North East Victoria Wine Grape Quality Measurement and Benchmarking Project

Vintage 2004 Report

A study of Shiraz wine grapes grown in the North East Victoria Wine Zone, encompassing the Alpine Valleys, Beechworth, Glenrowan, King Valley and Rutherglen Wine Regions.

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GWRDC RITA Project No. 03/22-4

Executive Summary:

This report outlines the 2004 Vintage results of the North East Victoria Wine Grape Quality Measurement and Benchmarking Project. The objective of the project is to measure and benchmark Shiraz wine grape quality from the five regions within the North East Victoria Wine Zone, encompassing the Alpine Valleys, Beechworth, Glenrowan, King Valley and Rutherglen Wine Regions.

The aim of the project is to provide wine grapegrowers and winemakers with an understanding of the development of colour, phenolics and flavour of the grape and how this contributes to wine quality. Spectrometry conducted by Myrrhee Consulting Services was used to analyse the berries and wine and the phenological status of each vineyard was determined using a vineyard assessment sheet developed by Southcorp Wines in conjunction with Patrick Iland.

This project has identified the large variation in climatic conditions throughout the grape growing regions of North East Victoria during the 2003 / 2004 season. This variation in climatic conditions has influenced the quality of wine grapes produced, with some Shiraz vineyards not realizing their full potential in the 2003 / 2004 season. Climatic conditions also vary widely from season to season, and highlights the need for wine grape growers to understand both the average and the expected extremes during the season and modify vineyard management practices each year to meet the seasonal conditions.

The objective berry measurements at harvest showed very pleasing relationships between berry anthocyanins, flavonols and phenolics. The previous berry samples (11-12° Baumé and 12-13° Baumé) resulted in a better understanding of berry composition and the development of anthocyanins, flavonols and phenolics of Shiraz grapes during the ripening period.

The results of this project also highlight the benefits to both the grower and the winemaker in undertaking objective berry measurements. By analyzing berries prior to harvest each year, growers can build a history of the quality of each block and therefore this will greatly assist with price negotiations. Likewise, wineries can batch the intake of grapes according to a known level of quality, therefore fully optimizing tank space as well as grape / wine quality.

Although the climatic conditions reduced the variation in canopy characteristics, the results of the vineyard assessment sheet validate the previous projects findings. (*Rolley 2002, 2003*) It can be concluded that Shoot Lignification, Bunch Exposure, Berry Size, and Berry Colour are key indicators of Shiraz wine grape quality and therefore wine quality. These points give a good indication of how the vineyard was managed throughout the season. It is also very likely that these indicators will apply to other varieties as well.

The variation in wine grape quality within each region highlights that there is considerable scope and potential for improvement, and this benchmarking project has assisted growers in establishing their position within their region.

Feedback from the participants has revealed that this project has achieved the aims and objectives as detailed above. Further research is required next season in order to compare the seasonal variation of each region, and to further improve our techniques / methods which will enable an accurate objective assessment of wine grapes.

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Intoduction / Background:

This report is not a full scientific report; it is compiled to communicate the results of a project conducted in North East Victoria during the 2004 Vintage and funded by the Grape and Wine Research and Development Corporation (GWRDC) via their Regional Innovation and Technology Adoption (RITA) progam

In 2003, three North East Victorian (Alpine Valleys, King Valley) Southcorp growers participated in a wine grape quality measurement project undertaken by Luke Rolley from Lake Marmal Vineyards in conjunction with Southcorp Wines. (GWRDC RITA Project No's RT 01/27-3, RT02/12-3 – RT02/15-3, RT02/37-4). Due to the success of those projects, it was decided to implement a project, which allowed a greater number of growers and winemakers to participate, and to encompass all five Geographical Indicator (G.I.) regions of the North East Victoria Wine Zone as well as vineyards within the confines of North East Victoria but not in a registered G.I. (referred to in this report as "other").

Project Aims / Objectives:

The aim of the project is to provide wine grapegrowers and winemakers with an understanding of the development of colour, phenolics and flavour of the grape and how this contributes to wine quality.

The project is designed to answer / address / result in the following:

- What are the characteristics of high quality vineyards?
- What is the composition of high quality berries?
- What are the relationships between vineyard & berry characteristics and potential wine quality?
- Grapegrowers and Winemakers brought together to discuss findings in a group format.
- Spectral analysis of the berries.
- Spectral analysis of the wine (post pressing)

The objective of the project is to measure and benchmark Shiraz wine grape quality from the five regions within the North East Victoria Wine Zone – Alpine Valleys, Beechworth, Glenrowan, King Valley and Rutherglen. Spectrometry conducted by Myrrhee Consulting Services is used to analyse the berries and wine and the phenological status of each vineyard is determined using a vineyard assessment sheet developed by Southcorp Wines in conjunction with Patrick Iland.

In this project **quality is defined as the potential end use and style of grape that meets the customers specifications and therefore will be more highly valued in the marketplace.** Objective measurements of anthocyanins, phenolics, and flavonols have been used to assess the quality of the grapes and wine.

Grapegrowers and Winemakers should use the information contained in this report to gain a more thorough understanding of the following:

How Vineyard Characteristic measurements can be used to assess potential grape / wine quality.
How Berry Analysis measurements can be used to assess potential grape / wine quality.
The variability in wine grape quality within and between vineyards in each region
How individual vineyards are performing against others within their own region and within the North East Victoria Wine Zone.
The climatic conditions in each region, and the impact that climate can have on grape / wine quality.

Project Methods:

Twenty-five vineyards - approximately five from each region - were selected by the project steering committee. The vineyards cover a broad range of small and large sites, and are a mixture of both winery owned and independent grapegrower operations. The selection process also ensured that there was a wide geographical spread of vineyards in each region, therefore providing a good representation of vineyards in each region.

This project utilized some of the methods used by the previous research projects, and therefore was completed with scientific principles and statistical validity, in order to produce valid and meaningful results. The sampling techniques, analytical measures and statistical analysis have been undertaken methodically, and consistently so as to minimize error.

Two transects were selected in each vineyard, in order to assess variation within the vineyard, giving a total of 50 sample sites. Grapes were sampled from these sites for spectral analysis at 11-12° baumé, 12-13° baumé and immediately prior to harvest. The sampling technique involved "zig–zagging" from each side along the length of pre determined rows within each transect, selecting 25 bunchlets (8 -10 berries) from the top, middle, bottom, inner and outer parts of the bunch and the top, middle and bottom of the fruiting zone of the canopy. This technique ensured that a representative and consistent grape sample was taken at each site on each occasion. A field assessment sheet, describing aspects of the canopy and crop was also completed by Stephen Lowe, Project Co-ordinator - in conjunction with the grower - at every sampling site immediately prior to harvest. Myrrhee Consulting Services completed spectral analysis of grapes and wine using sound laboratory techniques, which are described later in this report.

Climatic data - long term average and 2003 /2004 - consisting of temperature and rainfall was obtained from the Bureau of Meteorology for the King Valley, Beechworth and Rutherglen regions. Temperature and rainfall data was obtained from a winery in the Glenrowan region and DPI Research Station in the Alpine Valleys region.

Vineyard characteristics such as trellis type; rootstock, clone, row orientation, and irrigation method were also recorded, giving a total of 49 different parameters being measured for each sample site.
The vineyard and canopy characteristics measured are as follows:

Vineyard	**Canopy**	**Canopy**	**Canopy**	**Canopy**
Trellis type	Shoot length	Leaf condition 1st four leaves	Light condition	Berry size
Rootstock	Shoot length variation	Leaf condition last four leaves	% Fruit in full light	Berry shrivel
Clone	Shoot trimming	Fruit exposure	Spread of fruit	Pulp description
Irrigation system	Lateral growth 1st eight nodes	Leaf layer number	Fruit zone height	Flavour intensity
Row orientation	Lateral growth 2nd eight nodes		Fruit zone width	Skin chewiness
	Shoot lignification		Crop load description	Berry colour
			Yield (tonnes / ha)	Tannin intensity
				Seed lignification

Project Methods (cont):

The grapes were analysed by Myrrhee Consulting Services and participating wineries/processors* for the following:

Berries	Juice	Skin extract	Seed extract
Average berry weight	Baume	Anthocyanins	Phenolics
Avergae skin weight	pH*	Phenolics	
% Skin / berry	TA*	Flavonols	
Average seed weight			
% Seed / berry			

A sample of wine was collected after pressing and analysed by Myrrhee Consulting Services for the following attributes in order to gain an indication of final wine quality.

Wine	Wine	Wine
Anthocyanins	Colour density	Flavonols
Modified Anthocyanins	Hue index	Total phenolics
pH		

Statistics

Following the sampling stage the data was sent Mr. Brenton Dansie of University of South Australia and analysed for statistical co-relations and relationships between vines, berries and wine.

Spectral Analysis of Grapes – Methodology and Explanatory Notes
Written by Professor Alan Buchanan, Myrrhee Consulting Services

The most important quality constituents of red grapes are found almost exclusively in a thin layer of cells beneath the outer cuticle of the berry skin. While the seeds do contain tannin constituents, these are very difficult to extract unless the seed is crushed, however this is not usual in the winemaking process. The berry analysis procedure is therefore based on dissection of the berry into its component parts, so that each can be measured or extracted for separate measurement.

Fifty berries are selected as a representative sample of the berries from twenty five "bunchlets" (8 – 10 berries) which provides a good representation of the transect to be tested. The fifty berries are weighed to give an average berry weight and are then dissected by expressing the juice, pulp and seeds. Excess juice is removed from the skins, which are then weighed to give an average skin weight and percentage skin to berry. The seeds are also treated similarly. Both skin and seeds are extracted overnight in a very efficient solvent (1:1 methanol: water, 2% HCI). Whilst still in the solvent, the skins are thoroughly worked and pressed with a glass implement to ensure release of all the constituents of the sub-cuticular cells. The concentrated extract is then diluted quantitatively for spectrophotometric measurement.

Spectophotometric measurements.
The skin extract is measured at three wavelengths (in nanometre, nm) and the results are expressed in instrumental absorption units, (Au).

Anthocyanins – 520nm
This measures the total anthocyanins, which are in the coloured ionized monomeric form in the acid solution. Anthocyanins begin to accumulate in the skins about two weeks prior to the onset of veraison, then increase from veraison through to harvest.

Flavonols – 360nm
This gives an approximate indication of the concentration of flavonols, which are an important wine quality indicator. They may be regarded as being derived from tannin constituents by oxidation, induced by intense solar radiation. Flavonols begin to accumulate from fruit set to veraison, then accumulate in the skin during the late stage of berry maturation.

Total Phenolics – 280nm
This measurement is mainly due to tannin constituents based on flavon-3-ols (catechins) and various low molecular weight polymers (procyanidins). Other phenols including gallates and cinnamates make some contribution. The tannin constituents are important in providing mouthfeel characters (bitterness, astringency) and substance to wine. They also assist in stabilizing the wine over extended ageing. The phenolics in the skin mainly develop prior to veraison, but also increase from veraison to harvest. The seed extract 280nm is a tannin measurement as the seeds have very little anthocyanins or flavonols.

The skin extract measurements in Tables 2 & 3 are given, firstly as absorption units per gram of skin, then recalculated as absorption units per gram of berry to assist the winemaker in assessing the total available colour and tannin of a batch of grapes for winemaking purposes.

Interpreting the measurements is simple: The higher the measured spectrophotometric values the higher the grape quality. The quality can then be referred back to the physical properties of the berries, that is, berry weight, skin weight etc.

Spectral Analysis of Wine – Methodology and Explanatory Notes
Written by Professor Alan Buchanan, Myrrhee Consulting Services

Experienced tasters can assess red wines subjectively and this will usually result in ranking the very good wines as opposed to the poor in quality. The procedure is much less satisfactory for the great array of intermediate quality wines. However it is possible, using a set of spectrophotometric measurements closely related to those used in measuring fruit quality, to arrive at a set of numbers which provide a fully objective assessment for ranking wines in quality terms. This procedure has been used in this research project, and provides a reliable reference scale for relating fruit to wine quality, whilst also disclosing the effect of wine making procedures on the extent of extraction of the skins.

It must be emphasized that the measurements are for a number of major wine components readily accessible to straightforward instrumental assessment. There are a large number of minor components which add considerably to wine aroma and flavour, but these in general are not amenable to easy determination. They will, however influence subjective wine assessment.

The measurements made on red wines are detailed in Table 4 of this report. A small aliquot of wine is diluted 50-fold with dilute hydrochloric acid and spectrophotometric measurements are made at wavelengths of 520nm and 420nm in the visible range for the anthocyanin concentrations; at 360nm in the U-V range for an approximate measure of flavonols and at 280nm also in the U-V range for a measure of total phenols. The resulting numbers are in absorption units, A.U.

The E520 value refers to monomeric anthocyanins, and the E420 value to polymeric anthocyanins – the latter usually increasing as the wine ages. The sum, E520 + E420, gives the **colour density** of the wine and values may range from about 12 for aged wines to up to 60 for very young wines of intense colour.
The anthocyanins tend to be unstable in solution and progressively polymerize to form dark particles, which ultimately precipitate out. The colour density alone is not necessarily a good indicator of wine since ordinary and premium wines often differ little in colour and the anthocyanins contribute little to flavour themselves. The loss of anthocyanins is often quite rapid and this may depend on storage conditions: temperature, oxygen access, storage vessel (oak, stainless steel etc.), and the presence of other phenolics.

The E360 value gives an approximate indication of the concentration of **flavonols**, a diverse group of polyhydroxy phenols, which may be regarded as derived by oxidation of tannin components in the grape skin under the influence of intense solar radiation. They act as sunscreen agents in the near U.V. range.
In addition to contributing to wine quality in their own right (flavour, substance), they are an important indicator of the probable presence of the many secondary metabolites which are produced along with flavonols in the late stages of berry maturation by oxidative processes stimulated by solar radiation.
A particularly important aroma class of the secondary compounds is known as the iso-prenoids of which the damascenones are the most prominent. The measured values of E360 may range from about 10 to about 25-26. The flavonols appear to associate with the anthocyanins and suffer some losses accordingly. Extensive comparative measurements on ordinary and super premium Cabernet Sauvignon wines show that flavonols may be three to four times as high in the latter as the former.

The E280 value measures the total phenols and is sometimes called the **quality index** of the wine (*Chris Somers, The Wine Spectrum*). The primary contributors are the catechins (flavan-3-ols) and their low weight polymers, the procyanidins.

Spectral Analysis of Wine – Methodology and Explanatory Notes (cont.)

The very astringent gallates and also cinnamates contribute as well with minor absorptions due to anthocyanins and flavonols.The catechins and procyanidines collectively form the tannins which provide flavour (bitterness, astringency) and substance to the wine. They are also said to assist in limiting colour loss. The quality index E280 is the most stable of the quality measures and declines only very slowly with ageing. It is therefore the important indicator of the potential of a young wine to age successfully over an extended period of time. The tannins will change slowly, becoming less astringent with time. A long term average value for show wines has been found to be about 54 with the highest for a young Shiraz of about 120 (*Somers*). Values in the range 70 – 90 will therefore indicate wines of considerable potential. However, high tannins alone, in the absence of other aroma and flavour constituents as indicated above, will not necessarily ensure a super-premium wine.

Results:

Previous research (*Rolley 2002, 2003*) has shown a strong relationship between berry anthocyanin and final wine quality when the fermentation process is standardized. Throughout the past decade many Australian wineries have been using berry anthocyanin measurements to determine red wine grape quality. For this project, the berry anthocyanin levels at harvest have been used to determine wine grape quality and which vineyard and other berry measurements are related to potential wine quality.

