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Assessing Yield Water Use Efficiency (WUE) in the Murray Valley and Riverina wine regions

Season 2012/13

Prepared for : Murray Valley Winegrowers' Inc and Riverina Wine Grapes Marketing Board

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Murray Valley Winegrowers' Inc

Riverina WINE GRAPES MARKETING BOARD

gwrdc GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION REGIONAL

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EXECUTIVE SUMMARY

Murray Valley Winegrowers' Inc (MVWI) and Riverina Wine Grapes Marketing Board (RWGMB) are working collaboratively to examine water use efficiency for the production of wine grapes in each region. A combined total of eighty-six individual data sets were collected from both regions in 2012/13, comprising forty-three data sets from both the Murray Valley and Riverina wine regions.

Average water use and Yield water use efficiency (Yield WUE) were calculated for each region and individual summaries were prepared for each vineyard data set (supplied separately). Yield WUE is expressed as t/ML and is calculated by dividing yield (t/ha) by the volume of water applied (ML/ha) during the growing season.

Executive Summary Table 1: Details of the data sets collected for the each region

Region	Season 2011/12		Season 2012/13		Same data sets in both years	New data sets in 2012/13
	Data sets	Varieties	Data sets	Varieties		
Murray Valley	62	Semillon Chardonnay Shiraz Cabernet Sauvignon	43	*Gordo (Murray Valley) Semillon (Riverina) Chardonnay Shiraz Cabernet Sauvignon	28	15
Riverina	32		43		5	38
TOTAL	**94**	Same varieties	**86**	Semillon excluded and *Gordo included in Murray Valley in 2012/13	**33**	**53**

Only 28 of the 62 growers who submitted data from the Murray Valley, and 5 of the 32 growers who submitted data from the Riverina in 2011/12, submitted data in 2012/13. This should be taken into consideration when comparing the regional averages for the two seasons of this study.

Murray valley wine region

The 2012/13 growing season was drier than the 2011/12 season with 182 mm falling from July 2012 to June 2013 compared to 304 mm for the same period in 2011/12, or 122 mm (1.22 ML/ha) less rainfall overall.

No data was submitted for Semillon this season. Data was provided for Gordo instead. This will have an impact on the regional averages in 2012/13 compared to 2011/12.

The average water use was 7.7 ML/ha for drip and 8.2 ML/ha for low level sprinkler irrigated vineyards in season 2012/13, compared with 4.3 ML/ha for drip and 6.6 ML/ha respectively in season 2011/12. An increase in water use of 3.1 ML/ha (72%) for drip irrigated vineyards and 1.6 ML/ha (24%) for low level sprinkler irrigated vineyards was observed in season 2012/13 due to the drier seasonal conditions.

On average, low level sprinkler irrigated vineyards used an additional 0.5 ML/ha (or 6% more water) than drip irrigated vineyards. However, they produced 1.9 t/ha (or 8%) less yield on average than drip irrigated vineyards in the Murray Valley wine region in season 2012/13.

- The average production for each variety in 2012/13 was: Gordo 38.8 t/ha, Chardonnay 29.1 t/ha, Shiraz 21.2 t/ha and Cabernet Sauvignon 18.4 t/ha. Each variety yielded higher on average when compared to the 2011/12 season: Chardonnay 25.7 t/ha, Shiraz 19.9 t/ha and Cabernet Sauvignon 18.2 t/ha.
- An average yield of 27.0 t/ha was produced on drip irrigated vineyards, compared to 25.1 t/ha on low level sprinkler irrigated vineyards in the Murray Valley in 2012/13. The average yields in 2011/12 were 21.6 t/ha on drip irrigated vineyards and 23.4 t/ha on low level sprinkler irrigated vineyards.
- Average water use for each variety in 2012/13 was: Gordo (8.9 ML/ha), Chardonnay (8.1 ML/ha), Shiraz (7.5 ML/ha) and Cabernet Sauvignon (7.4 ML/ha). The average water use by variety in 2011/12 was: Semillon (4.7 ML/ha), Chardonnay (5.1 ML/ha), Shiraz (5.3 ML/ha) and Cabernet Sauvignon (4.9 ML/ha).

The average Yield WUE of drip irrigated vineyards in 2012/13 was 3.7 t/ML compared to 5.3 t/ML in 2011/12; a reduction of 1.6 t/ML (30%).

The average Yield WUE of low level sprinkler irrigated vineyards in 2012/13 was 3.2 t/ML compared to 3.7 t/ML in 2011/12; a reduction of 0.5 t/ML (14%).

Drip irrigated vineyards are on average 14% more efficient users of water than low level sprinkler irrigated vineyards, based on Yield WUE of 3.7 t/ML and 3.2 t/ML respectively.

- Yield WUE ranged from 1.5 ML/t (least efficient), to 6.6 t/ML (most efficient), with an average WUE of 3.5 t/ML for all vineyards surveyed (drip and low level sprinkler).

