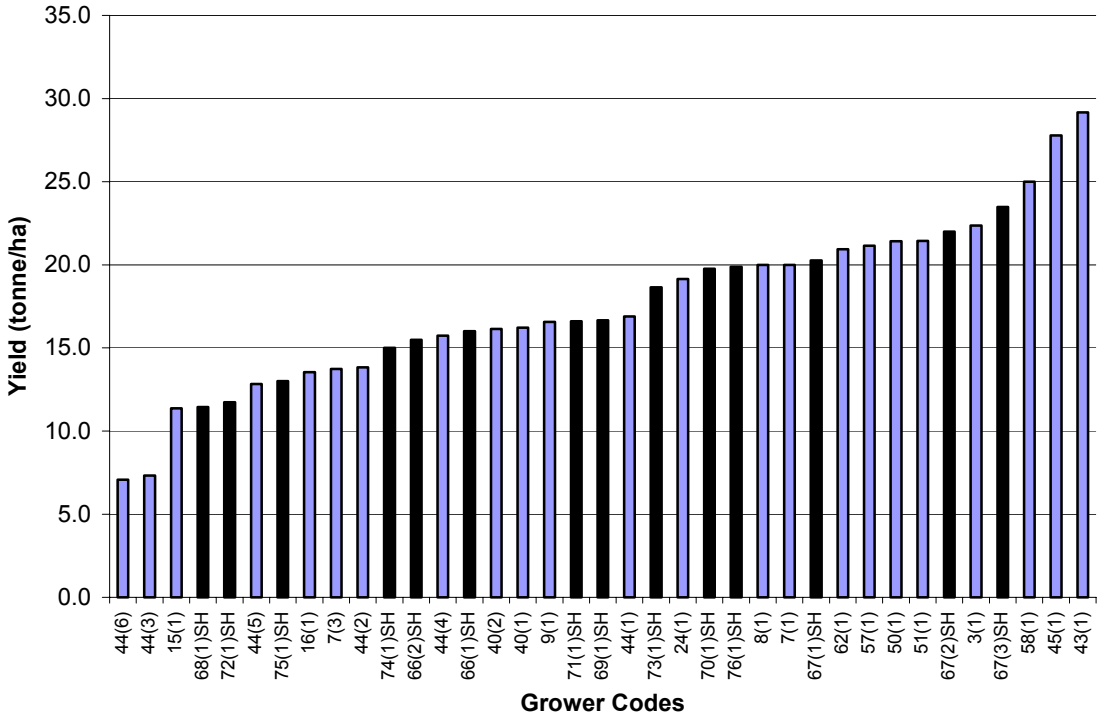


Figure 9: Yields from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Yield from Swan Hill sites ranged from 11 to 23 tonne/ha, averaging at 17 tonne/ha.

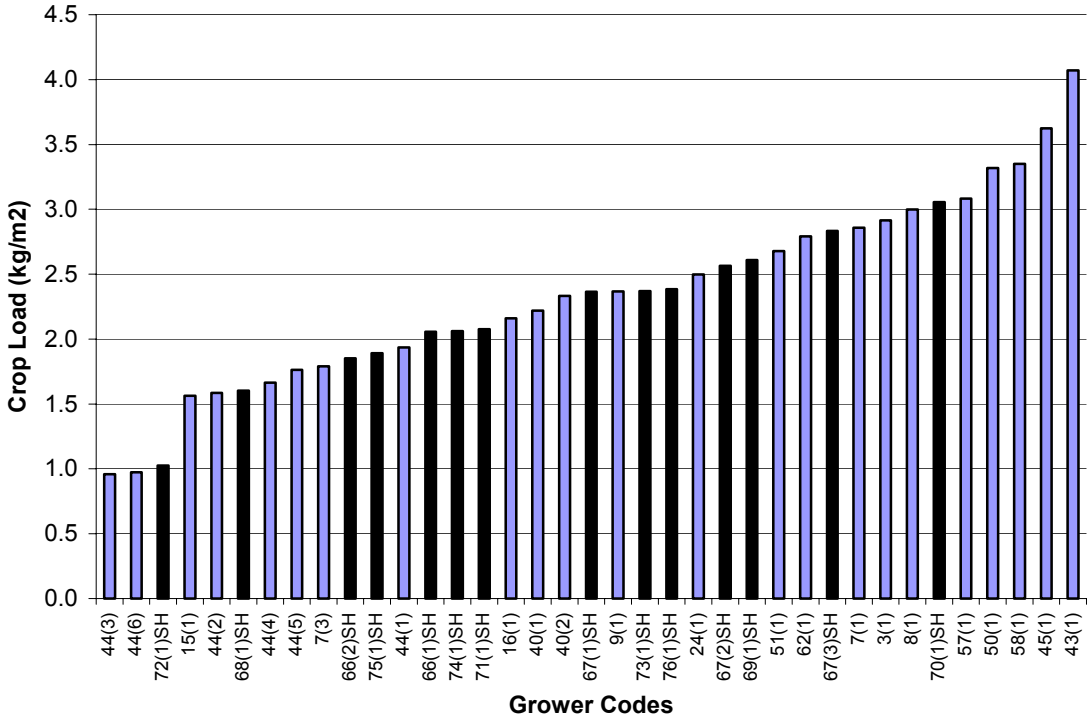


Figure 10: Crop load scores from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Crop load from Swan Hill sites ranged from 1 – 3 kg/m^2, averaging at 2.2 kg/m^2.

A relationship between crop load and quality

Comparing the crop load data against the quality data shows a tendency, at these sites, for fruit from larger crops to have lower phenolics, colour and baumé (Table 3).

The best quality fruit came from sites with crop loads between 1 and 1.8 kg/m^2, equivalent to 5.5 - 10 cm^2 of leaf area per 1 gram of fruit. This is similar to the ratio of 7 – 10 cm^2 of leaf area per gram of fruit described by Jackson and Lombard (1993) as being ideal for maximising sugar production. It is lower than the ratio of 12 cm^2 per gram of fruit recommended by Richard Smart (Smart and Robinson, 1991).

Table 3: Correlation coefficients and p-values for correlations between crop load and grape quality measures.[2]

Correlation between crop load (kg/m ^{2}) and ….	*R^2 value for the correlation*	*Significance level (P-value)*
Phenolics	R^2 = - 0.492	P = 0.002
Colour	R^2 = - 0.406	P = 0.013
Baumé	R^2 = - 0.419	P = 0.01

The correlations are shown in Figure 11.