The results of this project reflect the growing conditions of the 2003 – 2004 season in North East Victoria. Please take note that these results are for one year only, and therefore do not reflect the long - term growing conditions of each region.

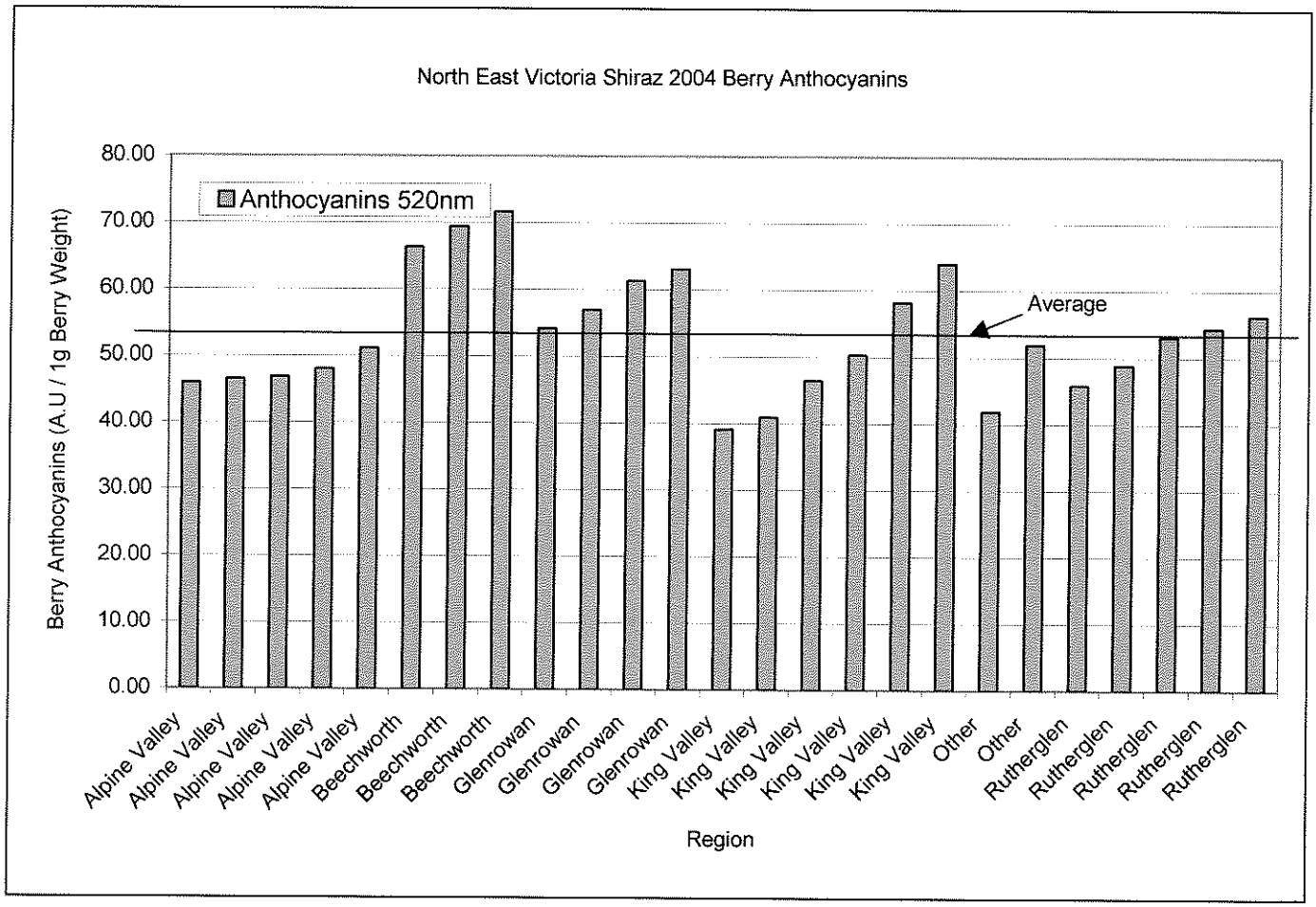


Figure 1. The anthocyanin levels (A.U. / g berry weight) of Shiraz grapes sampled at harvest 2004 from 25 vineyards in North East Victoria. This shows the variation in anthocyanin levels between vineyards within each region and between all regions of North East Victoria Wine Zone.

Results (cont.)

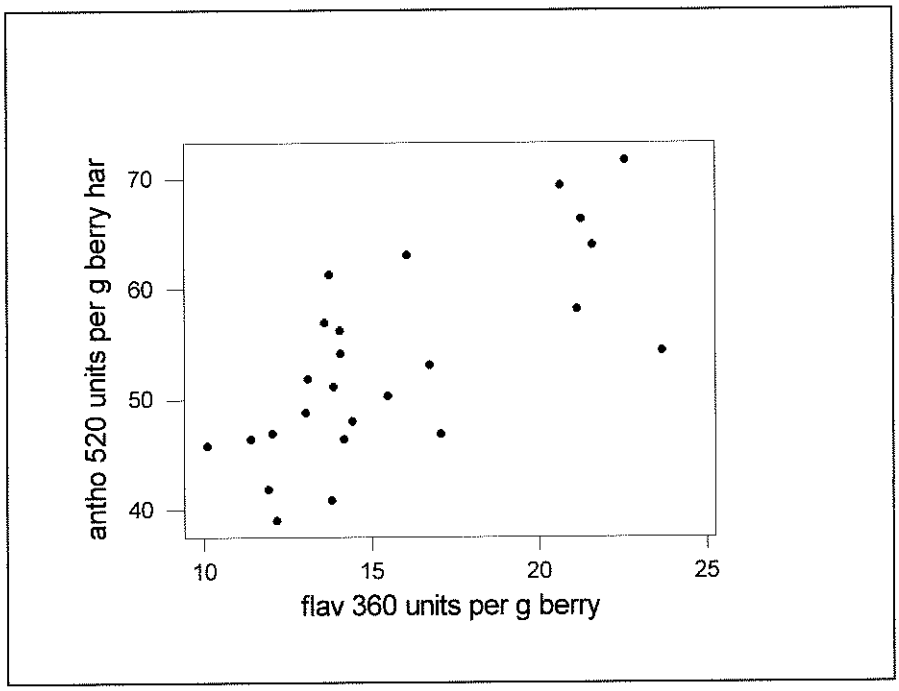


Figure 2. This graph shows the relationship between berry anthocyanins (A.U. / g berry weight) and berry flavonols (A.U. / g berry weight).

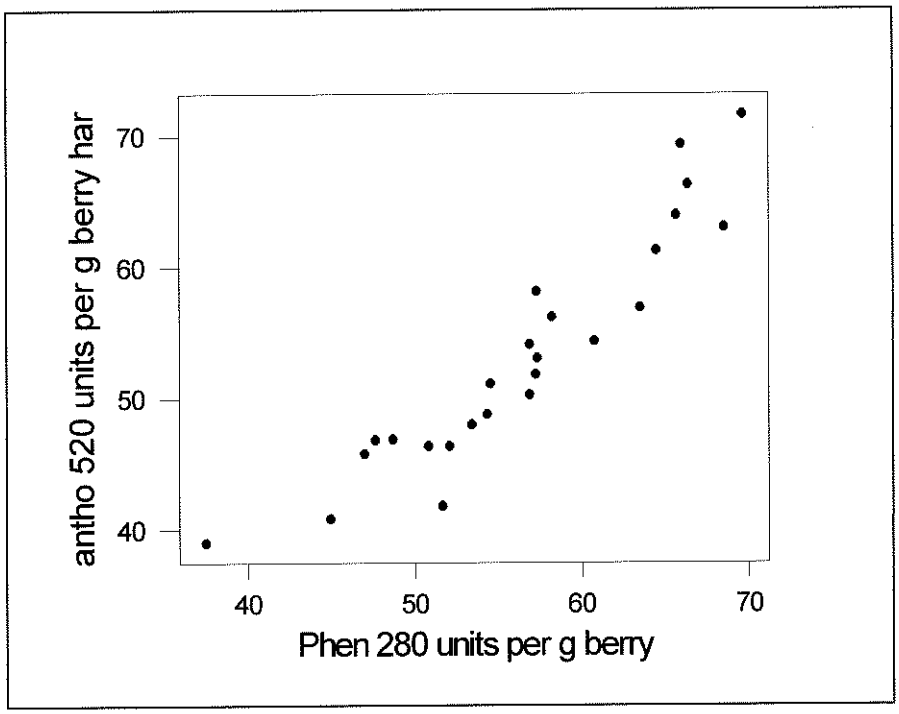


Figure 3. This graph shows the relationship between berry anthocyanins (A.U. / g berry weight) and berry phenolics (A.U. / g berry weight).

Data and Charts – Descriptions and Explanatory Notes

To ensure confidentiality is maintained each vineyard / transect has been given a code number. The code number is located on the left hand side of each page. When looking at the data, locate your code number and then read across the page to find your results. Please note that transects are identified as A and B. e.g. Vineyard code 11A relates to transect A of vineyard 11. When looking at the average data Vineyard code 11 relates to a combination (average) of 11A and 11B.

Tables 1(a) – 1(e). Vineyard and Canopy Characteristics

These tables contain vineyard characteristics and the results of the assessment sheet as completed immediately prior to harvest for all transects/vineyards. A description and rating level of each parameter is given at the bottom of each column. A number of canopy characteristics have good to strong relationships to final wine quality. These characteristics as well as other important quality indicators, and the desired level(s) of each are highlighted in the description cells.

Table 2. Berry Analysis (Individual Vineyard Results)

This table contains the individual results of the project participants berry analysis samples taken at 11-12° Baumé, 12-13° Baumé and immediately prior to harvest. Participating grapegrowers and winemakers should study this table carefully, as it tracks the development of their berries throughout the ripening period.

Tables 3(a) – 3(b). Average Berry Analysis and Standard Deviations.

These tables detail the average berry analysis results of both transects for each vineyard. Standard Deviations (St. Dev.) is a measure of the variability between the two sampling sites in each vineyard. Higher standard deviation values (the range of values differ according to parameter) mean high variability. Owners of vineyards high variations in several parameters, particularly Anthocyanin and Baumé levels should try to identify the cause (different rootstocks/clones, soil type etc) in order to minimize variability if possible.

Table 4. Wine Analysis Post Pressing Sample

This table details the wine analysis results from the wine sample taken at the post pressing stage. Whereas the berry analysis shows the total levels of extractable anthocyanins, prior to fermentation, these results show the available levels of anthocyanins, after the fermentation process.

Table 5. North East Victoria Climatic Details

This table details the long- term average and 2003 / 2004 season climatic data of each region in North East Victoria. The data consists of monthly rainfall and monthly average daily minimum, maximum and mean temperatures.

Data and Charts – Descriptions and Explanatory Notes (cont.)

Chart 1. Berry Analysis Results

This chart shows the berry analysis results of berry anthocyanins in order of the vineyard with the highest to that with the lowest.

Chart 2. Berry Analysis Results (anthocyanins, flavonols and total phenolics)

This chart shows the berry analysis results of the combined anthocyanin, flavonols and total phenolics in order of the vineyard with the highest to that with the lowest.

Chart 3. Berry Anthocyanin vs. Yield

This chart shows the relationship between the berry anthocyanins and yield (tonnes / ha).

Chart 4. Wine Analysis Results

This chart shows the wine analysis results of wine anthocyanins in order of the vineyard with the highest to that with the lowest.

Chart 5. Wine Analysis Results (anthocyanins, flavonols and total phenolics)

This chart shows the wine analysis results of the combined anthocyanin, flavonols and total phenolics in order of the vineyard with the highest to that with the lowest.

Please note: The large variation in winemaking techniques following delivery of grapes: i.e. different fermentation vessels, duration and temperatures, as well as winery additions etc. has influenced these results. This should be taken into account when comparing wine analysis results with berry analysis results.

Table 1 (a) Vineyard Characteristics							
Assessment Date	Region	Vineyard Code	Trellis Type	Rootsock	Clone	Irrigation System	Row Orientation
13-Apr-04	Alpine Valley	01A	Scot Henry	Own Roots	PT23	Drip	N / S
13-Apr-04	Alpine Valley	01B	Scot Henry	Own Roots	PT23	Drip	N / S
13-Apr-04	Beechworth	02A	Smart Dyson	Schwarzmann	n/a	Unirrigated	E / W
13-Apr-04	Beechworth	02B	Smart Dyson	Schwarzmann	n/a	Unirrigated	E / W
23-Mar-04	Glenrowan	03A	Smart Dyson	n/a	n/a	Drip	NW / SE
23-Mar-04	Glenrowan	03B	Smart Dyson	n/a	n/a	Drip	NW / SE
3-May-04	King Valley	04A	Scot Henry	Own Roots	PT23	Drip	NE / SW
3-May-04	King Valley	04B	Scot Henry	Own Roots	PT23	Drip	NE / SW
31-Mar-04	Rutherglen	05A	Sprawling	R99	1654	Drip	NE / SW
31-Mar-04	Rutherglen	05B	Sprawling	R99	1654	Drip	NE / SW
26-Mar-04	Rutherglen	06A	Smart Dyson	Schwarzmann	1654	Drip	NW / SE
26-Mar-04	Rutherglen	06B	Smart Dyson	Schwarzmann	1654	Drip	NW / SE
30-Mar-04	King Valley	07A	Scot Henry	Schw / R99	n/a	Drip	N / S
30-Mar-04	King Valley	07B	Scot Henry	Schw / R99	n/a	Drip	N / S
27-Mar--04	Other	08A	Smart Dyson	Schwarzmann	PT23	Control Furrow	N / S
27-Mar-04	Other	08B	Smart Dyson	Schwarzmann	PT23	Control Furrow	N / S
11-Mar-04	Other	09A	Smart Dyson	Ruggeri 140	Tabilk	Drip	N / S
11-Mar-04	Other	09B	Smart Dyson	Paulsen 1103	Tabilk	Drip	N / S
26-Mar-04	Alpine Valley	10A	Smart Dyson	Schwarzmann	PT23	Unirrigated	NE / SW
26-Mar-04	Alpine Valley	10B	Smart Dyson	Schwarzmann	PT23	Unirrigated	NE / SW
26-Mar-04	Alpine Valley	11A	Scot Henry	R99	PT23	Drip	N / S
26-Mar-04	Alpine Valley	11B	Scot Henry	R99	PT23	Drip	N / S
13-Apr-04	Beechworth	12A	Smart Dyson	Schwarzmann	PT23	Drip	N / S
13-Apr-04	Beechworth	12B	Smart Dyson	Schwarzmann	PT23	Drip	N / S
19-Mar-04	Glenrowan	13A	VSP	Schw/Paulsen	PT23	Overhead	NW / SE
19-Mar-04	Glenrowan	13B	VSP	Schw/Paulsen	PT23	Overhead	NW / SE
5-May-04	King Valley	14A	Smart Dyson	Schwarzmann	PT23	Drip	N / S
5-May-04	King Valley	14B	Smart Dyson	Schwarzmann	PT23	Drip	N / S
31-Mar-04	Rutherglen	15A	Scot Henry	Kober 5BB	PT23	Drip	E / W
31-Mar-04	Rutherglen	15B	Scot Henry	Teleki 5C	PT23	Drip	E / W
31-Mar-04	Rutherglen	16A	Scot Henry	Kober 5BB	PT23	Drip	NE / SW
31-Mar-04	Rutherglen	16B	Scot Henry	Kober 5BB	PT23	Drip	NE / SW
6-Apr-04	King Valley	17A	Scot Henry	Schwarzmann	n/a	Drip	N / S
6-Apr-04	King Valley	17B	Scot Henry	Schwarzmann	n/a	Drip	N / S
23-Mar-04	Glenrowan	18A	Smart Dyson	Schwarzmann	PT23	Drip	N / S
23-Mar-04	Glenrowan	18B	Smart Dyson	Schwarzmann	PT23	Drip	N / S
13-Apr-04	Beechworth	19A	Smart Dyson	Teleki 5C	1654	Drip	N / S
13-Apr-04	Beechworth	19B	Smart Dyson	Schwarzmann	PT23	Drip	N / S
6-Apr-04	Alpine Valley	20A	Smart Dyson	R99	PT23	Drip	N / S
6-Apr-04	Alpine Valley	20B	Smart Dyson	R99	PT23	Drip	N / S
1-Apr-04	Alpine Valley	21A	Smart Dyson	Own Roots	PT23	Drip	N / S
1-Apr-04	Alpine Valley	21B	Smart Dyson	Own Roots	PT23	Drip	N / S
19-Mar-04	Glenrowan	22A	Sprawling	ARG 1	n/a	Drip	NE / SW
19-Mar-04	Glenrowan	22B	Sprawling	ARG 1	n/a	Drip	NE / SW
14-Apr-04	King Valley	23A	Smart Dyson	Schwarzmann	PT23	Drip	E / W
14-Apr-04	King Valley	23B	Smart Dyson	Schwarzmann	1654	Drip	E / W
13-Apr-04	Rutherglen	24A	Scot Henry	Schwarzmann	BVRC12	Drip	N / S
13-Apr-04	Rutherglen	24B	Scot Henry	Schwarzmann	BVRC12	Drip	N / S
14-Apr-04	King Valley	25A	Smart Dyson	Schwarzmann	PT23	Drip	N / S
26-Apr-04	King Valley	25B	Smart Dyson	Schwarzmann	1654	Drip	N / S