Riverina wine region

The 2012/13 growing season was much drier than the 2011/12 season with 327 mm falling from July 2012 to June 2013, compared to 561 mm for the same period the previous year, or 234 mm (2.34 ML/ha) less rainfall overall.

Only one data set was submitted for furrow irrigated vineyards this season. Therefore, no comparisons can be made between seasons for this irrigation application method.

The average water use in 2012/13 was 4.0 ML/ha for drip irrigated vineyards, compared to 2.8 ML/ha in season 2011/12. An increase in water use of 1.2 ML/ha (43%) for drip irrigated vineyards was observed in season 2012/13, due to the drier seasonal conditions.

A 2.1 t/ha (16%) increase in yield, with 15.1 t/ha produced in 2012/13 compared to 13.0 t/ha in 2011/12 was also observed for drip irrigated vineyards in the Riverina wine region.

- The average production for each variety in season 2012/13 was: Semillon 20.4 t/ha, Chardonnay 14.0 t/ha, Shiraz 15.0 t/ha and Cabernet Sauvignon 10.5 t/ha. Semillon and Shiraz yielded higher on average and Chardonnay and Cabernet Sauvignon yielded lower, when compared to the 2011/12 season: Semillon 14.7 t/ha, Chardonnay 14.7 t/ha, Shiraz 9.7 t/ha and Cabernet Sauvignon 12.0 t/ha.
- An average yield of 14.9 t/ha was produced in 2012/13 compared to 13.0 t/ha in 2011/12; an increase of 1.9 t/ha across all varieties on drip irrigated vineyards in the Riverina.
- Average water use for each variety in 2012/13 was: Semillon (4.6 ML/ha), Chardonnay (3.5 ML/ha), Shiraz (4.4 ML/ha) and Cabernet Sauvignon (2.7 ML/ha). The average water use by variety in 2011/12 was: Semillon (3.4 ML/ha), Chardonnay (3.1 ML/ha), Shiraz (2.7 ML/ha) and Cabernet Sauvignon (2.7 ML/ha).

The average Yield WUE of drip irrigated vineyards in 2012/13 was 3.9 t/ML compared to 5.0 t/ML in 2011/12, a reduction of 1.1 t/ML (22%).

- Yield WUE ranged from 1.6 ML/t (least efficient) to 6.2 t/ML (most efficient), with an average WUE of 3.9 t/ML for all vineyards surveyed (drip and furrow) in 2012/13.

In many cases, Riverina wine growers had their production capped at 12.5 t/ha for red varieties and 20 t/ha for white varieties in season 2011/12. This may have been one of the key drivers for lower average yield and water use in the Riverina wine region last season.

Yield caps for the growers who submitted data were less of a driver in season 2012/13, and this may be one of the reasons the average yield for some varieties was higher in comparison to last season. This highlights the extent that external forces have on production levels in different seasons.

Regional comparisons

The average water application for all varieties in the Murray Valley was 7.9 ML/ha compared to 4.0 ML/ha in the Riverina, a difference of 3.9 ML/ha (or 49%) in season 2012/13.

- By comparison, the average water application for all varieties in the Murray Valley was 5.1 ML/ha compared to 3.0 ML/ha in the Riverina, a difference of 2.1 ML/ha (or 41%) in season 2011/12.

The average yield for all varieties in the Murray Valley was 26.4 t/ha compared to 14.9 t/ha in the Riverina, a difference of 11.5 t/ha (or 44%). While the Murray Valley applied almost twice the volume of water per hectare, a similar increase in yield was also achieved in season 2012/13.

- The average yield for all varieties in the Murray Valley in season 2011/12 was 22.2 t/ha compared to 12.8 t/ha in the Riverina, a difference of 9.4 t/ha (or 42%). Similarly, while the Murray Valley applied more water per hectare, a similar increase in yield was also achieved in season 2011/12.

The average Yield WUE for the Murray Valley was 3.5 t/ML compared to 3.9 t/ML in the Riverina, a difference of 0.4 t/ML (11%) in season 2012/13.

- The average Yield WUE for the Murray Valley was 4.7 t/ML compared to 4.6 t/ML in the Riverina, a difference of 0.1 t/ML (3%) in season 2011/12.

This demonstrates that both regions are able to grow grapes with similar water use efficiencies (differences of 0.1 t/ML to 0.4 t/ML), depending on seasonal conditions.