[2] See page 5 for an explanation of the R^2 value and *P*-value.

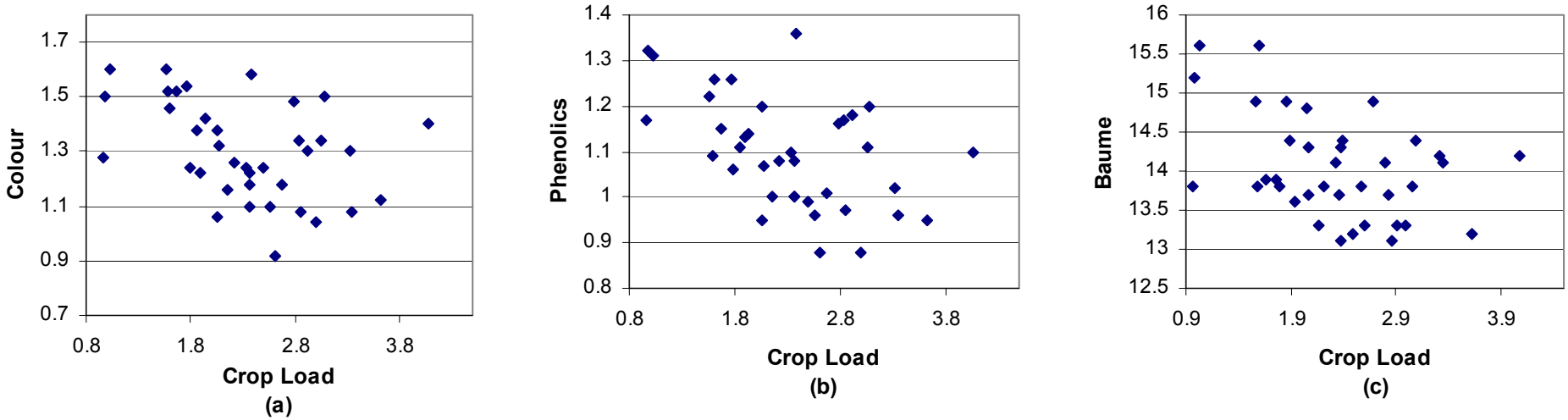


Figure 11: Plots (a) – (c) showing relationships between crop load and colour, phenolics and baumé. Note that the scales on the axis do not begin at zero. R^2 values and P-values are shown in Table 3.

Bunch number and bunch weight

Bunch number and bunch weight make up total yield. Both these parameters were calculated to enable growers to assess the effects of their pruning, irrigation and nutrient management on the volume of the crop and on the final fruit quality. Bunch number is expressed as the number of bunches per metre of row.

Bunch numbers in Swan Hill sites ranged from 76 – 161, averaging at 120. Average bunch weights from Swan Hill sites ranged from 74 – 118g and averaged across all sites at 96g.

Generally, low bunch numbers result from hard pruning. Young vines also naturally produce low bunch numbers and large berries.

Leaving more buds on the vine at pruning normally results in higher bunch numbers per metre of row, and smaller bunches. The tendency towards this inverse relationship between bunch number and bunch weight is evident from comparing the ranking of grower codes in the charts of bunch weight and bunch number. Note however that there are exceptions, for example site 43(1) produced a high bunch number with around average bunch weight.

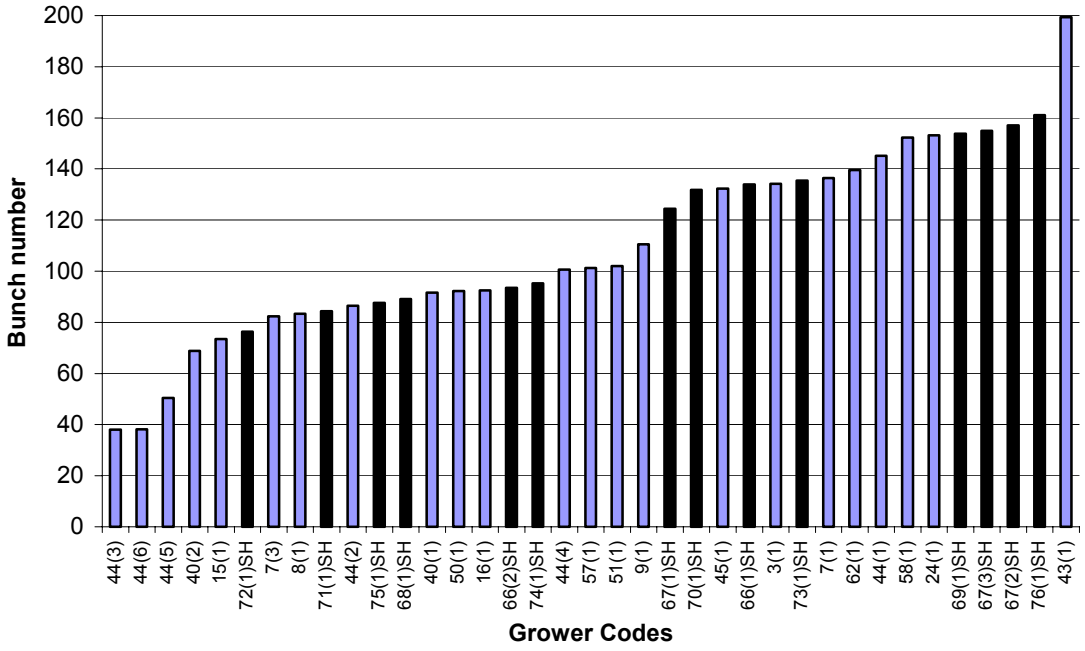


Figure 12: Bunch numbers (bunches per metre row) in Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Bunch numbers in Swan Hill sites ranged from 76 – 161, averaging at 120 bunches per metre.