Table 1 (b) Canopy Characteristics						
Vineyard Code	Shoot Length	Shoot Length Variation	Shoot Trim	Lateral Growth 1st 8 Nodes	Lateral Growth 2nd 8 Nodes	Shoot Lignification
01A	3	1	1	2	2	5
01B	3	1	1	2	2	5
02A	3	2	0	2	1	5
02B	3	2	0	2	1	5
03A	3	2	1	1	1	5
03B	3	2	1	1	1	4
04A	3	2	1	1	1	4
04B	3	2	1	1	1	4
05A	3	2	1	2	1	4
05B	3	2	1	2	1	4
06A	3	2	1	1	1	4
06B	3	2	1	1	1	4
07A	3	1	1	1	1	5
07B	3	1	1	1	1	5
08A	3	2	1	1	1	4
08B	3	2	1	1	1	4
09A	3	2	0	1	1	5
09B	3	2	0	1	1	5
10A	3	2	1	2	1	4
10B	3	2	1	2	1	5
11A	3	2	1	1	1	4
11B	3	2	1	1	1	4
12A	3	1	1	1	1	5
12B	3	1	1	1	1	5
13A	3	2	1	2	1	4
13B	3	2	1	2	1	4
14A	3	2	1	2	2	5
14B	3	2	1	2	2	5
15A	3	2	1	2	1	4
15B	3	2	1	1	1	5
16A	3	2	0	1	1	4
16B	3	2	0	1	1	4
17A	3	2	1	2	1	4
17B	3	2	1	2	1	4
18A	3	2	1	1	1	4
18B	3	2	1	1	1	4
19A	3	2	1	1	1	4
19B	3	2	1	1	1	4
20A	3	2	1	2	1	5
20B	3	2	1	2	1	5
21A	3	2	1	1	1	5
21B	3	2	1	1	1	5
22A	3	2	1	1	1	5
22B	3	2	1	1	1	5
23A	3	2	1	2	1	5
23B	3	2	1	1	1	5
24A	3	2	1	1	1	5
24B	3	2	1	1	1	5
25A	3	2	1	2	1	5
25B	3	2	1	2	1	5
	1 = <40cm	1 = Little Variation	1 = Trimmed	3 = High	3 = High	5 = 81 - 100%
	2 = 41 - 80cm	2 = Some Variation	0 = Not Trimmed	2 = Medium	2 = Medium	4 = 61 - 80%
	3 = 81 - 120cm	3 = Lots of Variation		1 = Low	1 = Low	3 = 41 - 60%
	4 = 121 - 160cm					2 = 21 - 40%
	5 = > 160cm					1 = <20%

Table 1 (c) Canopy Characteristics							
Vineyard Code	Leaf Plucked	Leaf Condition First Four Leaves	Leaf Condition Last Four Leaves	Fruit Exposure	Light Condition at Fruit Zone	Leaf Layer No	% Fruit in full light
01A	0	4	3	3	4	1.5	1
01B	0	3	3	3	3	1.5	1
02A	0	2	3	3	4	1.5	2
02B	0	3	3	3	4	1.5	2
03A	0	3	3	3	4	1.5	1
03B	0	3	3	3	4	2.0	1
04A	0	1	1	5	1	0.0	4
04B	0	1	1	5	1	0.0	4
05A	0	2	2	2	4	2.0	1
05B	0	2	2	2	4	2.0	1
06A	0	4	3	2	4	2.0	1
06B	0	3	3	3	4	1.5	1
07A	0	2	2	3	3	1.5	1
07B	0	3	3	2	4	2.0	1
08A	0	4	3	3	4	1.5	1
08B	0	3	3	4	3	1.5	2
09A	0	2	2	4	3	1.5	3
09B	0	2	2	5	2	1.0	4
10A	1	4	3	3	3	1.5	1
10B	1	3	3	3	3	1.5	1
11A	0	2	2	4	2	1.0	2
11B	0	2	2	4	3	1.0	2
12A	0	2	3	3	3	1.5	2
12B	0	2	3	3	3	1.5	2
13A	0	3	3	4	3	1.5	2
13B	0	2	3	4	2	1.0	3
14A	0	4	3	2	4	2.0	1
14B	0	3	3	2	4	2.0	1
15A	0	2	3	2	4	2.0	1
15B	0	2	3	3	3	1.5	2
16A	0	2	2	3	3	1.5	2
16B	0	1	2	4	2	0.5	3
17A	0	2	2	3	3	1.5	2
17B	0	2	2	3	3	1.5	2
18A	0	2	2	3	4	1.5	1
18B	0	2	2	3	4	1.5	1
19A	0	2	2	3	3	1.5	2
19B	0	2	2	4	3	1.5	2
20A	0	2	3	3	3	1.5	2
20B	0	2	3	3	3	1.5	2
21A	1	1	3	4	2	0.5	4
21B	1	1	3	4	2	0.5	4
22A	0	3	3	3	4	1.5	1
22B	0	4	2	3	4	1.5	1
23A	0	2	2	4	2	1.0	3
23B	0	2	2	4	2	1.0	3
24A	0	2	2	4	2	1.0	3
24B	0	2	2	4	2	1.0	3
25A	0	2	3	4	3	1.0	2
25B	0	2	2	3	4	1.5	1
	1 = Yes	5 = Green & Healthy	4 = Green Growing Tips	5 = 81-100%	1 = Full Sun	0.0	1 = <5%
	0 = No	4 = Pale Green	3 = Green No GTs	4 = 61 - 80%	2 = Mostly Sunny	0.5	2 = 6 - 10%
		3 = Yellowing	2 = Pale Green No GTs	3 = 41 - 60%	3 = Mod. Filtered	1.0	3 = 11 - 20%
		2 = Yellow / Brown	1 = Yellow No GTs	2 = 21 - 40%	4 = Mostly Filtered	1.5 - 2	4 = >20%
		1 = Absent		1 = <20%	5 = Shaded	> 2	

Table 1 (d) Canopy Characteristics					
Vineyard Code	Spread of Fruit	Fruit Zone Height	Fruit Zone Width	Cropload Description	Yield (T / Ha)
01A	2	2	2	3	17.5
01B	2	2	2	3	17.5
02A	1	2	2	2	9.9
02B	1	2	2	2	9.9
03A	1	2	2	2	12.0
03B	1	2	2	2	12.0
04A	2	3	2	3	14.8
04B	2	3	2	3	14.8
05A	1	2	3	1	5.2
05B	1	2	3	1	5.2
06A	2	2	2	2	13.0
06B	2	2	2	2	13.0
07A	2	3	2	2	10.9
07B	2	3	2	2	10.9
08A	1	2	2	2	14.8
08B	1	2	2	2	14.8
09A	1	2	2	2	3.0
09B	1	2	2	2	3.0
10A	1	2	2	1	7.4
10B	1	2	2	1	7.4
11A	1	2	2	2	8.5
11B	1	2	2	2	9.0
12A	1	2	1	1	5.4
12B	1	2	1	1	5.4
13A	1	2	2	2	7.4
13B	2	2	2	2	7.4
14A	1	2	2	3	20.3
14B	1	2	2	2	20.3
15A	2	3	2	2	13.5
15B	2	3	2	2	13.5
16A	1	3	2	3	7.8
16B	1	3	2	3	7.8
17A	2	2	2	2	14.8
17B	1	2	2	2	14.8
18A	1	2	2	2	12.3
18B	1	2	2	2	12.3
19A	1	1	1	2	7.5
19B	1	1	1	2	7.8
20A	1	2	2	2	11.4
20B	1	2	2	2	11.4
21A	1	2	2	2	15.0
21B	1	2	2	2	15.0
22A	1	3	2	2	5.4
22B	1	3	2	2	5.4
23A	1	3	2	2	10.1
23B	1	3	2	2	10.1
24A	2	2	1	2	10.4
24B	2	2	1	2	10.4
25A	1	2	2	2	6.5
25B	2	2	2	2	10.0
	1 = Open	1 = <30cm	1 = <15cm	1 = Undercropped	
	2 = Some Congestion	2 = 31 - 50cm	2 = 16 - 30cm	2 = Balanced	
	3 = Severe Clumping	3 = >50cm	3 = >30cm	3 = Overcropped	

Table 1 (e) Canopy Characteristics								
Vineyard Code	Berry Size	Berry Shrivel	Pulp Description	Flavour Intensity	Skin Chewiness	Berry Colour	Tannin Intensity	Seed Lignification
01A	5	1	2	3	3	3	3	5
01B	5	1	2	3	3	3	3	5
02A	3	1	3	3	4	5	3	5
02B	3	1	3	4	4	5	4	6
03A	3	1	2	4	4	4	3	5
03B	3	1	2	3	3	4	3	5
04A	4	1	2	3	3	4	3	5
04B	4	1	2	3	3	4	3	5
05A	4	1	3	3	4	3	3	5
05B	4	1	3	3	3	3	3	5
06A	4	1	2	3	3	3	2	5
06B	3	2	3	3	4	4	3	6
07A	3	1	3	3	4	3	3	6
07B	3	1	2	3	3	3	3	5
08A	4	0	2	3	3	3	3	5
08B	3	1	2	3	3	4	3	5
09A	3	2	3	3	4	4	3	5
09B	3	3	3	3	4	4	3	6
10A	4	0	2	3	3	3	3	5
10B	4	1	3	4	4	4	3	6
11A	4	1	2	3	3	4	2	5
11B	4	1	2	4	3	4	3	5
12A	4	2	2	3	3	4	3	5
12B	4	2	2	3	3	4	3	5
13A	3	2	2	3	4	4	3	6
13B	3	2	2	3	4	4	3	5
14A	5	1	2	3	2	3	3	4
14B	5	1	2	3	3	3	3	5
15A	4	1	2	3	3	3	2	6
15B	4	1	2	3	3	3	3	6
16A	4	2	2	3	4	3	2	5
16B	4	2	3	3	4	3	2	5
17A	4	1	2	3	3	3	3	6
17B	4	1	2	3	3	4	3	6
18A	3	1	2	3	3	3	3	6
18B	3	1	2	3	3	4	3	6
19A	4	1	2	4	4	4	3	6
19B	4	2	2	3	4	4	3	6
20A	4	1	2	3	4	3	3	6
20B	4	1	2	3	4	4	3	6
21A	4	1	2	3	4	4	3	6
21B	4	1	2	3	4	4	3	6
22A	3	1	3	3	4	4	3	5
22B	3	1	3	3	4	5	3	6
23A	4	2	3	4	4	4	3	6
23B	4	2	3	4	4	4	3	6
24A	3	1	2	3	3	3	3	5
24B	3	2	2	3	3	3	3	6
25A	4	3	2	4	4	3	3	5
25B	4	3	2	3	3	3	3	5
	1 < 9mm	0 = No Shrivel	4 = Dry	5 = V intense	5 = Thick	5 = V High	4 = High	1 = Light Green
	2 = 10mm	1 =< 10%	3 = Firm	4 = Intense	4 = Chewy	4 = High	3 = Medium	2 = Green
	3 = 11mm	2 = 11 - 20%	2 = Mod. Firm	3 = Medium	3 = Medium	3 = Med	2 = Low	3 = Yellow
	4 = 12mm	3 = 21 - 50%	1 = Juicy	2 = Low	2 = Thin	2 = Low	1 = None	4 = Tan
	5 = >13mm	4 = > 50%	or Watery	1 = Nil	1 = V Thin	1 = V Low		5 = Light Brown
								6 = Chocalate
								7 = Dark Brown

Table 2. Berry Analysis Individual Results ***EXAMPLE ONLY***															
Date Tested	Vineyard Code	Av Berry Wt (gms)	Av Skin Wt (gms)	% Skin / Berry	Av Seed Wt (gms)	% Seed / Berry	Baume	Ph	Ta	Skin Extract Abs. Units 1g in 1cc Solvent			Skin Extract Abs. Units / 1g Berry		
										Anthocyanins	Flavonols	Phenolics	Anthocyanins	Flavonols	Phenolics
20-Mar-04	19A	1.24	0.22	17.36	0.07	5.77	11.8	n/a	n/a	266.20	71.06	283.33	46.21	12.34	49.18
02-Apr-04	19A	1.23	0.21	16.90	0.08	6.51	13.3	n/a	n/a	285.95	74.54	303.93	48.33	12.60	51.37
14-Apr-04	19A	1.28	0.22	16.89	0.08	6.51	14.2	3.81	5.9	368.15	118.15	372.33	62.18	19.96	62.88
20-Mar-04	19B	1.26	0.23	18.02	0.08	6.17	11.9	n/a	n/a	277.56	72.53	289.02	50.02	13.07	52.08
02-Apr-04	19B	1.22	0.21	17.39	0.08	6.29	13.6	n/a	n/a	310.39	83.65	330.59	53.97	14.55	57.48
14-Apr-04	19B	1.15	0.21	18.10	0.07	6.16	14.3	3.82	4.7	389.21	124.52	386.08	70.44	22.54	69.88
Block Averages															
20-Mar-04	19	1.25	0.22	17.69	0.07	5.97	11.85	n/a	n/a	271.88	71.80	286.18	48.11	12.70	50.63
02-Apr-04	19	1.23	0.21	17.15	0.08	6.40	13.45	n/a	n/a	298.17	79.10	317.26	51.15	13.57	54.43
14-Apr-04	19	1.22	0.22	17.50	0.08	6.34	14.25	3.82	5.28	378.68	121.34	379.21	66.31	21.25	66.38