Executive Summary Table 2: Snapshot of key WUE indicators for each region

Region	Season	Annual rainfall (mm)	Irrigation application method	Average irrigation (ML/ha)	Average yield (t/ha)	Average water application (L/Kg)	Average Yield WUE (t/ML)
Murray Valley	**2011/12**	304 mm	Drip	4.3 ML/ha	21.6 t/ha	236 L/Kg	5.3 t/ML
			Low level sprinkler	6.6 ML/ha	23.4 t/ha	306 L/kg	3.7 t/ML
	2012/13	182 mm	Drip	7.7 ML/ha	[2]27.0 t/ha	312 L/Kg	3.7 t/ML
			Low level sprinkler	8.2 ML/ha	25.1 t/ha	369 L/Kg	3.2 t/ML
Riverina	**2011/12**	561 mm	Drip	2.8 ML/ha	13.0 t/ha	239 L/Kg	5.0 t/ML
			Furrow	3.7 ML/ha	12.0 t/ha	348 L/Kg	3.2 t/ML
	2012/13	327 mm	Drip	4.0 ML/ha	14.9 t/ha	285 L/Kg	3.9 t/ML
			[1]Furrow	N/A	N/A	N/A	N/A

[1] Only one data set was submitted for a Riverina furrow irrigated vineyard in 2012/13
[2] The average yield was higher due to inclusion of Gordo instead of Semillon in 2012/13

As with last season, there was a broad range of yields produced at similar rates of irrigation application rates. This indicates that there is the potential to reduce the volume of water applied, or change the irrigation application method, with no detriment to production expected, in some instances.

Similarly, 22 of the 43 growers in the Murray Valley and 23 of the 43 growers in the Riverina had lower Yield WUE scores than the average and this indicates that a number of wine growers may have the capacity to improve irrigation efficiencies. This would be dependent on the capacity of each grower to improve Yield WUE, while ensuring that fruit is produced 'fit for purpose' and that quality parameters are preserved.

This may, or may not, result in increased vineyard profitability (economic WUE was not assessed in this study). In some cases there may be limitations on achieving further efficiencies due to the irrigation infrastructure in place. Additional efficiencies are expected if drainage past the root zone is monitored closely.

The study highlights that the average Yield WUE in the Murray Valley and Riverina are very similar, based on the comparative volume of irrigation applied and the subsequent yield that is produced in each region.

INTRODUCTION

Retallack Viticulture Pty Ltd (Retallack Viticulture) was engaged by Murray Valley Wine growers' Inc (MVWI) and Riverina Wine Grapes Marketing Board (RWGMB) to analyse irrigation water use efficiency data for the 2012/13 growing season. A similar study was conducted in 2011/12.

Funding for this project was provided by the Grape and Wine Research and Development Corporation (GWRDC) Regional program.

Seasonal conditions

Weather conditions during the 2012/13 season were drier and warmer than the 2011/12 season. The mean average rainfall was below the long term average and the mean maximum monthly temperature was above average in both regions.

From July 2012 to June 2013 the Murray Valley received 182 mm of rainfall, compared to 327 mm in the Riverina in season 2012/13. Last season 304 mm rainfall occurred in the Murray Valley and 561 mm in the Riverina in 2011/12.

Bureau of Meteorology (BoM) temperature and rainfall data from the 2012/13 growing season for the Murray Valley (Mildura Airport weather station) and Riverina (Griffith Airport weather station) wine growing regions is presented in **Figures 1 to 8**. Additional weather data is presented in **Appendix 1a and b.**

Growers can access weather data from a station closer to their property (or review data from previous seasons), by visiting www.bom.gov.au/climate/data/index.shtml

Mildura weather data

The rainfall from July 2012 to June 2013 was 182 mm (108 mm below the long term mean of 291 mm), and 122 mm less than the 2011/12 season where 304 mm fell, see **Figure 1.**