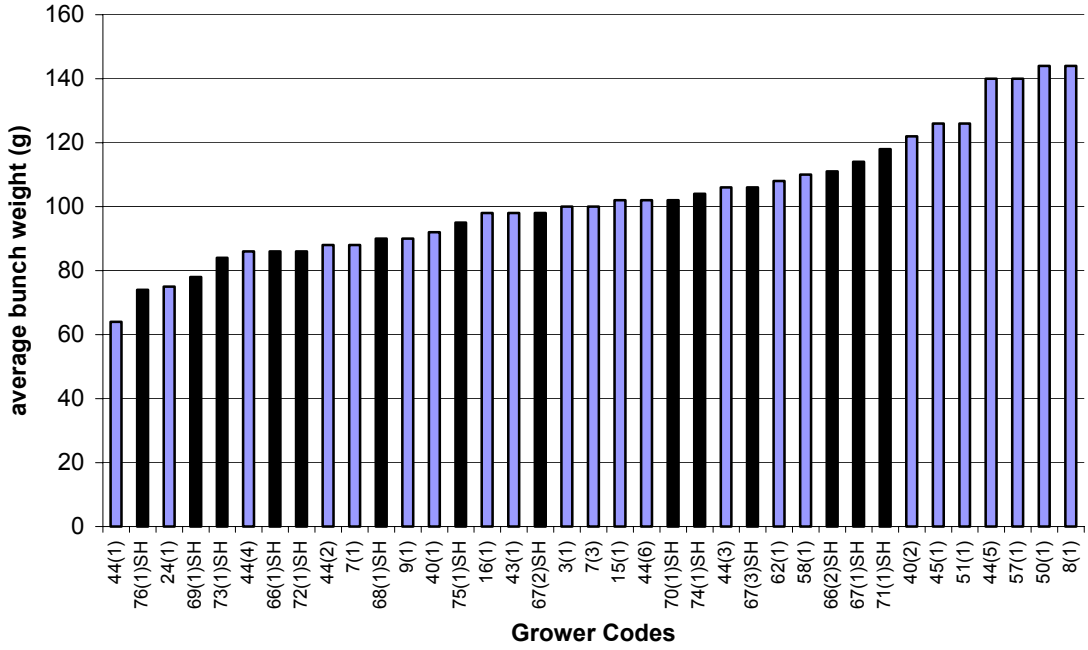


Figure 13: Average bunch weights in Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Average bunch weights from Swan Hill sites ranged from 74- 118 g, and averaged across all sites at 96g.

Pruning

The way vines are pruned determines the number of buds remaining in the canopy, the spatial positioning of the fruiting wood and the likely vigour of the shoots in Spring.

- Hand pruning to short spurs, spaced far apart, often results in vigorous shoots, big bunches and relatively low yields per hectare.
- Mechanical hedging, coupled with hand clean-up to take out wood that was missed by the hedger, is a common method of pruning vines. Mechanical hedging results in high bud numbers and generally higher yield than hand-pruned vines, although continual use of mechanical hedgers without regular substantial clean up can result in congested canopies.
- Minimal pruning, currently less common than mechanical hedging in winegrapes, is an efficient method for producing winegrapes in the Swan Hill region when managed with appropriate irrigation and nutrition.

The Swan Hill sites were classified from 1-5 according to the number of buds left on the vine after pruning. The proportion of growers using each approach is summarised in Table 3.

Sites that were pruned to leave more buds (ie had higher pruning codes) had higher bunch numbers and also higher canopy scores. Conversely, pruning to leave more buds lead to an overall reduction in phenolics and baumé (Table 5). Note, however that these correlations have not been observed consistently in previous years benchmarking studies.

Table 4: Relative bud numbers remaining after pruning using different techniques, and the proportion of the Swan Hill sites managed using each technique.

Code	*Number of buds remaining*	*Explanation of pruning*	*Frequency**
1	Low numbers	Hand pruned, 2-bud spur	12
2	Low to medium numbers	Mechanical hedging or boxing with quite hard clean up	7
3	Medium numbers	Mechanical hedging or boxing with medium clean up	8
4	Medium to high numbers	Mechanical hedging or boxing with minimal clean up	5
5	High numbers	Minimal pruned	2

* Frequencies include both the Swan Hill and Sunraysia benchmarking sites.

Table 5: Correlation coefficients and p-values for correlations between pruning and other canopy or crop measures

Correlation between Pruning Code (1-5) (ie bud number) and ….	*R^2 value for the correlation*	*Significance level (P-value)*
Number of bunches per metre row	R^2 = 0.435	P = 0.010
Canopy score	R^2 = 0.428	P = 0.012
Phenolics	R^2 = -0.348	P = 0.043
Baumé	R^2 = -0.486	P = 0.004

Berry weight

Berry weight was determined by weighing a sub-sample of 500 berries, from 50 bunches taken across the block and calculating the average berry weight, expressed in grams.

Berry weights from Swan Hill sites ranged from 0.71 g to 1.39 g, averaging 1.14 g.

It is often suggested that because smaller berries have a greater skin to flesh ratio, they will therefore have greater concentrations of colour and flavour compounds. However, grape quality cannot be assumed from berry size, and in the data from this benchmarking study there were no significant correlations between berry weight and colour (P=0.62) or phenolics (P=0.53) or pH (P=0.98) or TA (P=0.079).[3]

Lack of correlation between berry size and quality is partly explained by the strongly inverse relationship between berry weight and berry number, ie bunches with smaller berries tended to have more berries per bunch (R^2 = -0.6, P<0.001). Comparing between Figure 14 and Figure 15 shows that inverse relationship.

During the five years that benchmarking has been conducted in this region there were only two years when there was a relationship between berry weight and colour. In 2001 there was a negative correlation (colour decreased with increasing berry weight) and in 2000 there was a positive correlation (colour increased with increasing berry weight).

Note that Sunraysia site 44, which had the highest QIN scores in the study, had high berry weights and relatively few berries per bunch.

[3] See page 5 for an explanation of R^2 value and P-value.