Wine Analysis Individual Results ***EXAMPLE ONLY***															
Date Tested	Vineyard Code							pH		Modified Anth. E420	Colour Den. E520+E420	Hue Index E420 / E520	Antho. E520	Flavonols E360	Phenols E280
30-Apr-04	19A							3.38		13.20	49.95	0.36	36.75	20.75	73.60
30-Apr-04	19B							3.65		16.45	62.40	0.36	45.95	20.95	89.20
Wine Averages															
30-Apr-04	19							3.52		14.83	56.18	0.36	41.35	20.85	81.40

Table 3 (a) Average Berry Analysis and Standard Deviations Harvest Sample													
Date Tested	Region	Vineyard Code	Av Berry Wt (gms)	Av Berry Wt St. Dev.	Av Skin Wt (gms)	Av Skin Wt St. Dev.	% Skin / Berry	% Skin St. Dev.	Av Seed Wt (gms)	Av Seed Wt St. Dev.	% Seed / Berry	% Seed St. Dev.	Baume	Baume St. Dev.
21-Apr-04	Alpine Valley	1	1.71	0.01	0.27	0.01	15.61	1.59	0.07	0.00	4.05	0.15	14.10	0.14
14-Apr-04	Beechworth	2	1.27	0.16	0.22	0.00	17.63	1.93	0.07	0.01	5.53	0.07	13.85	0.78
24-Mar-04	Glenrowan	3	1.27	0.12	0.29	0.04	22.61	0.54	0.09	0.01	6.51	0.16	14.85	0.21
3-May-04	King Valley	4	1.29	0.05	0.24	0.00	18.81	0.81	0.07	0.00	5.59	0.14	12.90	0.14
2-Apr-04	Rutherglen	5	1.44	0.09	0.24	0.01	16.43	0.47	0.07	0.00	4.97	0.31	14.70	0.14
27-Mar-04	Rutherglen	6	1.10	0.13	0.23	0.01	20.37	1.75	0.06	0.00	5.54	0.17	14.25	0.35
2-Apr-04	King Valley	7	1.26	0.18	0.22	0.02	17.30	0.62	0.08	0.01	6.41	0.13	14.40	0.28
27-Mar-04	Other	8	1.12	0.13	0.22	0.01	19.75	3.46	0.07	0.00	6.30	0.64	14.15	0.49
13-Mar-04	Other	9	1.07	0.06	0.19	0.01	17.25	0.38	0.08	0.00	7.30	0.31	14.20	0.28
27-Mar-04	Alpine Valley	10	1.75	0.04	0.29	0.01	16.74	1.17	0.07	0.00	4.20	0.04	13.35	0.49
27-Mar-04	Alpine Valley	11	1.38	0.12	0.23	0.01	16.69	0.43	0.07	0.00	5.24	0.20	12.80	0.28
14-Apr-04	Beechworth	12	1.61	0.05	0.27	0.01	16.65	0.07	0.07	0.00	4.45	0.05	14.95	0.21
20-Mar-04	Glenrowan	13	0.90	0.04	0.20	0.02	21.57	1.48	0.07	0.01	7.57	0.75	13.85	0.07
6-May-04	King Valley	14	1.61	0.06	0.26	0.00	16.21	0.86	0.08	0.00	4.90	0.33	13.45	0.78
2-Apr-04	Rutherglen	15	1.30	0.04	0.21	0.00	15.96	0.27	0.08	0.01	5.82	0.30	13.15	0.21
26-Mar-04	Rutherglen	16	1.28	0.07	0.24	0.03	19.09	1.07	0.08	0.01	6.53	0.76	14.00	0.71
7-Apr-04	King Valley	17	1.22	0.04	0.20	0.00	16.65	0.53	0.08	0.01	5.87	0.34	13.40	0.28
24-Mar-04	Glenrowan	18	1.16	0.04	0.22	0.01	18.99	0.96	0.07	0.00	6.05	0.33	12.85	0.64
14-Apr-04	Beechworth	19	1.22	0.09	0.22	0.01	17.50	0.86	0.08	0.01	6.34	0.25	14.25	0.07
7-Apr-04	Alpine Valley	20	1.52	0.01	0.26	0.01	16.82	0.57	0.08	0.00	5.12	0.12	14.20	0.42
2-Apr-04	Alpine Valley	21	1.56	0.01	0.23	0.01	14.55	0.15	0.08	0.01	4.58	0.41	13.50	0.14
20-Mar-04	Glenrowan	22	1.33	0.05	0.26	0.01	19.55	0.55	0.07	0.00	5.30	0.47	14.10	0.14
17-Apr-04	King Valley	23	1.29	0.10	0.23	0.02	17.66	0.43	0.08	0.01	5.88	0.77	14.65	1.20
14-Apr-04	Rutherglen	24	1.13	0.06	0.20	0.01	17.58	0.55	0.07	0.01	5.72	0.44	13.65	0.35
17-Apr-04	King Valley	25	1.55	0.10	0.27	0.05	17.27	4.65	0.07	0.00	4.61	0.45	14.80	0.57
Regional Averages														
4-Apr-04	Alpine Valley	Average	1.58	0.04	0.26	0.01	16.08	0.78	0.07	0.00	4.64	0.18	13.59	0.30
14-Apr-04	Beechworth	Average	1.37	0.10	0.24	0.00	17.26	0.95	0.07	0.01	5.44	0.12	14.35	0.35
22-Mar-04	Glenrowan	Average	1.17	0.06	0.24	0.02	20.68	0.88	0.08	0.00	6.36	0.42	13.91	0.27
18-Apr-04	King Valley	Average	1.37	0.09	0.24	0.02	17.32	1.32	0.08	0.00	5.54	0.36	13.93	0.54
1-Apr-04	Rutherglen	Average	1.25	0.08	0.22	0.01	17.89	0.82	0.07	0.00	5.72	0.40	13.95	0.35
20-Mar-04	Other	Average	1.10	0.10	0.21	0.01	18.50	1.92	0.08	0.00	6.80	0.48	14.18	0.39
	North East Vic	Average	1.31	0.08	0.24	0.01	17.96	1.11	0.08	0.00	5.75	0.33	13.99	0.37

Table 3 (b) Average Berry Analysis and Standard Deviations Harvest Sample										
			Skin Extract Abs. Units / 1g Berry							
Region	Vineyard Code	Anthocyanins	Anthocyanin St. Dev.	Flavonols	Flavonol St. Dev.	Phenolics	Phenolics St. Dev.	Seed Extract 280nm	Seed Extract St. Dev.	Yield Tonnes/ha
Alpine Valley	1	46.83	0.74	17.07	0.52	47.63	0.35	32.63	8.37	17.50
Beechworth	2	71.65	3.75	22.58	2.78	69.66	5.23	34.63	4.79	9.90
Glenrowan	3	61.30	0.07	13.73	0.73	64.45	2.01	36.40	1.19	12.00
King Valley	4	58.22	8.08	21.13	0.75	57.28	6.07	13.52	1.80	14.80
Rutherglen	5	53.11	5.89	16.72	1.37	57.33	7.90	22.78	2.49	5.20
Rutherglen	6	56.24	4.37	14.04	1.83	58.23	5.88	12.33	4.04	13.00
King Valley	7	46.40	7.18	11.38	1.26	52.06	7.22	10.75	3.24	10.90
Other	8	51.89	3.80	13.09	1.56	57.24	6.68	13.68	1.97	14.80
Other	9	41.83	4.19	11.89	0.08	51.66	3.36	63.01	20.77	3.00
Alpine Valley	10	45.96	2.62	12.03	1.10	48.66	2.72	20.08	2.08	7.40
Alpine Valley	11	48.00	3.00	14.41	2.21	53.38	3.93	10.73	0.42	8.80
Beechworth	12	69.41	2.03	20.63	0.67	65.96	0.16	31.31	0.74	5.40
Glenrowan	13	63.07	0.24	16.06	0.35	68.56	1.80	26.41	0.13	7.40
King Valley	14	39.06	3.23	12.16	0.53	37.46	2.47	14.60	1.31	20.25
Rutherglen	15	45.84	0.40	10.08	0.11	46.97	0.24	7.84	0.28	13.50
Rutherglen	16	48.83	5.66	13.02	1.56	54.32	5.96	20.65	2.55	7.80
King Valley	17	50.31	2.58	15.48	0.97	56.89	3.34	28.25	6.69	14.80
Glenrowan	18	56.98	4.49	13.58	1.17	63.48	2.64	29.48	0.71	12.30
Beechworth	19	66.31	5.84	21.25	1.82	66.38	4.95	28.67	1.44	7.60
Alpine Valley	20	51.14	6.46	13.86	1.30	54.52	5.69	24.63	1.64	11.40
Alpine Valley	21	46.44	0.18	14.17	0.22	50.79	0.40	13.90	0.40	15.00
Glenrowan	22	54.17	2.30	14.07	0.54	56.85	2.11	21.70	1.48	5.40
King Valley	23	63.99	1.03	21.58	0.10	65.66	0.31	17.49	0.35	10.10
Rutherglen	24	54.40	1.51	23.67	0.68	60.76	1.27	21.89	0.62	10.40
King Valley	25	40.91	0.84	13.79	0.95	44.91	2.57	19.85	2.08	8.30
		Regional Averages								
Alpine Valley	Average	47.67	2.60	14.31	1.07	51.00	2.62	20.39	2.58	12.02
Beechworth	Average	69.12	3.87	21.49	1.76	67.33	3.45	31.54	2.33	7.63
Glenrowan	Average	58.88	1.77	14.36	0.70	63.34	2.14	28.50	0.88	9.28
King Valley	Average	49.82	3.82	15.92	0.76	52.38	3.67	17.41	2.58	13.19
Rutherglen	Average	51.68	3.57	15.51	1.11	55.52	4.25	17.10	2.00	9.98
Other	Average	46.86	4.00	12.49	0.82	54.45	5.02	38.35	11.37	8.90
North East Vic	Average	54.01	3.27	15.68	1.04	57.34	3.53	25.55	3.62	10.17

Table 4 Wine Analysis Post Pressing Sample									
Date Tested	Region	Vineyard Code	pH	Modified Antho. E420	Colour Density E520 + E420	Hue Index or Age E420 / E520	Anthocyanins E520	Flavonols E360	Total Phenolics Quality Index E280
3-May-04	Alpine Valley	1	3.56	9.70	41.20	0.31	31.50	15.35	54.10
3-May-04	Beechworth	2	3.64	12.45	51.35	0.32	38.90	17.20	57.25
2-Apr-04	Glenrowan	3	3.85	16.75	64.85	0.35	48.10	19.15	90.00
16-May-04	King Valley	4	3.60	14.20	58.20	0.32	44.00	23.55	74.35
14-Apr-04	Rutherglen	5	3.42	10.80	43.20	0.33	32.40	18.80	75.70
7-Apr-04	Rutherglen	6	3.64	15.25	56.05	0.37	40.80	17.05	69.60
14-Apr-04	King Valley	7	3.61	10.20	41.20	0.33	31.00	15.55	62.60
14-Apr-04	Other	8	3.85	12.73	46.50	0.37	33.77	15.10	64.30
7-Apr-04	Other	9	3.45	14.35	55.20	0.35	40.85	19.85	93.60
19-Apr-04	Alpine Valley	10	3.94	14.50	53.25	0.37	38.75	21.55	75.60
14-Apr-04	Alpine Valley	11	3.63	10.75	43.05	0.33	32.30	18.10	66.60
26-Apr-04	Beechworth	12	3.99	10.15	39.55	0.35	29.40	17.75	61.15
2-Apr-04	Glenrowan	13	4.40	16.95	60.60	0.39	43.65	19.25	85.50
16-May-04	King Valley	14	3.55	7.90	33.28	0.31	25.38	12.90	42.23
14-Apr-04	Rutherglen	15	3.73	10.15	43.10	0.31	32.95	15.50	55.05
24-Apr-04	Rutherglen	16	3.65	10.83	42.73	0.33	31.90	20.38	72.03
19-Apr-04	King Valley	17	3.70	14.45	52.35	0.38	37.90	19.75	75.45
2-Apr-04	Glenrowan	18	3.56	7.00	29.40	0.31	22.40	10.00	52.95
30-Apr-04	Beechworth	19	3.52	14.83	56.18	0.36	41.35	20.85	81.40
19-Apr-04	Alpine Valley	20	3.53	11.75	47.00	0.33	35.25	18.15	67.00
26-Apr-04	Alpine Valley	21	3.58	11.05	45.80	0.32	34.75	18.85	66.60
2-Apr-04	Glenrowan	22	3.63	10.55	46.70	0.29	36.15	15.40	70.20
26-Apr-04	King Valley	23	3.88	17.15	68.05	0.34	50.90	26.65	90.30
24-Apr-04	Rutherglen	24	3.65	9.95	38.45	0.35	28.50	19.45	64.95
5-May-04	King Valley	25	3.64	10.98	42.25	0.36	31.28	19.05	66.40

Regional Averages									
	Alpine Valley	Average	3.65	11.55	46.06	0.33	34.51	18.40	65.98
	Beechworth	Average	3.72	12.48	49.03	0.34	36.55	18.60	66.60
	Glenrowan	Average	3.86	12.81	50.39	0.34	37.58	15.95	74.66
	King Valley	Average	3.66	12.48	49.22	0.34	36.74	20.25	68.56
	Other	Average	3.65	13.54	50.85	0.36	37.31	17.48	78.95
	Rutherglen	Average	3.62	11.40	44.71	0.34	33.31	18.24	67.47
	North East Vic	Average	3.69	12.38	48.38	0.34	36.00	18.15	70.37