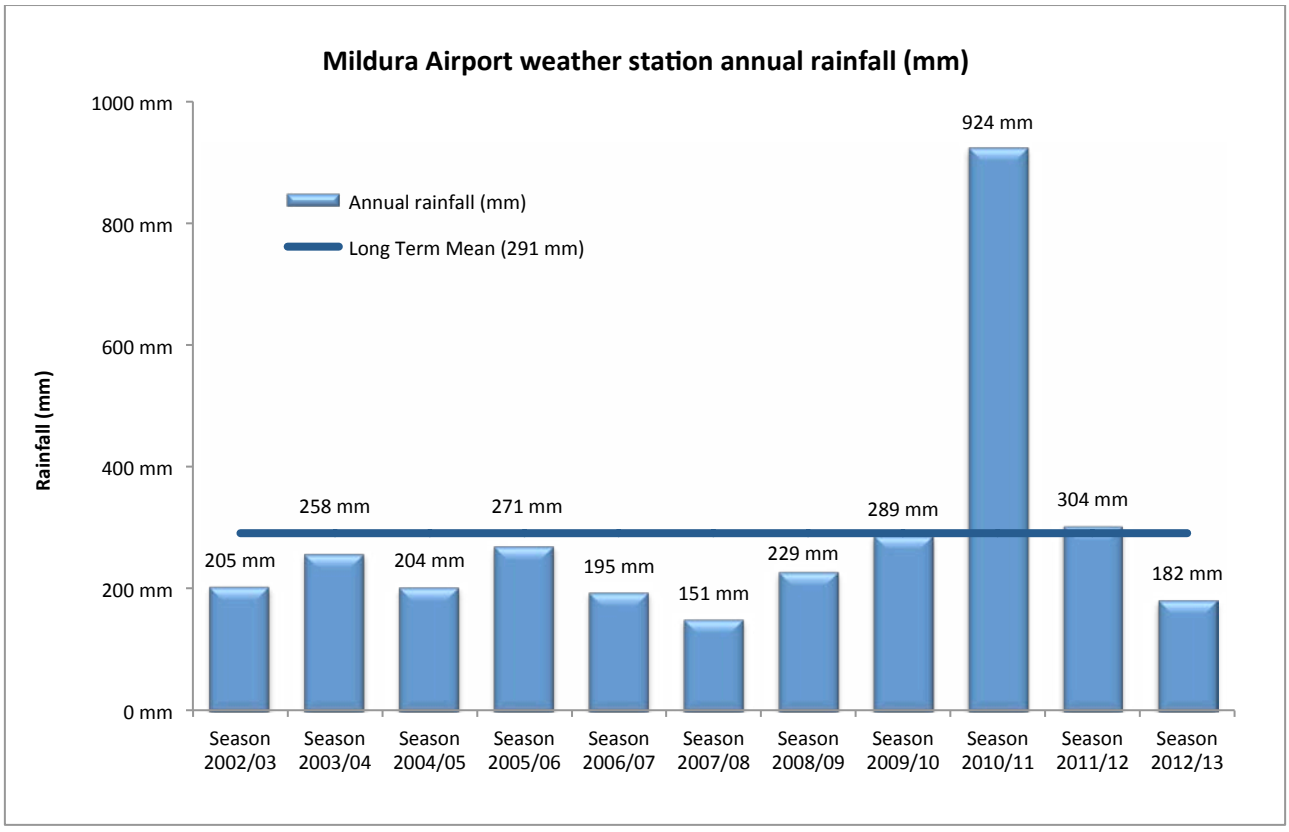

Figure 1 : Mildura Airport weather station – long term mean versus seasonal rainfall (mm)

Rainfall was below average for the entirety of the growing season from August to April, and rebounded to 'above average' in May and June after vintage. The monthly rainfall recorded at the Mildura Airport weather station is presented in **Figure 2**.

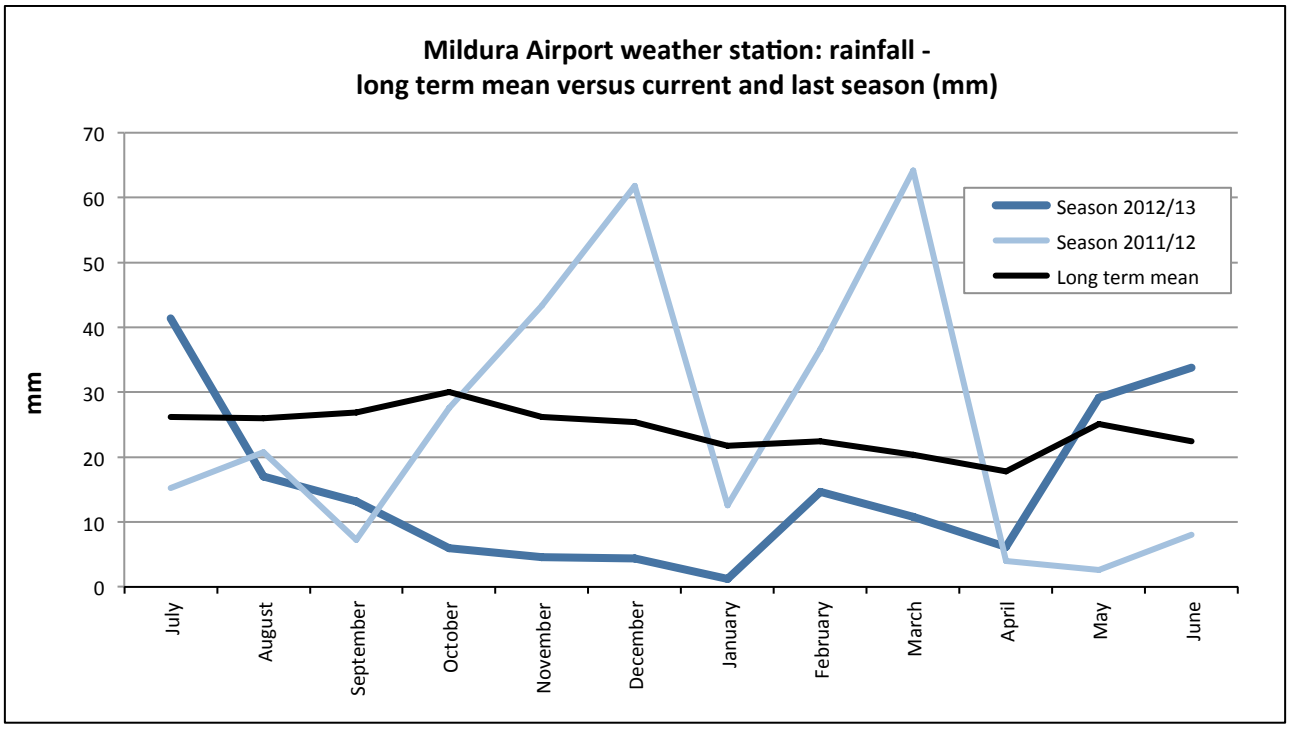

Figure 2 : Mildura Airport weather station – long term mean rainfall versus current and last season (mm)

Mean maximum temperature was warmer than the long term average for the entirety of the growing season. The mean maximum temperature recorded at the Mildura Airport weather station is presented in **Figure 3**.