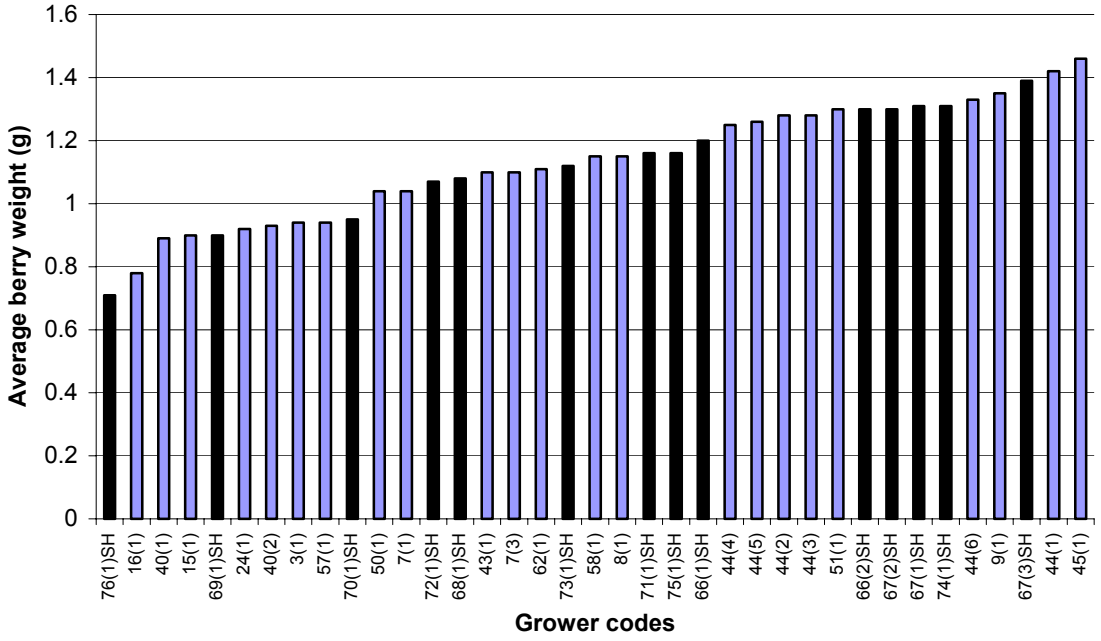


Figure 14: Berry weights (g) from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Berry weights from Swan Hill sites ranged from 0.71 g to 1.39 g, averaging 1.14 g.

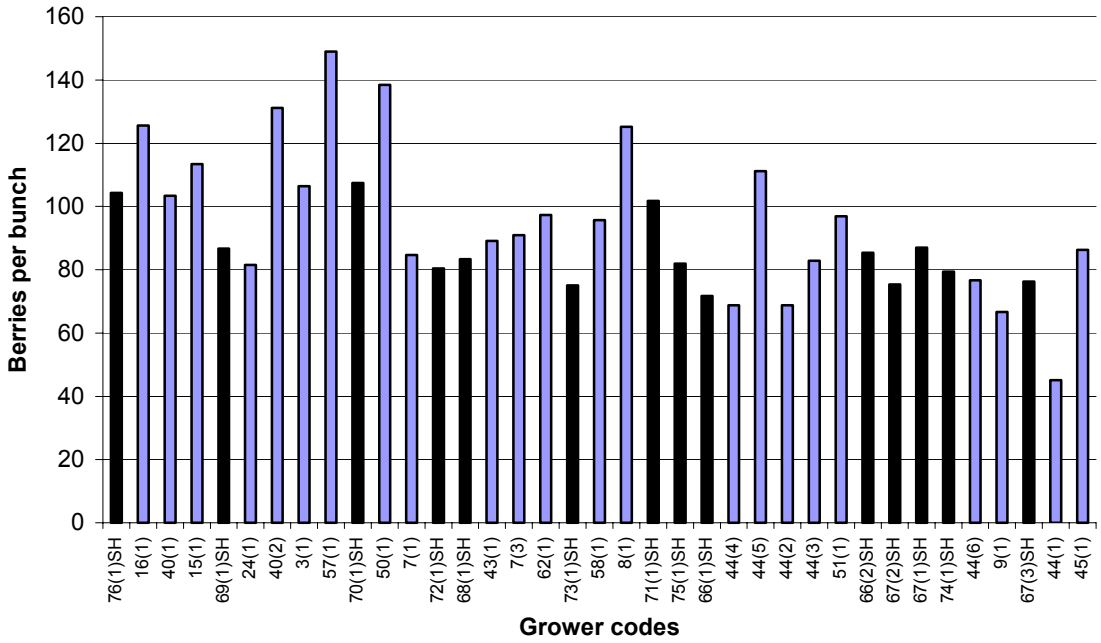


Figure 15: Number of berries per bunch from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Berry number from Swan Hill sites ranged from 72 to 107, averaging 85 berries per bunch. The grower codes are ranked according to berry weight rather than berries per bunch, to allow for direct comparison with Figure 14.

Canopy leaf area and 'canopy score'

The surface area of the vine canopy is an important factor in determining the capacity of the vine to ripen the fruit between veraison and harvest. The leaf area was measured by placing a plastic sheet over the canopy to imitate its shape and size and approximate (on a relative scale) the surface area intercepting sunlight.

The leaf area is often a reflection of how the vines were pruned in winter and managed in early spring when cane growth was at its maximum. Leaf are is expressed as square metres of leaf area per linear metre of row (m^2/m).

Canopy leaf area needs to be in balance with the amount of fruit within that canopy. Vines carrying a large amount of fruit with only a relatively small canopy will struggle to ripen the crop. A canopy with large leaf area but small crop will become too vigorous, excessively shading the fruit.

In order to record the structure of the canopy, and the degree to which the fruit was exposed to light, a scoring system was developed.

- Very open canopies with low vigour, short canes and high fruit exposure were scored between 1 and 3.
- Very dense, shady, congested canopies with very low fruit exposure we scored between 7 and 10.
- Canopies considered to be in balance with good cane vigour, open structure, dappled light and average exposure of bunches were scored between 4 and 6. The ideal canopy was scored 5.

The grower codes in Figure 17 (canopy scores) are ranked according to the leaf areas shown in Figure 16 to allow a direct comparison to illustrate that while canopy score is correlated with leaf area, it provides a separate measure.