Table 5 North East Victoria Climatic Details								
Region		OCT	NOV	DEC	JAN	FEB	MAR	APR
Alpine Valley	2003/04 Maximum	17.5	24.9	29.1	29.5	32.6	28.9	23.0
Ovens	Average Maximum	20.3	23.8	27.2	30.2	30.2	27.0	21.7
Research	2003/04 Minimum	5.7	9.4	13.9	12.0	13.7	10.1	8.2
	Average Minimum	6.9	8.6	10.4	12.4	12.5	10.1	6.9
	2003/04 Mean	11.6	17.2	21.5	20.8	23.2	19.5	15.6
	Average Mean	13.6	16.2	18.8	21.3	21.4	18.6	14.3
	2003/04 Rainfall	75	75	163	32	9	5	28
	Average Rainfall	98	70	66	62	47	52	68
Beechworth	2003/04 Maximum	n/a	24.5	28.6	28.6	32.2	28.3	23.3
Woolshed	Average Maximum	17.8	21.6	25.1	27.3	27.3	23.9	18.6
	2003/04 Minimum	n/a	7.7	12.4	10.4	12.7	7.9	6.4
	Average Minimum	7.1	9.3	11.6	13.4	13.8	11.4	7.9
	2003/04 Mean	n/a	16.1	20.5	19.5	22.5	18.1	14.9
	Average Mean	12.5	15.5	18.4	20.4	20.6	17.7	13.3
	2003/04 Rainfall	101	80	133	22	10	2	17
	Average Rainfall	91	66	59	49	49	61	67
Glenrowan	2003/04 Maximum	16.0	26.7	31.0	31.2	34.0	30.5	24.0
Taminick	Average Maximum	20.8	24.9	28.9	31.4	30.8	27.3	22.4
	2003/04 Minimum	3.5	8.4	12.6	9.9	11.9	9.0	6.0
	Average Minimum	6.8	9.1	11.5	14.1	13.8	10.6	6.9
	2003/04 Mean	9.7	17.5	21.8	20.5	23.0	19.8	15.0
	Average Mean	13.8	17.0	20.2	22.8	22.3	19.0	14.7
	2003/04 Rainfall	56	79	87	4	13	4	20
	Average Rainfall	60	56	41	56	37	38	47
King Valley	2003/04 Maximum	17.1	24.8	28.3	27.5	31.8	28.4	21.6
Edi Upper	Average Maximum	19.0	22.8	26.2	29.3	28.5	25.8	21.5
	2003/04 Minimum	5.1	9.4	12.3	11.5	14.6	11.4	7.8
	Average Minimum	7.2	9.3	11.3	13.5	13.8	11.1	8.4
	2003/04 Mean	11.1	17.1	20.3	19.5	23.2	19.9	14.7
	Average Mean	13.1	16.1	18.8	21.4	21.1	18.5	14.9
	2003/04 Rainfall	73	99	133	12	6	3	26
	Average Rainfall	101	82	71	63	52	55	64
Rutherglen	2003/04 Maximum	17.4	25.8	30.5	30.0	33.4	29.0	23.8
Research	Average Maximum	20.8	25.1	29.2	31.2	30.8	27.3	21.8
Station	2003/04 Minimum	3.9	7.4	13.2	11.3	13.8	8.1	6.4
	Average Minimum	6.3	8.6	11.4	13.7	13.9	10.9	7.1
	2003/04 Mean	10.7	16.6	21.9	20.7	23.6	18.6	15.1
	Average Mean	13.6	16.9	20.3	22.5	22.4	19.1	14.5
	2003/04 Rainfall	81	50	99	17	2	3	23
	Average Rainfall	59	44	44	37	35	38	42

Chart 1. North East Victoria 2004 Shiraz Berry Anthocyanins

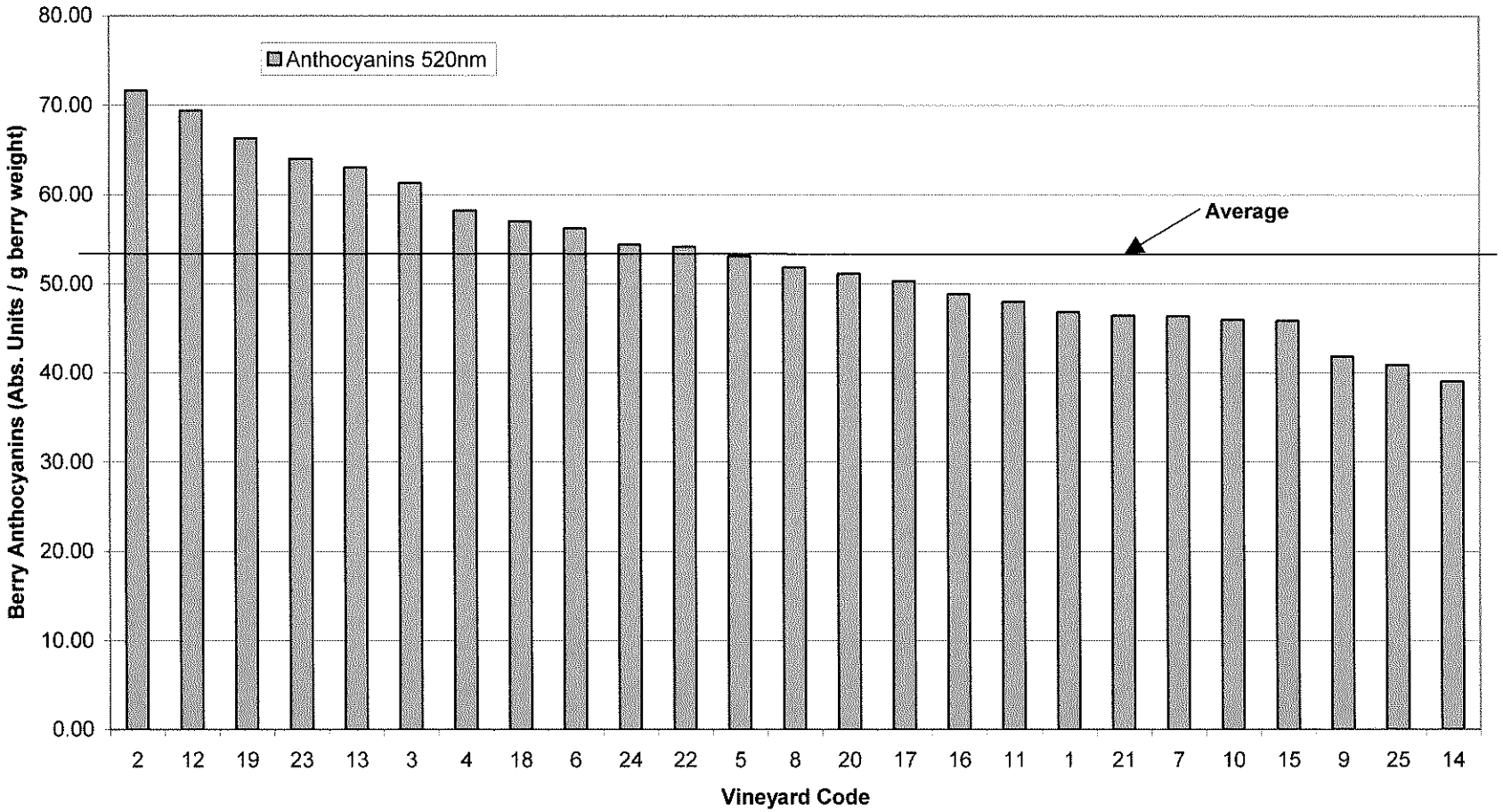


Chart 2. North East Victoria 2004 Shiraz
Combined Berry Anthocyanins, Flavonols and Total Phenolics