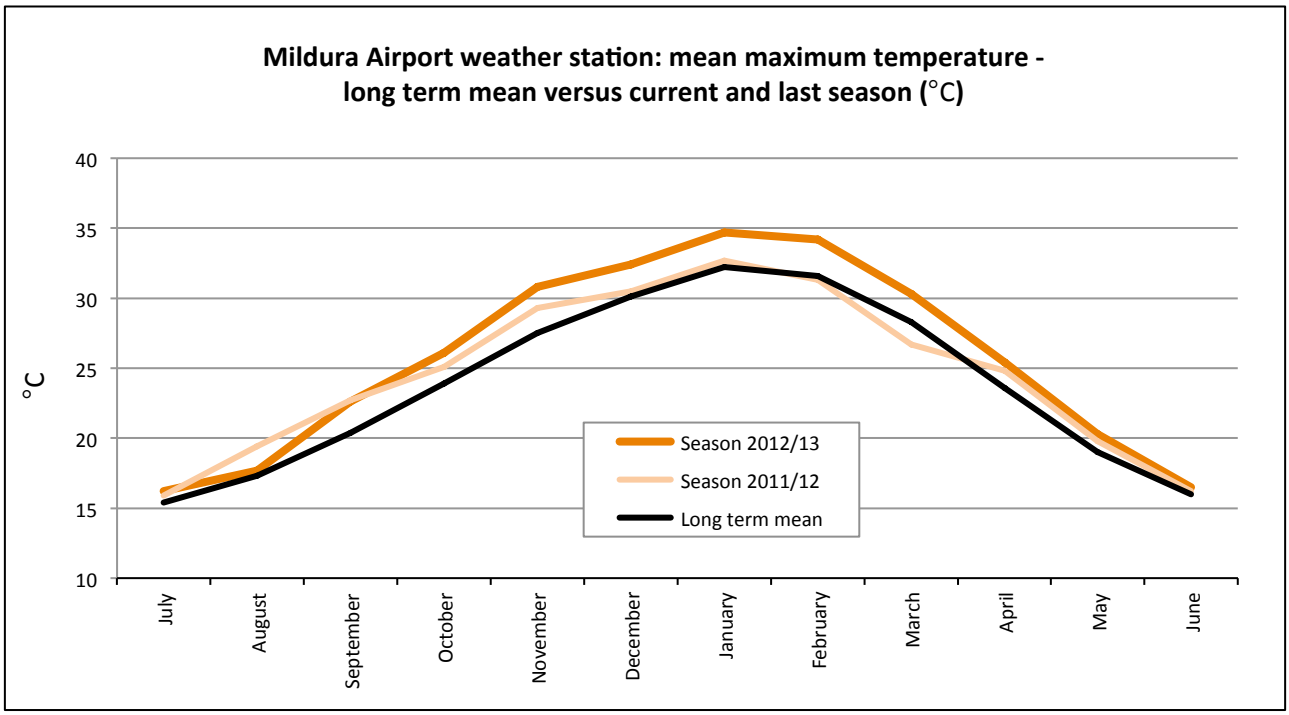

Figure 3 : Mildura Airport weather station – long term mean max temp versus current and last season (°C)

Riverina weather data

Mean monthly rainfall from July 2012 to June 2013 was 327 mm (77 mm below the long term mean of 403 mm), and 234 mm less than the 2011/12 season, where 561 mm fell, see **Figure 4**.