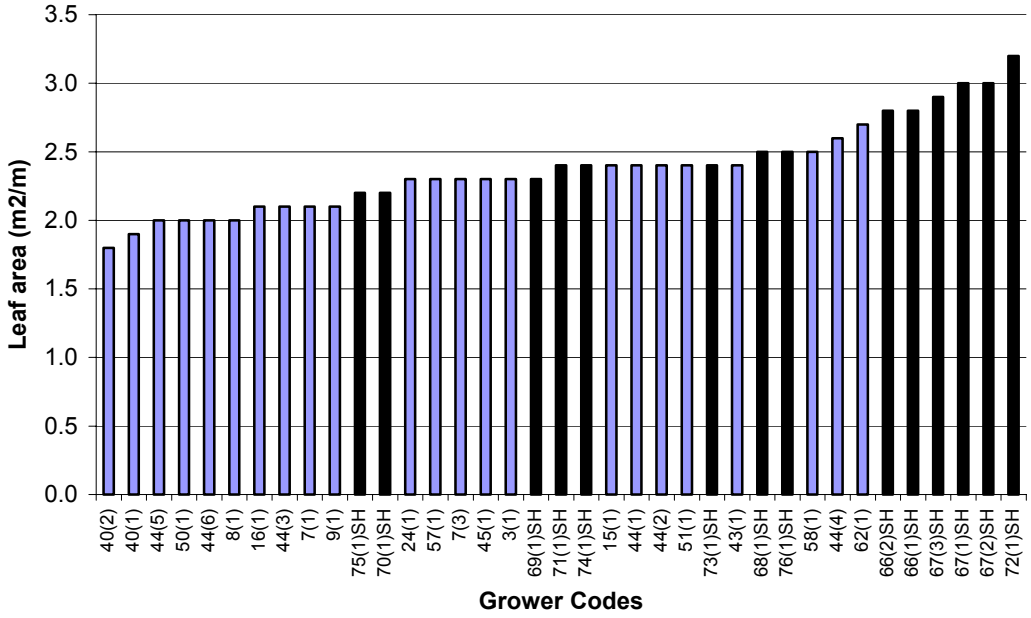


Figure 16: Leaf areas (m^2/m) in Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Leaf areas from Swan Hill sites ranged from 2.2 to 3.2 m^2/m, averaging 2.6 m^2/m.

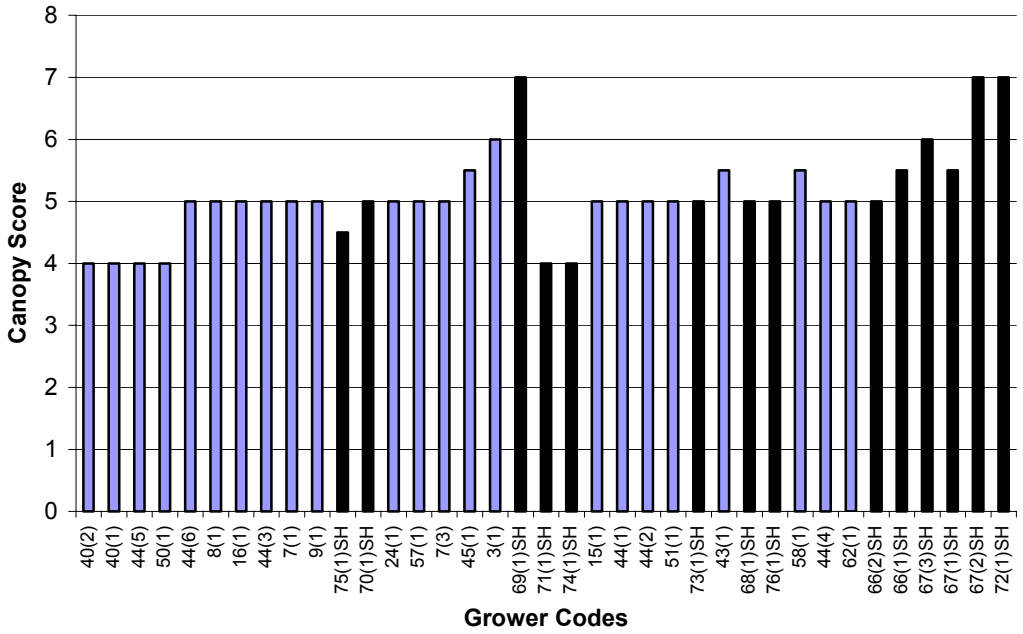


Figure 17: Canopy scores from Swan Hill shiraz blocks are shown as black bars. The Sunraysia data are shown as blue bars. Canopy scores from Swan Hill sites ranged from 4 to 7, averaging at 5.4.

Seasonal characteristics

Shiraz harvest date

Wineries often say that fruit that is harvested early in the season makes the best wine. Their rationale is not clear, although colour and flavour components do decline if fruit hangs for a prolonged period.

Vines with high crop loads (small canopy and large crop) may struggle to reach target baumé, so that fruit may have to stay on the vine until late in the season.

Although the date of harvest of a patch of grapes does not reflect the maturity for that fruit every season, it can provide a general indication of the relative crop loads and perhaps a comparison between vineyard sites and rootstocks.

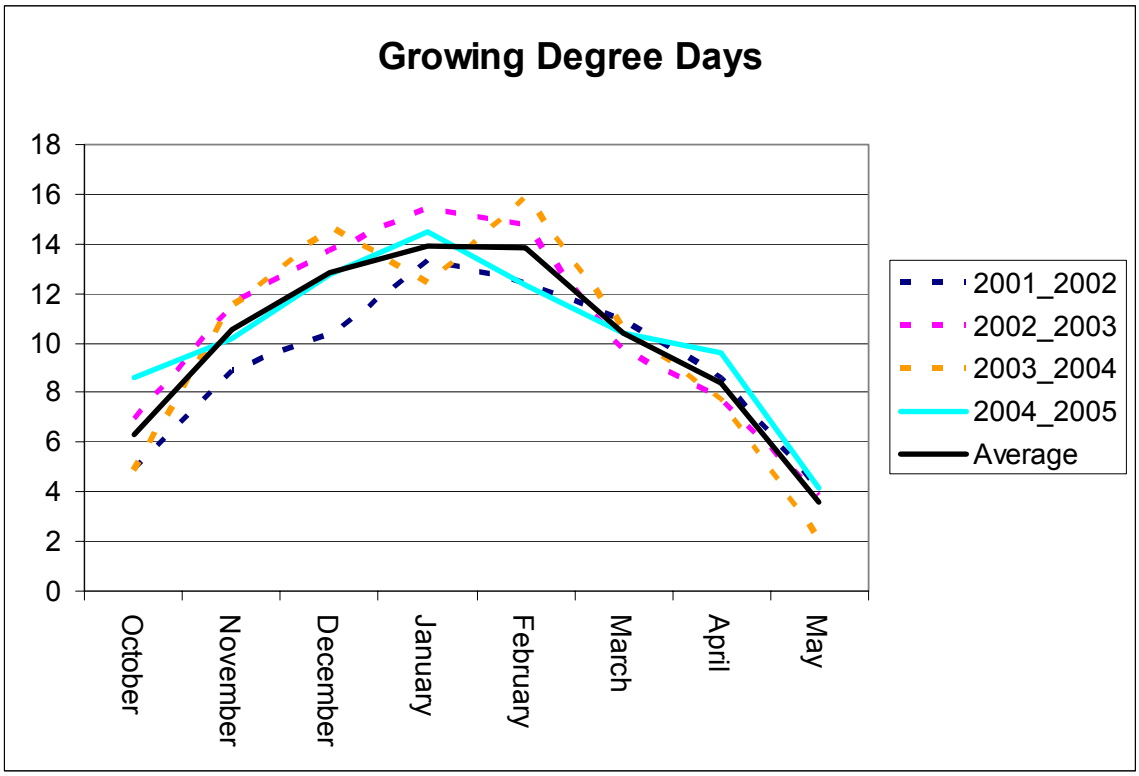
The earliest harvest date at the Swan Hill sites was 1st March 2005. The latest harvest was 58 days later, on 28th April 2005. The average harvest date was 16th March 2005.