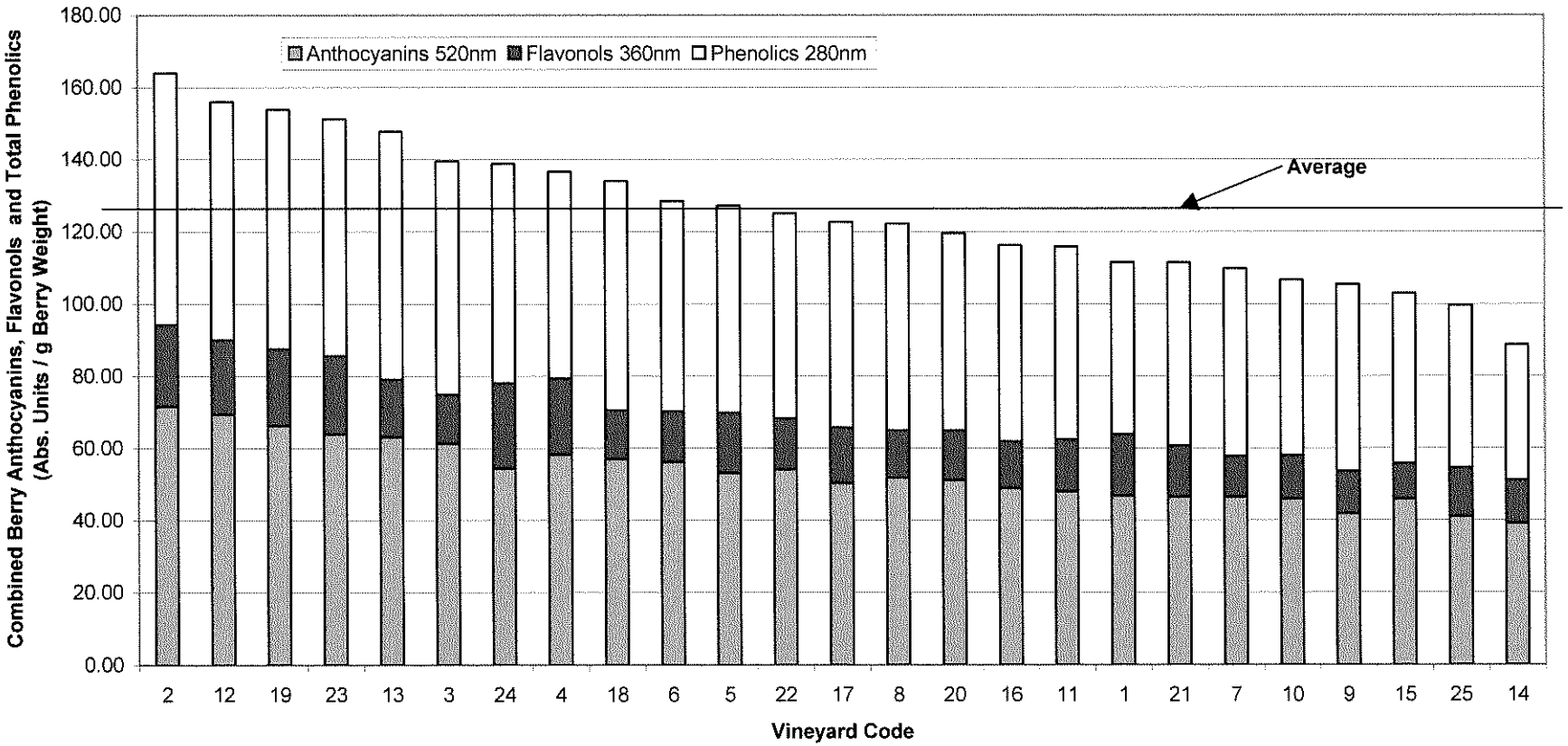


Chart 3. North East Victoria 2004 Shiraz Berry Anthocyanins vs. Yield

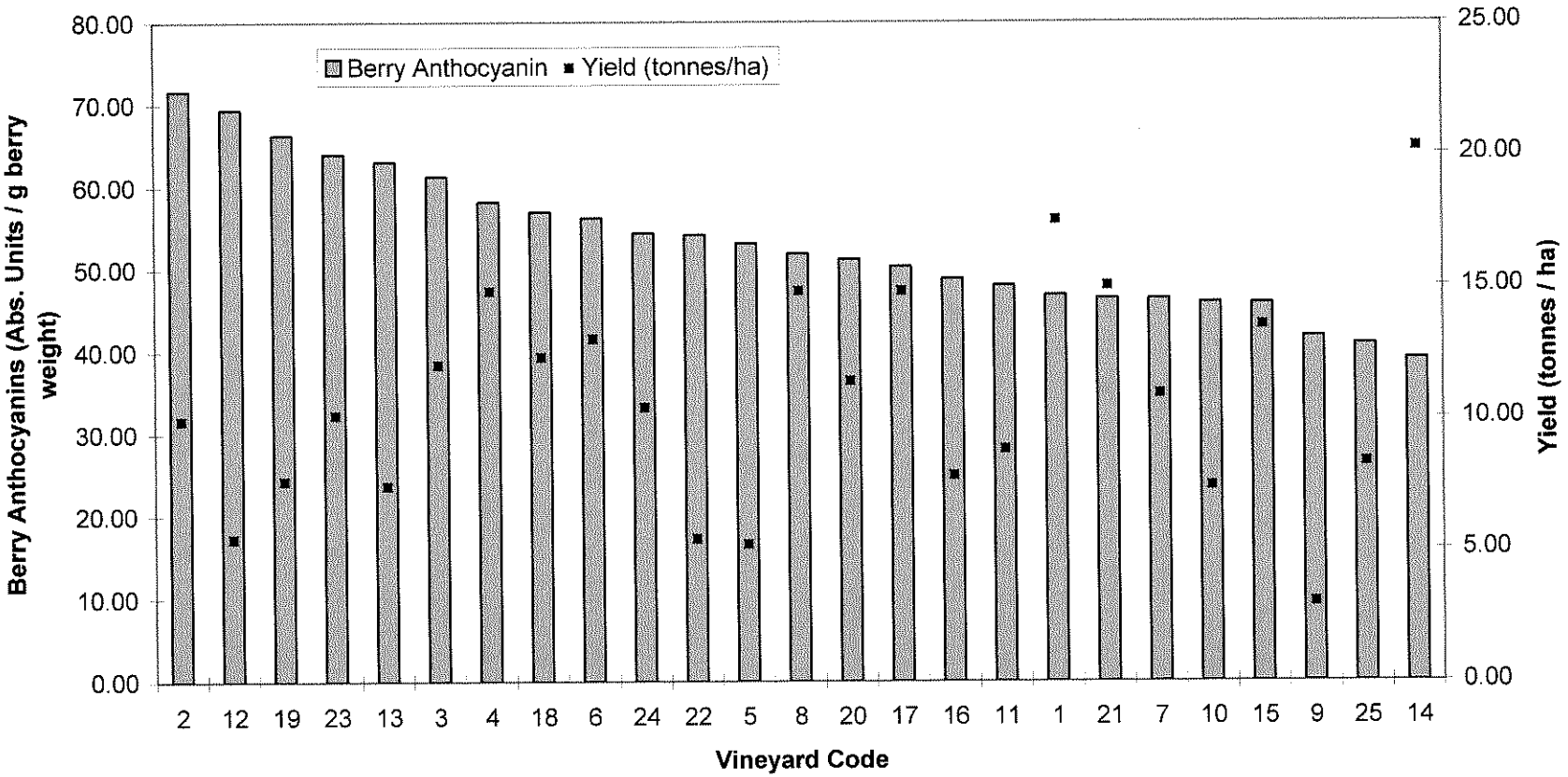


Chart 4. North East Victoria 2004 Shiraz Wine Anthocyanins

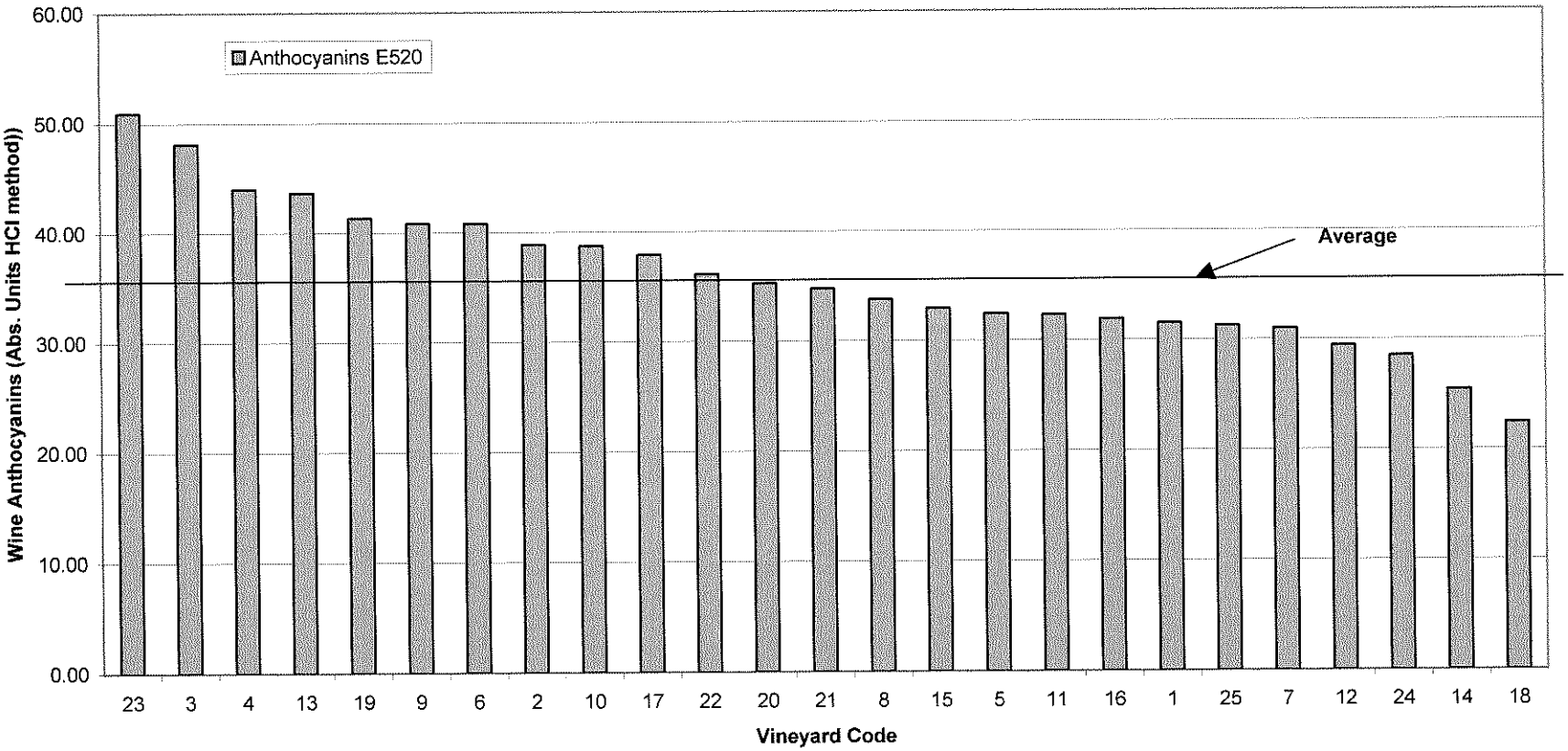
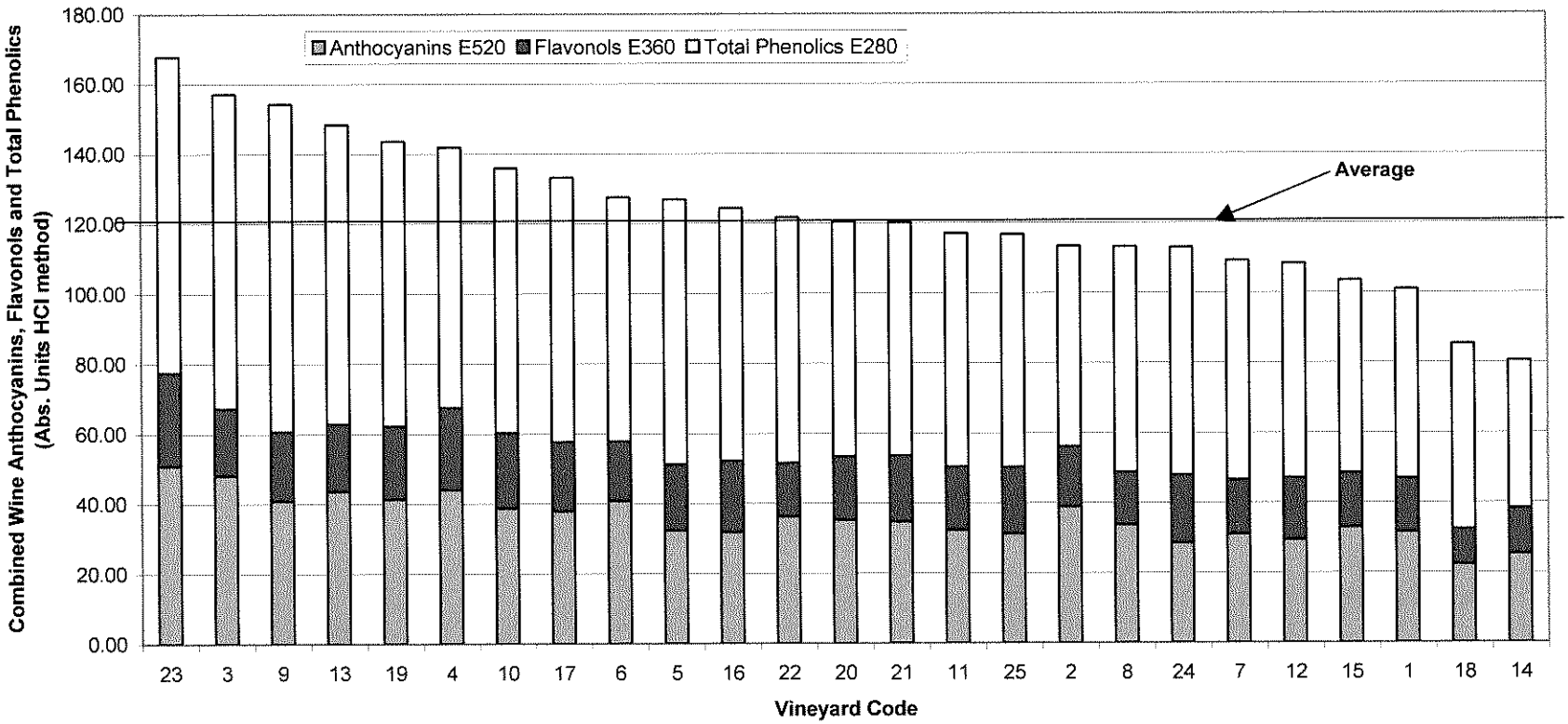


Chart 5. North East Victoria 2004 Shiraz
Combined Wine Anthocyanins, Flavonols and Total Phenolics



Discussion of Results: Vineyard Assessment.

The following points of discussion written by the author are presented as a source of information for discussion purposes only. The authors views are based on the following (a) Practical experience of grapegrowing in the King Valley Wine region for the past eighteen years (b) Reference to previous research results and published data (*referred to in italics*) (c) Participation in wine grape research projects (d) Extensive vineyard and weather observations throughout North East Victoria over the past eighteen years and (e) Extensive grape sampling for berry analysis for the past seven years.

The vineyard assessment sheet used in this project was developed in 2001 by Southcorp Wines in conjunction with Patrick Iland of Adelaide University. The assessment sheet is designed to record different canopy and crop characteristics. It is useful as a benchmarking tool for quantifying various aspects of the vineyard and to find trends for vineyards producing both good or poor quality fruit.

Due to the extremely dry conditions throughout January – April 2004 in all regions of North East Victoria many vineyards had similar canopy characteristics, therefore reducing the variation in several parameters of the assessment sheet. Statistically, this has resulted in poor relationships between some of the canopy characteristics and potential wine quality.

Previous research projects (*Luke Rolley, 2002, 2003 Wine Grape Quality Measurement and Benchmarking Group*)), using this assessment sheet have identified good to strong relationships between some canopy characteristics and final wine quality. They are as follows:

Shoot Periderm (Lignification).

The grape growing season can be divided into the growth stage and the ripening stage. Shoot lignification (or shoot maturity) signals the end of the growth stage and occurs shortly before veraison (the onset of the ripening stage). Previous projects (*Rolley 2002, 2003*) have shown that as a guide shoots need to be approximately 60% lignified at the start of veraison (resulting in 80 – 100% at harvest) in order for the vines to have sufficient reserves to be used throughout the ripening stage. If the vine has less than 60% shoot lignification at the start of veraison, shoot maturition competes with berry maturition resulting in less reserves being available for colour and flavour formation. In addition, the baumé level post veraison will be lower requiring more time for the berries to achieve target baumé levels.

Water management from flowering to veraison is extremely important in achieving a high rate of shoot lignification. Commonly practiced deficit irrigation regimes (regulated deficit and partial rootzone drying) that result in moderate water stress shortly after flowering have been shown to slow, then stop shoot growth and initiate the lignification process at the appropriate time. Over watering, either by natural rainfall or excessive irrigation throughout the flowering to veraison period will allow shoot growth to continue, therefore delaying the lignification process, resulting in a low rate of shoot lignification at veraison.

As a result of the extremely dry conditions, shoot lignification was high (70 – 100% at harvest) in all vineyards participating in this project, therefore minimizing the variation between vineyards for this parameter resulting in a poor relationship to potential wine quality. Previous projects (*Rolley 2002, 2003*) have shown a good relationship to final wine quality when the range is between 20%- 100% shoot lignification.

Discussion of Results: Vineyard Assessment (cont.)

Bunch Exposure

Research is still continuing on the effects of bunch exposure in different regions throughout Australia. It has been shown (*CRCV Winegrape Quality Management – Research to Practice)* that the appropriate level of bunch exposure will differ according to climate. In cool climates such as Alpine Valleys, Beechworth and King Valley increased bunch exposure (60 – 80%) after veraison leads to (a) An increase in sugar transfer to the berries resulting in improved ripening rate. (b) Improved microclimate around bunches resulting in improved disease prevention. (c) Improved light conditions at fruit zone resulting in increased levels of light dependant enzymes and abscisic acid, which are necessary for colour formation. In warm - hot climates high levels of bunch exposure (70 – 100%) after veraison should be avoided, as negative effects on colour are possible at temperatures above 27° Celsius.. This suggests that an appropriate level for Glenrowan and Rutherglen is 40 –60% bunch exposure after veraison.

Berry Size.

Generally, smaller berries produce higher quality wine, mainly due to a higher skin: juice ratio. Typically larger berries will contain a higher volume of juice than small berries, resulting in a dilution of colour. Large berry size also usually increases crop level (kgs per vine) resulting in more reserves being needed to ripen the crop. This means that fewer reserves are available for colour and flavour formation.

Water management from flowering to veraison is also extremely important in achieving smaller berries. Cell division, which largely determines the final berry size occurs shortly after fruit set. Moderate water stress applied at this stage will retard cell division resulting in smaller berry size. In this project, average berry size at harvest ranged from 11mm – >13mm in diameter. In North East Victoria, spring and early summer (December) rainfall is a significant factor in determining berry size (see Climate section)

Berry Colour

Berry colour can be visually assessed by taking a mouthful of berries and macerating the skins by chewing. Discard excess juice, and then squeeze skins between your thumb and forefinger for 10 – 15 seconds. The stain left on your fingers can then be assessed and recorded as very low – very high (vibrant). The results of this project showed a good relationship between berry colour and berry anthocyanin.

Measuring the four parameters outlined above at harvest reveals how the vineyard was managed throughout the season, in particular water management. The results from this project suggest that water management is a critical factor in wine grape quality. The results also suggest that vineyards with a high level of shoot lignification, appropriate berry size and appropriate yield, open and airy canopies with appropriate bunch exposure and high berry colour will lead to high quality grapes and potentially high quality wine. Conversely, vineyards with a low level of shoot lignification, large berry size and yield; dense canopies with shaded fruit and low berry colour will lead to low quality grapes and potentially low quality wine.

Discussion of Results: Berry Analysis

As mentioned earlier the berry anthocyanin levels at harvest have been used to determine wine grape quality and which vineyard and other berry measurements are related to potential wine quality. The berry analysis is an objective measure and is repeatable.

The results of this project have shown some very good relationships between berry anthocyanins and other berry components, namely flavonols and total phenolics. This means that grapes with a high level of anthocyanin (A.U. / g berry weight) are most likely to also have high levels of flavonols and total phenolics (A.U. / g berry weight). These relationships also suggest that berry anthocyanin analysis at harvest provides accurate information on all components of wine grape quality (colour, flavor and tannin).

The sampling of berries at three stages throughout the ripening period (11 - 12° Baumé, 12 -13° Baumé and at harvest) provided a very good picture of berry development and composition. The results at each sample time showed a large variation in berry components between vineyards within each region suggesting that there are several factors, which influence anthocyanin, flavonol and phenolic development.

These factors include the following:

Berries.
The statistical analysis in this project has shown that there is a relatively poor relationship between berry skin weight and berry anthocyanin. However, there is a better relationship between % skin/ berry weight and berry anthocyanin content (A.U. / g berry weight). This is consistent with a higher skin: juice ratio as mentioned earlier in this report.

Ripening Rate.
In order to achieve a continuous increase in levels of anthocyanins, flavonols and phenolics from veraison to harvest the grapes must have an uninterrupted, constant ripening rate. (*CRCV Winegrape Quality Management – Research to Practice)* If the ripening process is interrupted, causing a stalling or decrease of baumé level, these berry components may be diverted to other parts of the vine for carbohydrate storage purposes resulting in a minimal increase or a decrease in the levels of anthocyanins, flavonols and phenolics measured at harvest.

For a continuous ripening rate to occur, vine leaves – particularly the last eight to twelve on each cane – must be fully functional to allow maximum photosynthesis. Some vineyards in this project experienced erratic ripening rates suggesting that leaves were not fully functional throughout the ripening period.

Water Management.
Severe water stress resulting in the last eight to twelve leaves becoming parched and dry or senescing (turning yellow) during the final weeks before harvest may cause the vine to divert anthocyanins, phenolics and flavonols to other parts of the vine. This may cause a minimal increase or reduction in the levels of these components. The extremely dry conditions during January – April 2004 throughout North East Victoria resulted in some vineyards experiencing detrimental leaf condition well before harvest

Over watering, whether by natural rainfall or excessive irrigation during the ripening period may result in the berries "taking up" excess water, thereby diluting and reducing the levels of sugars as well as anthocyanins, phenolics and flavonols. It is therefore very important to ensure that vineyards are harvested before the onset of heavy autumn rains.

Discussion of Results: Berry Analysis (cont).

Crop Level.

It is the authors opinion that each vineyard will have an optimal crop level according to the vines capacity. According to (*CRCV Winegrape Quality Management – Research to Practice)* vine capacity is the total amount of growth of all parts of the vine, including shoots, fruit, trunk and roots. Vine capacity will differ from vineyard to vineyard depending on factors such as (a) soil characteristics, which determine the amount of water and nutrients available to the vine. (b) micro-climate, which influences growth through temperature and rainfall (c) vine / row spacing and (d) rootstock and clone selection. This means the optimal crop level will vary from vineyard to vineyard, and perhaps explains the reason why some vineyards can produce high quality grapes at higher crop levels than other vineyards, hence the relatively low relationship between yield and quality. Vine capacity will also differ from year to year due to climatic conditions that affect the amount of photosynthate that can be produced: i.e. less is produced in cool years.

The author believes that whenever a vineyards optimal crop level is exceeded, extra reserves are required to ripen the crop. This may reduce the amount of reserves available for colour and flavour formation, and may also result in insufficient reserves being available for good budburst and early shoot growth in the following season. Although there is not a strong relationship between yield and wine grape quality in this project, there is some evidence that the optimal crop level was exceeded in some vineyards. Slower than average ripening rates resulting in later than average harvest dates and below average levels of anthocyanins, flavonols and phenolics are examples of this.

Vine Nutrition.

Excessive Nitrogen will extend the growth stage of the vine's cycle, delaying the onset of cane lignification and veraison, therefore high levels of Nitrogen should be avoided. Deficiencies of other elements such as Phosphorous, Calcium, Potassium and Magnesium may also restrict the development of colour and flavour due to these nutrients competing for the vines reserves. Magnesium deficiency symptoms were evident on some vineyards in this project prior to harvest.

Site Characteristics.