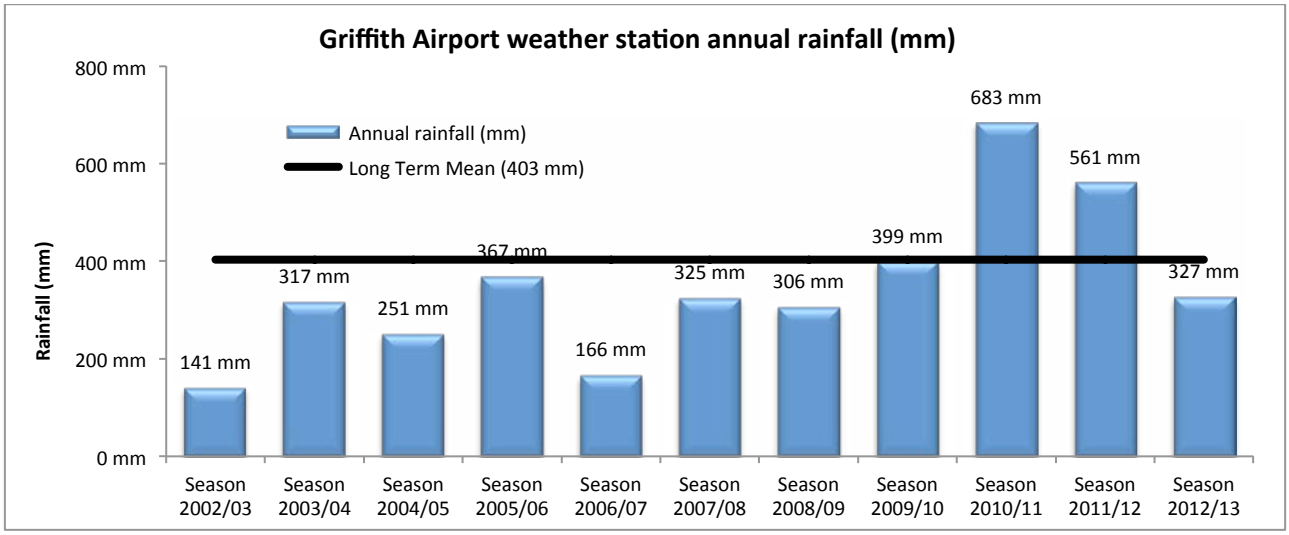

Figure 4 : Griffith Airport weather station – long term mean versus seasonal rainfall (mm)

Rainfall was below average from July to October, at the start of the growing season, but rebounded in November with rainfall 61 mm above the monthly average. Rainfall in December and January was again below average, with no rainfall recorded in January.

Rainfall rebounded in February with 19 mm above average occurring. The remainder of the season was 'on par' with the long term average, with the exception of April which was well below the long term average, with only 1.6 mm recorded.

A summary of the monthly rainfall recorded at the Griffith Airport weather station is presented in **Figure 5**.

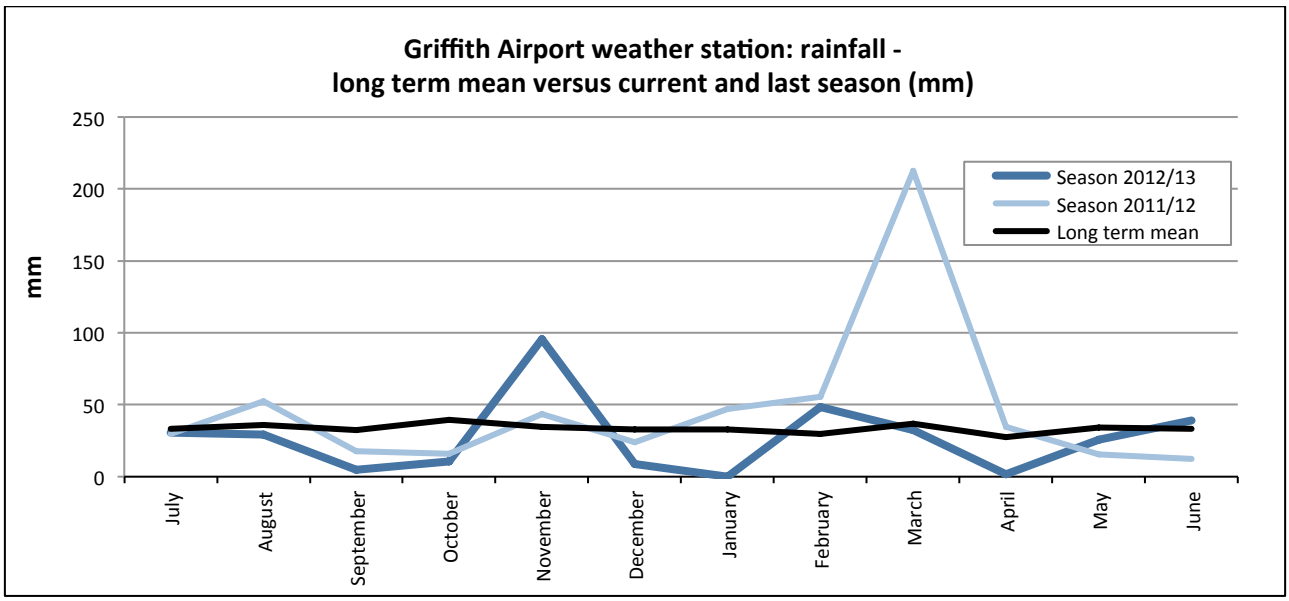

Figure 5 : Griffith Airport weather station – long term mean rainfall versus current and last season (mm)

Mean maximum temperature was 'on par' at the start of the growing season (July and August), warmer than the long term average from September to February, back 'on par' from March to May and above average for June. A summary of the mean maximum temperature recorded at the Griffith Airport weather station is presented in **Figure 6**.