However when harvest dates were compared with crop loads and with fruit quality from the Swan Hill and Sunraysia sites, there were no significant correlations. This means that crop load and canopy score did not affect harvest date, which in turn did not affect TA, pH, Baume, phenolics or colour.

Growing degree days

2004-05 was a mild season, but did not start that way. This may explain why vineyards did not produce fruit of a hoped-for quality.

The black line shows the 5-year average. The pale blue, intact line is the 2004-05 season. The 2004-05 season was an average year, although temperatures during veraison were below average. The 2004-05 conditions can be contrasted with the 2001-02 season, which was a good year for quality. In 2001-02 temperatures stayed below average for the whole of veraison.



Returns

Probably the most important indicator of high performance in wine grape production in the Swan Hill region is *Gross Return Per Hectare*. This indicator combines the tonnes of grapes harvested from a specific block and the returns per tonne of grapes, determined by each winery's grading and payment system.

To optimise gross returns, growers need to know what the optimal yield levels are for each vineyard block, in order to achieve a certain quality standard.

For each site included in the study, the Gross returns per hectare, water used (megalitres) per hectare and Return ($) per megalitre of water used can be compared against quality and crop parameters measured in this study.

Gross return per hectare

Gross return per hectare from the Swan Hill shiraz sites ranged from $3,500 to $14,082/ha. The highest return from all sites in the study was $24,419/ha (Figure 18).

Wineries and growers aim for high quality fruit, in the interests of sustaining contracts and maintaining markets for Australian wine, but it should be noted that in this benchmarking study, quality was not reflected in gross returns. Comparing gross returns from sites with the lowest QIN score (site 67(3)) and the highest QIN score (site 44(2)) (Figure 18) shows that they provided similar returns. Also of note is Site 15(1) which delivered the lowest gross return: vines were 11 years old; fruit had a QIN score of 88; bunch weights were average; the low return was simply a consequence of low bunch number.

Water use (ML/ha and $/ML)

Water is our most valuable resource in wine grape production. The use and abuse of water are the major determinants of vineyard performance, whether from a perspective of fruit quality, crop yield, or environmental impacts.

Therefore it makes sense to look at water use in terms of water used per hectare (ML/ha) but also how much was earned from the crop per volume of water used ($/ML).

The amount of revenue generated from 1 megalitre of irrigation is a useful economic indicator, not only within one vineyard but also within a region. It will become increasingly important to know how water resources are being allocated to different enterprises, whether this means different crops, or varieties, or even sections of the vineyard, and which of these are providing the greatest return on this asset.

Water use in Swan Hill sites ranged from 1.8 to 6 ML/ha, and averaged 4.42 ML/ha (Figure 19).

Revenue generated per ML of water used in Shiraz for 2004-2005 at the Swan Hill sites ranged from $697 to $4,107 per ML, and averaged $2,356/ML (Figure 20).

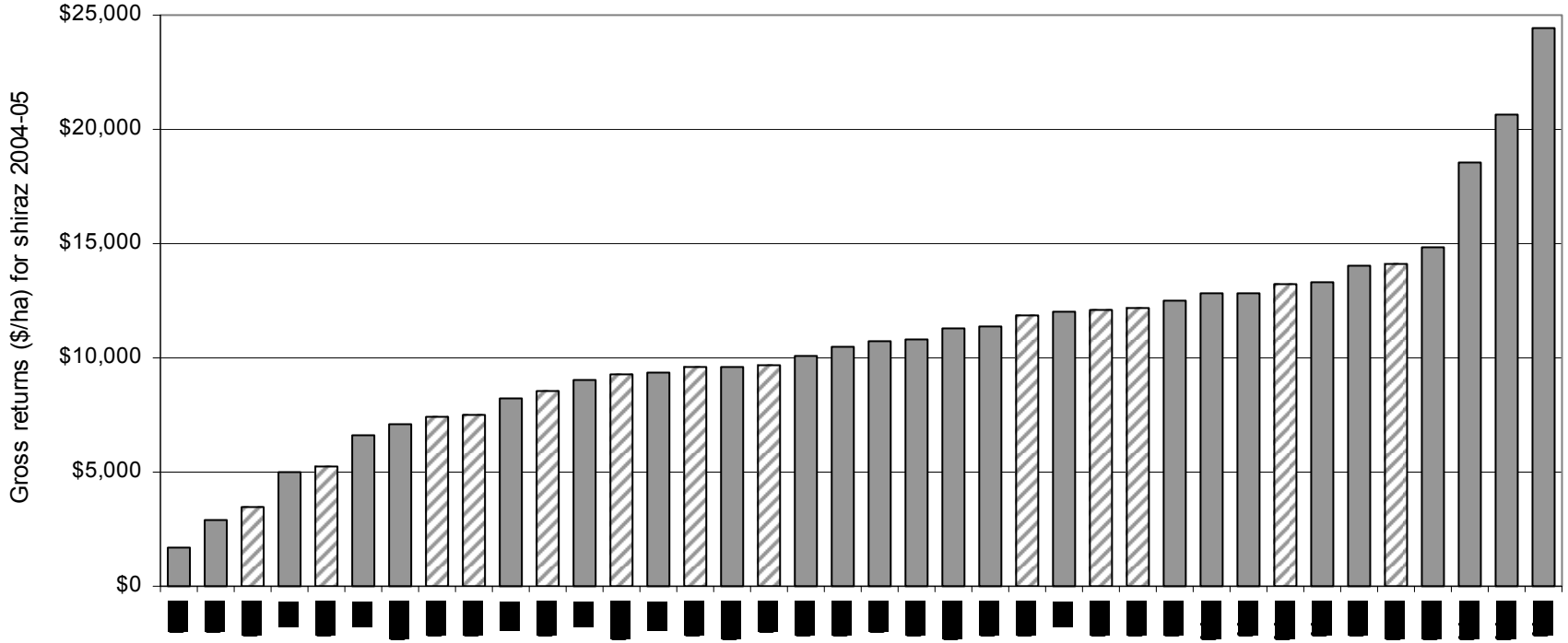


Figure 18: Gross returns ($) per hectare from Swan Hill shiraz sites ranged from $3,500 to $14,082/ha, and averaged at $9,554/ha. The highest return from all sites in the study was $24,419/ha.