Extensive berry analysis work undertaken in the King / Alpine Valleys by the author over the past seven seasons has shown a large variation in anthocyanin, flavonol and phenolic levels within each region. The auhors observations have revealed a number of site attributes and site limitations. They are:

Site attributes

(a) a high amount of morning sunlight at the fruit zone (b) east/west row orientation, which increases the amount of morning sunlight at the fruit zone (c) free draining soils (d) moderately fertile soils (e) good air flow.

Site limitations

(a) Limited amount of early morning sunlight; i.e. later sunrise. (b) high moisture retention soils (c) overly fertile soils (d) poor air flow.

The large variation in anthocyanin, flavonol and phenolic levels in this project suggests that these components are site dependent, and as such the values differ from site to site. Considering the large variation in site characteristics and topography throughout North East Victoria, site attributes and site limitations are possibly the main cause for variation in wine grape quality within each region.

Discussion of Results: Climate.

Due to the diverse range in climatic conditions throughout the five regions of North East Victoria, and the significant season to season variation in wine grape quality in some regions, the project steering committee thought it would be advantageous to link climatic data to the wine grape quality measurements. Unfortunately, it was beyond the scope of this project to install weather monitoring devices in each of the twenty five vineyards. However, it was decided to obtain one set of data for each of the five regions from a central location (where possible) within each region. Although the data does not reflect the microclimate of each vineyard, it does reflect the macroclimate of each region. The two elements measured are rainfall and temperature for each of the months of the grape growing season. Refer to Table 5 for the full set of data.

Rainfall

The following graph shows rainfall figures for the 2003/ 004 season. Rainfall is variable between the regions reflecting the drier regions of Genrowan and Rutherglen vs. the wetter regions of Alpine Valleys, Beechworth and King Valley.

Experience has shown that rainfall throughout October – December has a significant effect on shoot growth, and rainfall in December has a significant effect on berry development. As detailed in other sections of this report, berry size is very important in relation to wine grape quality. As can be seen there is a significant variation in rainfall between regions in December 2003 i.e. 87mm – 163mm. Therefore, it is very difficult- particularly in above average December rainfall years- to control / reduce berry size in the wetter regions, due to vines being irrigated by natural rainfall at this time. This problem is exacerbated on those sites with high moisture holding capacities.

The minimal rainfall figures throughout January – April for all regions, resulting in no effective rainfall from mid January to mid April is unusual and reflects the extremely dry conditions experienced this year. Rainfall occurring throughout the ripening months can also have a significant effect on wine grape quality. Rainfall events of greater than 50mm during this time causes a stalling or reduction of the ripening process, resulting in dilution of colour, flavour and sugars.

Another factor that may affect wine grape quality, and is usually associated with rainfall, is cloud cover. Anthocyanin, flavonol and phenolic development is dependent on solar radiation, therefore on cloudy days the production of these components is reduced. The abundance of cloudless days in all regions of North East Victoria throughout February to mid April 2004 is one of the reasons why the long term average levels of berry components were exceeded this season. The following graph shows the average daily cloud cover for King Valley recorded at 9am and 3pm for January – April on a scale of 0 (cloudless) to 8 (full cloud). As can be seen the 2003 / 2004 season was well below average throughout January – March. The above average figure for April reflects the rainfall event in mid April, and the cloudy conditions for two weeks thereafter.

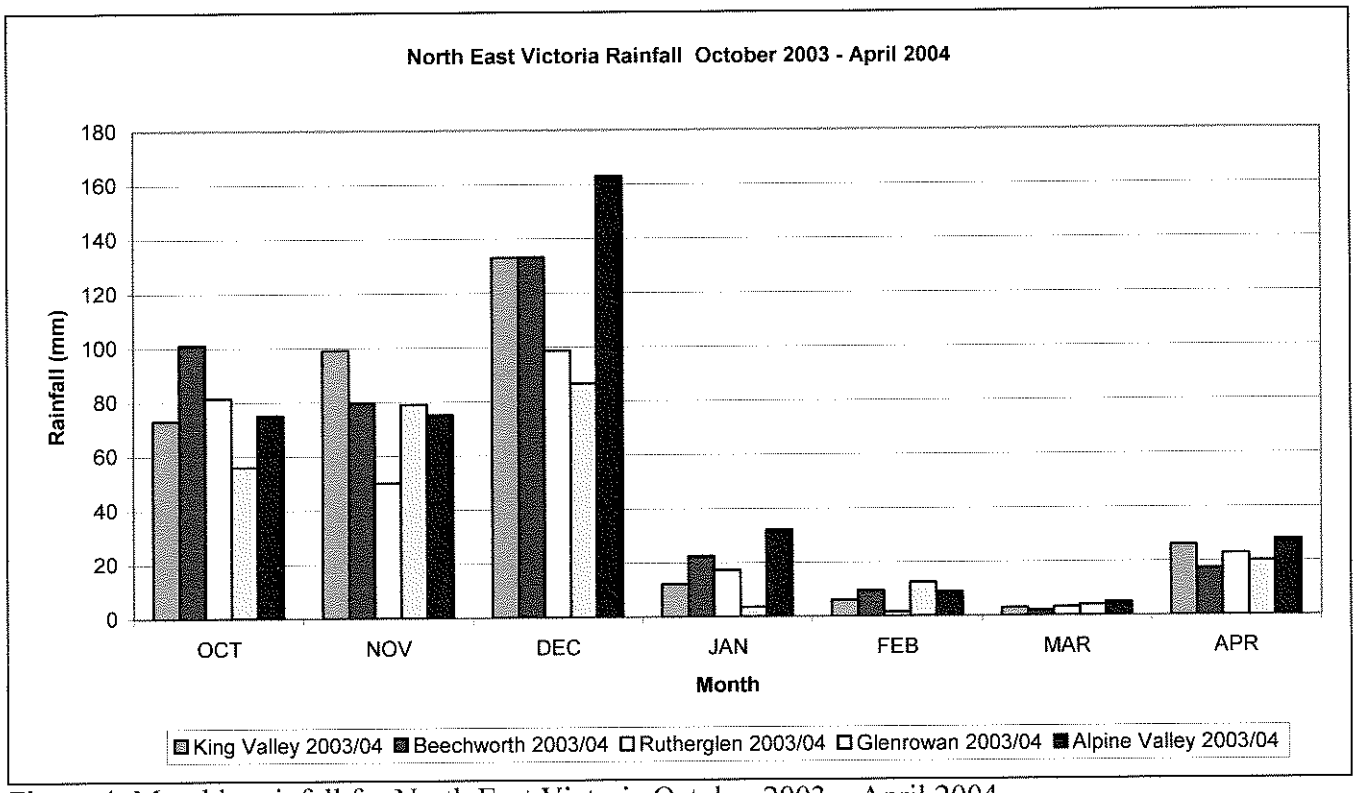
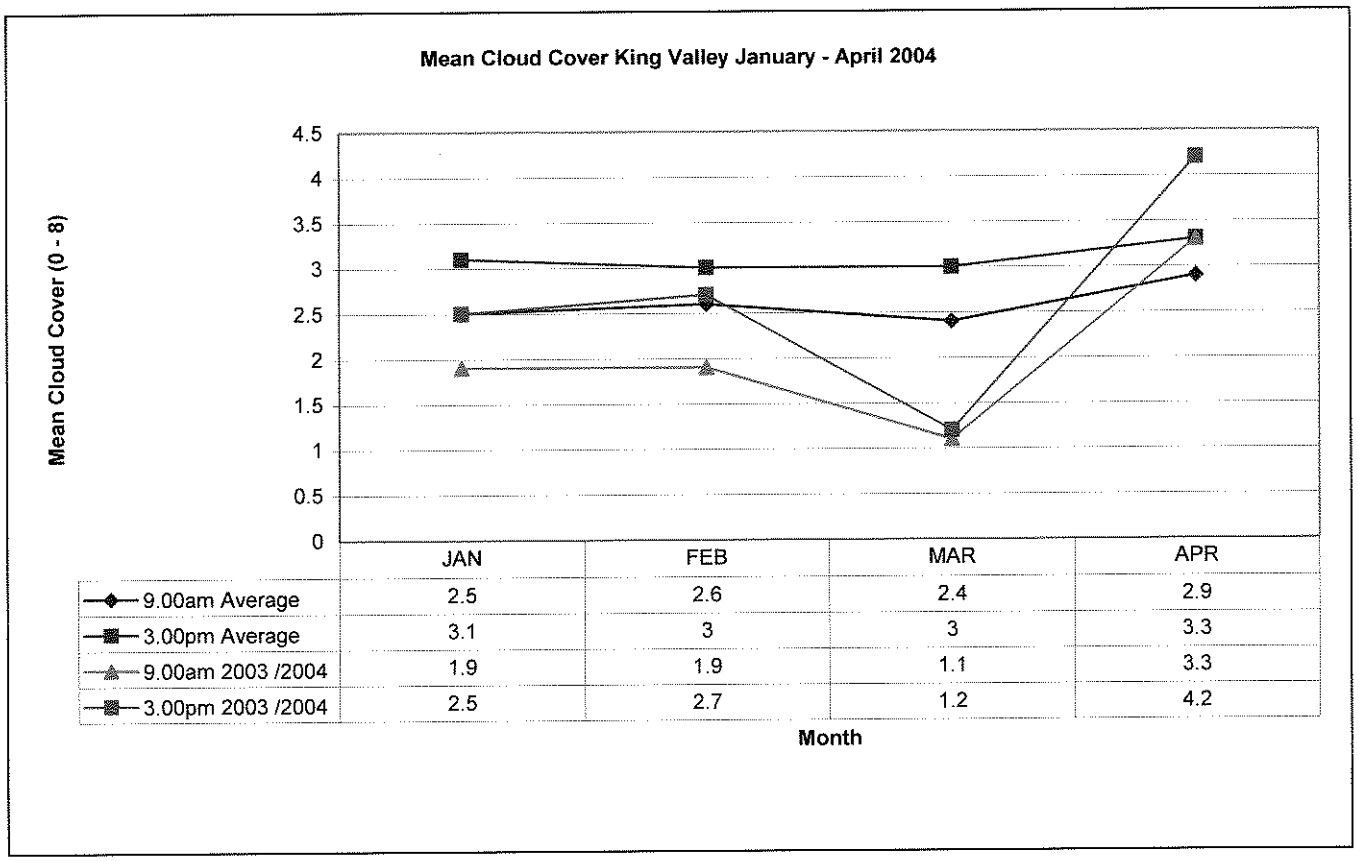


Figure 4. Monthly rainfall for North East Victoria October 2003 – April 2004.



	JAN	FEB	MAR	APR
9.00am Average	2.5	2.6	2.4	2.9
3.00pm Average	3.1	3	3	3.3
9.00am 2003 /2004	1.9	1.9	1.1	3.3
3.00pm 2003 /2004	2.5	2.7	1.2	4.2

Figure 5. Long term average (1985-2003) and 2004 mean cloud cover for King Valley.

Discussion of Results: Climate (cont.)

Temperature

Temperature is also variable between the regions, reflecting the warmer regions of Glenrowan and Rutherglen vs. the cooler regions of Alpine Valleys, Beechworth and King Valley. The following graphs show the average daily maximum and minimum temperatures for the 2003/ 2004 season, and the variation from the long term average mean temperature for the 2003 /2004 season. As can be seen, the maximum temperatures throughout the ripening months (post veraison) of February, March and April vary between the regions and months, with March and April progressively becoming cooler.

Previous research (*P. Iland et al. Canopy microclimate and berry composition. Aust. Journal Grape and Wine Research Vol. 6 2000)* has shown that colour enzymes are temperature sensitive and the optimum temperature range was found to be 17 - 27° Celsius. Heat above 27° will slow enzyme activity. The study also showed that fully exposed berries can be up to 10° Celsius higher than ambient temperature. This year, the optimal temperature range was exceeded in all regions throughout February and March (refer to Table 5 for long term average temperatures). The higher average maximum temperature for the Glenrowan and Rutherglen regions is the reason why it is probably more appropriate to have medium bunch exposure (40 – 60%) post veraison as this reduces berry temperature. Throughout these months the maximum temperature for all regions is attained between 2 – 3pm. This means that the optimum temperature range (17 -27° Celsius) in North East Victoria is exceeded at approximately 12noon – 1pm. Therefore, a vast majority of anthocyanin production occurs during the morning hours throughout February, March and mostly during the morning hours in April.

Minimum temperatures also vary between regions and months, with March and April also becoming progressively cooler. Low nighttime temperatures are also very important for anthocyanin and in particular, flavonol development. Local research (*A. S. Buchanan)* has found that low night temperatures coupled with wind chill and radiative loss of heat can result in berries (and leaves) being up to 5° Celsius lower than ambient temperature by early morning. This leads to a reduced ability for the vine to synthesise and store materials at the time in the 24 hour period when the stomata are fully open: they close later in the heat of the day. To restore berry tissue temperature rapidly in the early morning sunlight (which lacks heat), the berries deposit the coloured anthocyanin pigments in the skin and these absorb much of the visible light energy of the sunlight and convert it to heat. The ability of the vine to synthesise and store secondary products such as flavonols is thus enhanced during the most favourable period of the 24 hours.

Provided leaves and berries are well exposed to early morning sunlight, the long slow ripening of berries in cool climates can be very advantageous for producing high quality grapes as indicated by high skin colour densities.

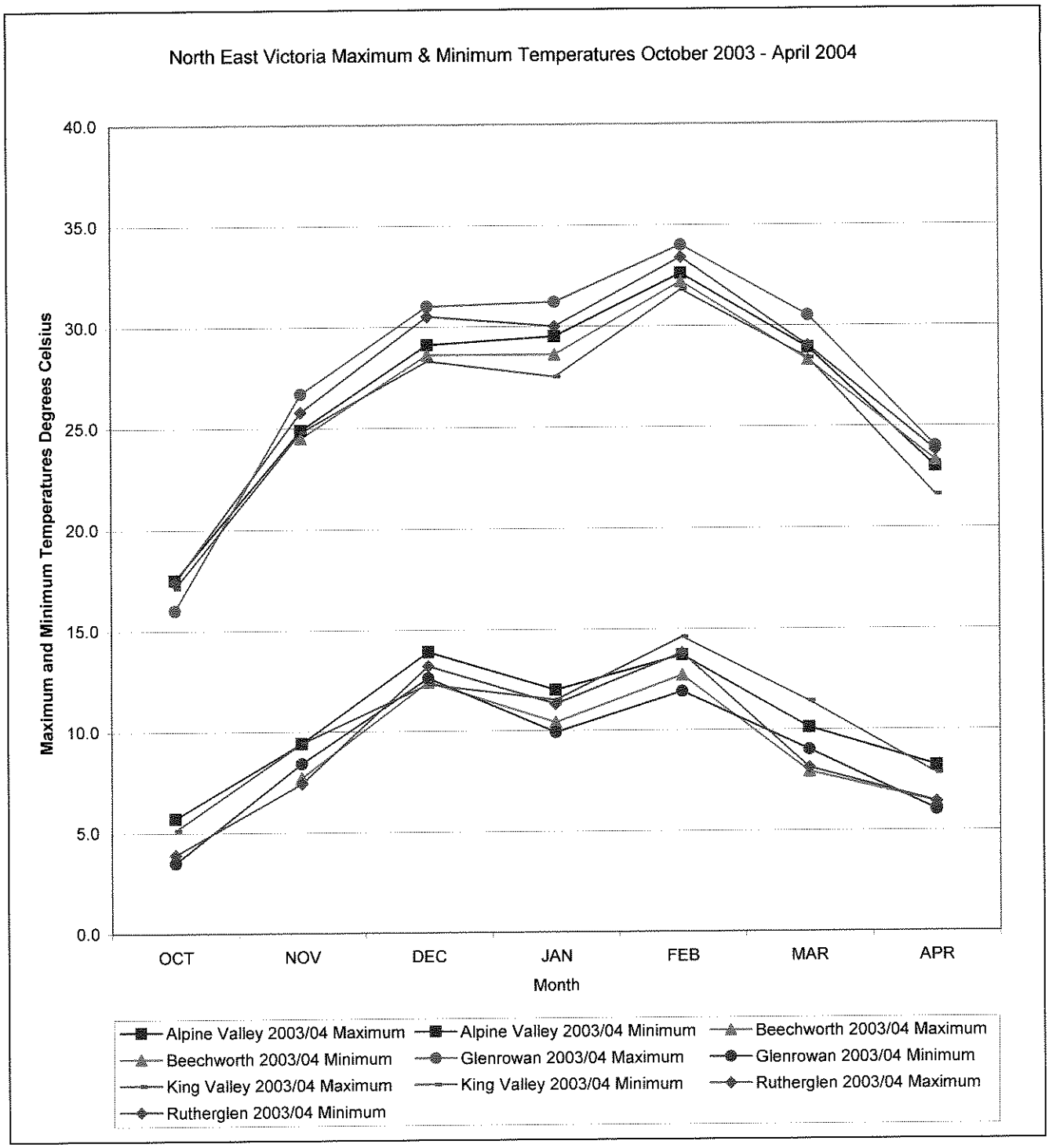


Figure 6. Mean maximum and mean minimum daily temperatures measured for the period October 2003 – April 2004 for the five regions of North East Victoria Wine Zone.