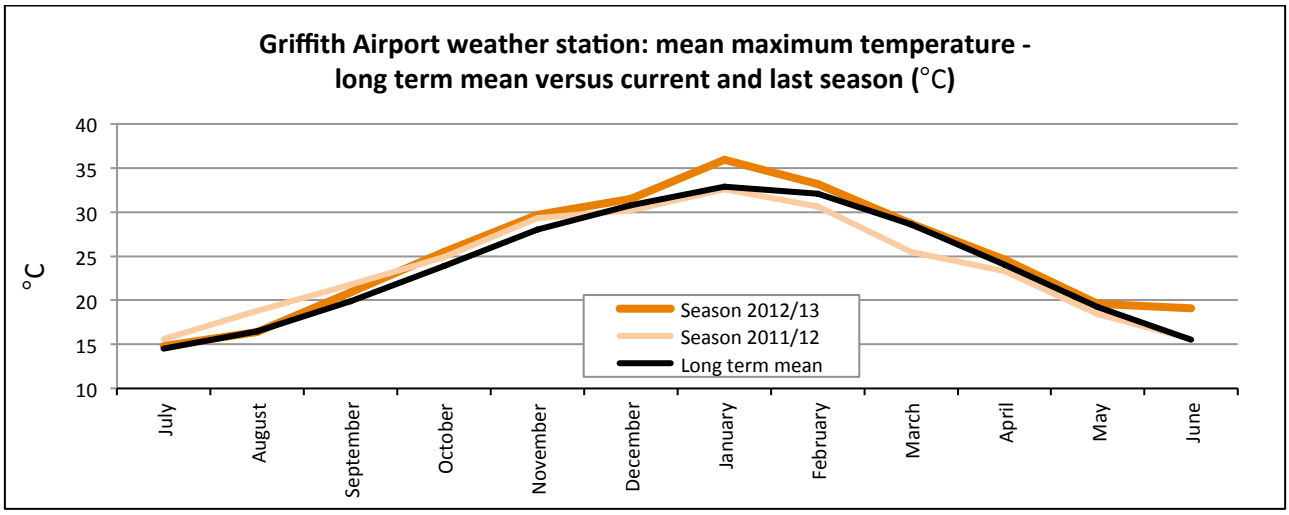

Figure 6 : Griffith Airport weather station – long term mean max temp versus current and last season (°C)

Regional weather data seasonal comparisons

A summary of the mean rainfall and mean maximum temperatures recorded at the Murray Valley and Griffith Airport weather station is presented in **Figures 7 and 8.**

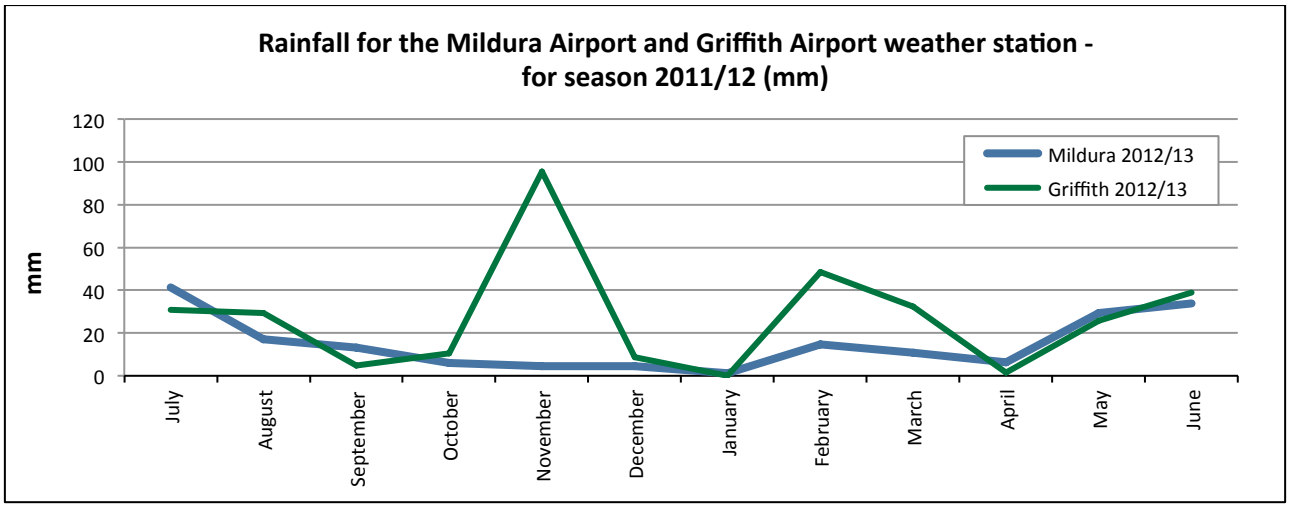

Figure 7 : Rainfall for the Mildura Airport and Griffith Airport weather station for season 2012/13