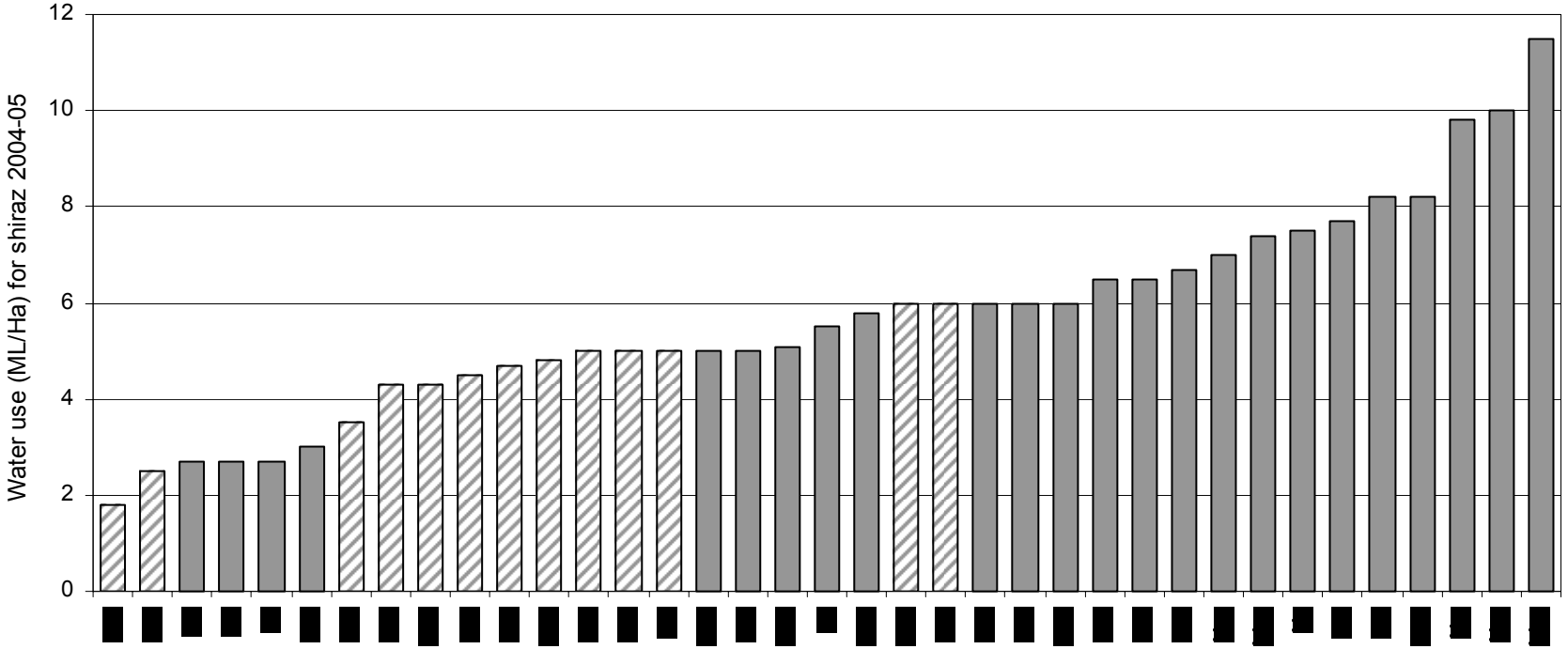


Figure 19: Water use in Shiraz for 2004-2005 at the Swan Hill sites ranged from 1.8 to 11.5 ML/ha and averaged 4.42 ML/ha.