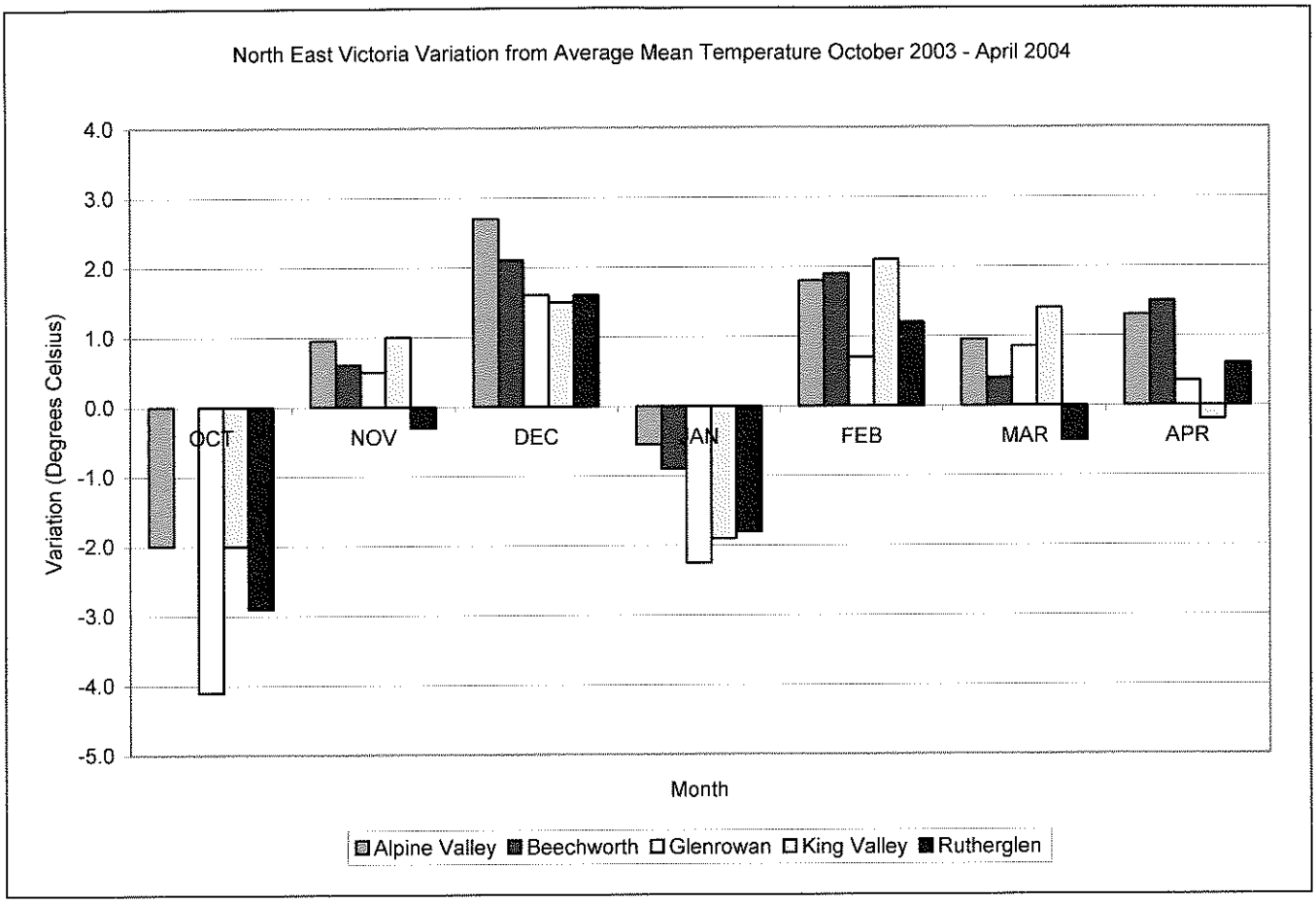


Figure 7. The deviation from the long term average daily mean temperatures measured for the period October 2003 to April 2004 for the five regions of North East Victoria Wine Zone.

Statistical Analysis.

The following table shows the relationship between the vineyard canopy characteristics and the berry anthocyanin level. Due to the very dry conditions experienced in all regions of North East Victoria this year, many vineyards had similar canopy characteristics regardless of berry anthocyanin values. This reduced the variation both within and between vineyards, thus influencing these results. As such, none of these results (with the exception of berry colour) can be considered statistically, as having good to very good relationships. Generally a value of 0.6 or greater is regarded as significant. However, it is pleasing to see that some of the characteristics previously identified as having good relationships with final wine quality; i.e. berry colour and berry size have the highest values. In interpreting these results, higher values mean a higher relationship with berry anthocyanin. A negative value; i.e. berry size, means that as berry size decreases, anthocyanin levels increase. A positive value; i.e. berry colour, means that as berry colour increases, anthocyanin levels also increase. Interestingly, in these results lateral growth of second eight nodes has a high negative value. This reflects either excessive shoot growth early in the season or excessive irrigation later in the season resulting in extensive lateral growth. Another interesting result is fruit zone width, suggesting that a thinner fruit zone is preferable. This is a reflection of foliage managed trellis types; i.e. V.S.P; Smart Dyson and Scot Henry. All of these vertical trellis types are known to have greater light interception, which is necessary for anthocyanin development.

Correlation of vineyard characteristics with Anthocyanin per g berry weight.

Vineyard characteristic	Correlation with Anthocyanin / g berry weight
Shoot length	0.00
Shoot length variation	-0.04
Shoot trim	-0.03
Lateral growth first 8 nodes	-0.15
Lateral growth second 8 nodes	-0.35
Shoot periderm	-0.17
Leaf plucked	-0.23
Leaf condition first four leaves	-0.09
Leaf condition second four leaves	-0.04
Fruit exposure	0.12
Light condition at fruit zone	-0.04
Leaf layer number	-0.06
% fruit in light	0.11
Spread of fruit	-0.16
Fruit zone height	-0.15
Fruit zone width	-0.36
Berry size	-0.35
Berry shrivel	0.02
Pulp description	0.12
Flavour intensity	0.31
Skin chewiness	0.27
Berry colour	0.63
Tannin intensity	0.32
Seed lignification	0.20
Cropload	-0.21

Statistical Analysis.

The following table shows the relationship between berry characteristics and berry anthocyain level. These results show a very good relationship between berry phenolics and berry anthocyanins, and a good relationship between berry flavonols and berry anthocyanins. This means that berries that have high anthocyanins will also have high phenolics and will mostly have high flavonols. The results also show a general trend that as % skin increases anthocyanin levels also increase and that as berry weight decreases anthocyanin levels increase.

Correlation of Berry Characteristerics with Anthocyanins per g berry weight.

Berry Characteristic	Correlation with Anthocyanin / g berry weight
Flavonols 360 units per g berry weight	0.72
Phenolics 280 units per g berry weight	0.93
Seed extract 280 nm	0.18
Av Berry Wt	-0.32
Av Skin Wt	0.08
% Skin	0.41
Av Seed Wt	-0.27
% Seed	0.20
Baume	0.24
st dev average berry weight	0.20
st dev av skin wght	-0.12
st dev %skin per berry	-0.14
st dev av seed wght	0.31
st dev %seed per berry	-0.05
st dev baume	0.02
st dev flavanols 360	0.28
st dev phenolics 280	-0.01
st dev seed extract 280	-0.29

Statistical Analysis.

The following tables show the correlations between individual wine quality measures and berry characteristics. Results from previous projects have shown a strong relationship between berry anthocyanins, flavonols and phenolics and wine anthocyanins, flavonols and phenolics when standardized fermentation procedures / methods were used. This project is a commercial study and therefore non standardized fermentation procedures / methods were employed. The large variation in fermentation procedures / methods have influenced the following results, resulting in lower relationship values being recorded.

Analysis of relationship between wine measurements and berry characteristics.

(1) Total phenolics E280

Berry characteristic	Correlation with wine total phenolics
Anthocyanin 520 units per g berry weight	0.26
Flavonol 360 units per g berry weight	0.13
Phenolics 280 units per g berry weight	0.42
Seed extract 280 nm	0.40
Av Berry Wt	-0.40
Av Skin Wt	-0.17
% Skin	0.41
Av Seed Wt	0.15
% Seed	0.51
Baume	0.35

(2) Flavanols E360

Berry characteristic	Correlation with wine flavonols
Anthocyanin 520 units per g berry weight	0.25
Flavonol 360 units per g berry weight	0.45
Phenolics 280 units per g berry weight	0.26
Seed extract 280 nm	0.06
Av Berry Wt	-0.03
Av Skin Wt	-0.03
% Skin	0.02
Av Seed Wt	0.07
% Seed	0.10
Baume	0.21

Statistical Analysis.

Analysis of relationship between wine measurements and berry characteristics.

(3) Anthocyanins E520

Berry characteristic	Correlation with wine anthocyanins
Anthocyanin 520 units per g berry weight	0.42
Flavonol 360 units per g berry weight	0.25
Phenolics 280 units per g berry weight	0.43
Seed extract 280 nm	0.19
Av Berry Wt	-0.30
Av Skin Wt	-0.06
% Skin	0.42
Av Seed Wt	0.06
% Seed	0.36
Baume	0.25

(4) Colour Density E520 + E420

Berry characteristic	Correlation with wine colour density
Anthocyanin 520 units per g berry weight	0.42
Flavonol 360 units per g berry weight	0.24
Phenolics 280 units per g berry weight	0.45
Seed extract 280 nm	0.20
Av Berry Wt	-0.33
Av Skin Wt	-0.08
% Skin	0.45
Av Seed Wt	0.04
% Seed	0.39
Baume	0.26

Statistical Analysis.

Analysis of relationship between wine measurements and berry characteristics.

(5) Modified anthocyanins E420

Berry characteristic	Correlation with wine modified anthocyanin
Anthocyanin 520 units per g berry weight	0.40
Flavonol 360 units per g berry weight	0.20
Phenolics 280 units per g berry weight	0.45
Seed extract 280 nm	0.21
Av Berry Wt	-0.39
Av Skin Wt	-0.13
% Skin	0.48
Av Seed Wt	-0.02
% Seed	0.43
Baume	0.27

(6) Hue index E420/E520

Berry characteristic	Correlation with wine hue index
Anthocyanin 520 units per g berry weight	0.17
Flavonol 360 units per g berry weight	0.07
Phenolics 280 units per g berry weight	0.29
Seed extract 280 nm	0.15
Av Berry Wt	-0.35
Av Skin Wt	-0.22
% Skin	0.33
Av Seed Wt	-0.24
% Seed	0.32
Baume	0.26

Conclusions:

Wine Grape Quality Measurement

This project has identified the large variation in climatic conditions throughout the grape growing regions of North East Victoria during the 2003 / 2004 season. Whilst all regions experienced temperatures, which deviated from the long term average, the amount of deviation differs greatly from region to region, with some regions recording below average temperatures and others recording above average temperatures for the same month. This variation in climatic conditions has influenced the quality of wine grapes produced, with some Shiraz vineyards not realizing their full potential in the 2003 / 2004 season.

Climatic conditions also vary widely from season to season, and as such wine grape growers need to understand both the average and the expected extremes during the season and modify vineyard management practices each year to meet the seasonal conditions.

The objective berry measurements at harvest highlighted very pleasing relationships between the berry components. The previous samples (11-12° Baumé and 12-13° Baumé) resulted in a better understanding of berry composition and the development of anthocyanins, flavonols and phenolics of Shiraz grapes during the ripening period.

The results of this project also highlight the benefits to both the grower and the winemaker in undertaking objective berry measurements. By analyzing berries prior to harvest each year, growers can build a history of the quality of each block and therefore this will greatly assist with price negotiations. Likewise, wineries can batch the intake of grapes according to a known level of quality, therefore fully optimizing tank space as well as grape / wine quality.

Benchmarking:

Although the climatic conditions reduced the variation in canopy characteristics, the results of the vineyard assessment sheet validate the previous projects findings. (*Rolley 2002, 2003*) It can be concluded that Shoot Lignification, Bunch Exposure, Berry Size, and Berry Colour are key indicators of Shiraz wine grape quality and therefore wine quality. These points give a good indication of how the vineyard was managed throughout the season. It is also very likely that these indicators will apply to other varieties as well.

The variation in wine grape quality within each region highlights that there is considerable scope and potential for improvement, and this benchmarking project has assisted growers in establishing their position within their region.

Presentation of Results:

Upon the completion of this report the project steering committee will hold a meeting with participants in a group forum to discuss the results of the project. All participants will receive a copy of this report and feedback will be sought on the future direction of a wine grape quality measurement and benchmarking project. As part of the presentation, a selection of wines made from grapes from this project, will be assessed by an independent winemaker and discussed during a tasting session. Regional characteristics and flavour will be the focus of the discussions.

Future Direction for Project:

It was beyond the scope of this project to investigate all aspects of each vineyard site, however the large variation between vineyards within the same region has raised the question Are there site specific factors that we have not measured or recorded? These factors include the following:

- Microclimate – Temperature, Rainfall, Humidity, Evaporation, Sunshine hours.
- Aspect and elevation – The amount of morning sunlight, Prevailing wind direction.
- Soil – Type, Depth, Water holding capacity.
- Irrigation – Quantity of water applied throughout the season
- Health of vines – Nutrient status, Fertiliser program

Utilisng the data that we now have, it would be logical to repeat the project next year in order to compare the variability of this season with next season. It would also be advantageous to select three key sites within each region and undertake a more intensive study taking into account the site specific factors as mentioned above, in particular the microclimate of each site. This would involve installing temperature monitoring devices at each vineyard.

By taking both regional and site specific factors into account, a site index for each region could then be established which would rate each vineyard according to site attributes or limitations.

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Paul Dahlenberg, Baileys of Glenrowan; Tony Ciavarella, Ciavarella Wines

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