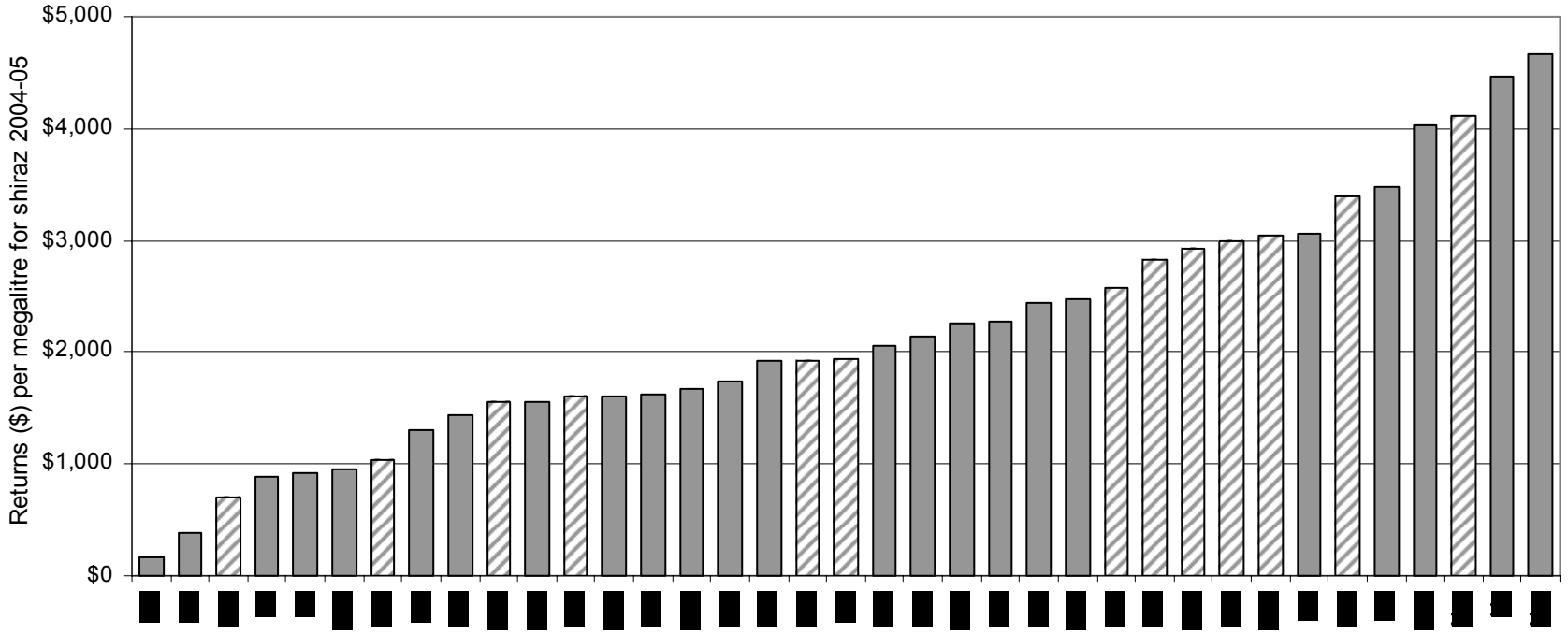


Figure 20: Revenue generated per ML of water used in Shiraz for 2004-2005 at the Swan Hill sites ranged from $697 to $4,107 per ML, and averaged $2,356/ML.

Communication

February 2005

Pruning get-together (and BBQ dinner).
Duralgai vineyards, Tresco West Rd, Lake Boga

This get-together was to provide the Swan Hill growers with an opportunity to see the effects of various pruning levels on Shiraz vaines and to make canopy, fruit and yield assessments. It was also a chance to discuss management decisions and winery expectations.

Speakers:
Scholefield Robinson (Garth Swinburne),
Southcorp (Marcus Everett),
DPI Viticare Trials Regional Support (Nicole Dimos).

July 1995

Workshop to discuss benchmarking results
Swan Hill.

This was a meeting of the participants in the benchmarking study, to review and discuss results and implications of the study.

Speaker: Susan Saris discussed
…Weather data – helping to explain some of the benchmarking results
...Explanation of the difference between acid and pH
...Benchmarking results for acid and pH
...Correlations in the data

Discussion

Benchmarking winegrape quality in the Swan Hill region in the 2005 vintage has provided valuable information for the Swan Hill growers. While participants may have hoped that the study would identify single parameters that would influence (improve) winegrape quality, the study highlights that there are few clear relationships between management practices and quality or returns. There was certainly no single variable that made a consistent difference to quality, crop load or net returns.

Ranking sites according to each of the different measures was however a very useful process. It has provided individual growers with comparisons within and between their vineyards and highlighted areas for individual growers to focus on, for example fruit/canopy balance, water use efficiency or bunch number, to optimise vine productivity and returns. Ranking the sites against the larger set containing Sunraysia data provided additional benchmarks so that the Swan Hill district could be compared against a similar district.

Ranking the sites, and recognising the complexity in grape quality and productivity, raised awareness of the importance of considering each vineyard as unique. The benchmarking project has now provided data from a series of seasons, revealing that variables that are strongly correlated in one season are not necessarily correlated in the following season, and again highlighting the complexity of interactions between the vine, weather and management.

There was much discussion among participating growers about pH and TA, because these fell away late in the season, probably due to heavy rains. Loss of acidity by harvest may have masked correlations between management and quality. The logistics of harvest and vagaries of weather may mean that many crops have passed their optimum quality when they are harvested. To maximise the information gained in any further benchmarking study, it would be valuable to assess quality components in fruit sampled *as soon as* the baumé approaches an acceptable level for harvesting, as well as when it is harvested.

The participating growers were disappointed that their fruit could not be made into small lots of wine, to provide sensory analysis data. This was beyond the resources of the project, but was felt by the participants to be key information necessary to help them understand the relationships between berry components and wine quality. They felt that relating wine quality to the fruit would provide the best leads to meeting winery expectations. They also felt that such information would allow them to assess the potential of fruit so as to better manage it throughout the season, and/or identify strengths or management issues particular to optimising production in the Swan Hill region. Availability of such information may help open dialogue between growers and wineries regarding understanding the crop and how to meet winery expectations. Therefore, small lot winemaking would be recommended as part of any further benchmarking study.

Conclusions

The benchmarking study has provided the Swan Hill growers with a comprehensive set of crop measurements against which to compare their individual crop management, fruit quality and economic returns.

While participating growers may have hoped that the study would reveal aspects of their crop or management that most influenced quality, it actually highlighted the complexity of grape production, and uniqueness of each site. The benchmarks enabled participants to see clearly that vine blocks must be managed according to the individual needs of a particular block in a particular season.

Contrary to suggestions that smaller berries produce more flavour components per kg, there were no significant correlations between berry weight and quality (colour, phenolics, pH or TA). There was also no significant correlation between harvest dates and crop loads or fruit quality, ie crop load and canopy score did not affect harvest date, which in turn did not affect TA, pH, baumé, phenolics or colour. Any such relationship was confounded by other variables.

Fruit from larger crops had lower phenolics, colour and baumé. Sites that were pruned to leave more buds (ie had higher pruning codes) had higher bunch numbers and also higher canopy scores. Conversely, pruning to leave more buds lead to an overall reduction in phenolics and baumé, although this had not been observed in previous years benchmarking studies.

Acidity was relatively poor in the fruit, reflected in high pH and low TA across the district. Generally poor acid may have masked a clear correlation with harvest date, and despite lack of a statistically significant relationship between harvest date and acid, participants certainly felt that the acid fell away when rain delayed harvest. To overcome any such masking of effects in a future benchmarking study, samples could be taken as soon as the fruit reaches a minimum baumé in addition to sampling at harvest.

Across the sites included in the study there was a three-fold variation in water used (ML/ha), almost a six-fold variation in revenue generated ($/ML) from water used, and almost a three-fold variation in gross returns. Return was a consequence of bunch number and weight, and did not reflect fruit quality. Maintaining or improving the quality of fruit is however paramount to maintaining markets.

The Swan Hill growers were encouraged to reflect on where their fruit was ranked for each variable measured in the benchmarking study, to support any management decisions. Towards maximising their crop potential, the Swan Hill growers were able to identify those parameters that would provide the greatest benefit to economic returns and crop quality.

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MILDURA PTY LTD

AM MacGREGOR
Consultant
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