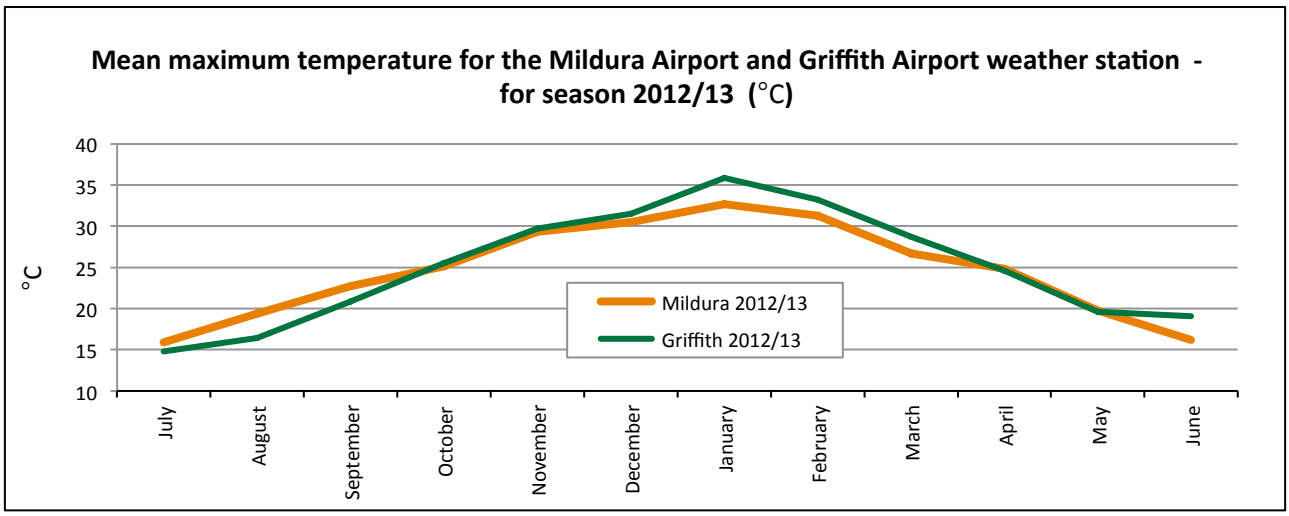

Figure 8 : Temperature for the Mildura Airport and Griffith Airport weather station for season 2012/13

METHODOLOGY

Data collection

Irrigation, phenology and yield data was collected by Liz Singh and April Winckel from MVWI, and Kristy Bartrop from RWGMB for the 2012/13 growing season. This is the second consecutive season of this study. A data coding system was used to maintain grower confidentiality.

Data collected from each region varied in detail and comprised:

- **Murray valley wine region**
  - Variety (*Gordo, Chardonnay, Shiraz and Cabernet Sauvignon),
  - Own roots or rootstock (Ramsey, Ruggeri 140, Paulsen 1103, Schwarzmann, Richter 99, Kober 5BB, K51-40, SO4 and Dogridge),
  - Drip or low level sprinkler irrigation,
  - Yield (t/ha),
  - Soil type, and
  - Water applied throughout the growing season (ML/ha) and collated by the key EL growth stages.

* Data was collected for Gordo in 2012/13 and Semillon in 2011/12.

- **Riverina wine region**
  - Variety (Semillon, Chardonnay, Shiraz and Cabernet Sauvignon),
  - Own roots or rootstock (Ramsey, Schwarzmann, Paulsen 1103),
  - Drip or *furrow irrigation,
  - Yield (t/ha), and
  - Water applied throughout the growing season (ML/ha) and collated by the key EL growth stages.

* Only one set of data was submitted for furrow irrigation. No seasonal comparisons are presented for furrow irrigation in the Riverina.

A copy of the data presented for analysis for each region is presented in **Appendix 2a and b**.

Data analysis and reporting

A combined total of eighty-six individual data sets were collected from both regions. Forty-three data sets from both the Murray Valley and Riverina wine region were forwarded to Mary Retallack from Retallack Viticulture for analysis.

The following regional data codes were used in the 2011/12 season:

- Murray Valley - 'Vineyard **MV**'# 1 to 62 (28 data sets were received from existing growers in 2012/13),
- Riverina - 'Vineyard **R**#' 1 to 32 (5 data sets were received from existing growers in 2012/13).

Where data was received from the same grower and block in both years, the same unique data code was used. Many growers did not submit data in both seasons. New data sets were assigned a new unique data code in season 2012/13, which continued on from last season. For example:

- Murray Valley wine region - 'Vineyard **MV**'# 63 to 77 (15 new data sets received), and
- Riverina wine region - 'Vineyard **R**#' 33 to 70 (38 new data sets received).

Data is presented using key grapevine growth stages and standard units of measurement.

Key grapevine growth stages

Key grapevine growth stages used in this study are:

- Bud burst (EL 4) to flowering (EL 26),
- Fruit set (EL 27) to veraison (EL 35),
- 100% Veraison (EL 36) to harvest (EL 38), and
- Post harvest (EL 41) to end of leaf fall (EL 47).

The same benchmark indicators have been used in both seasons of this study.

Benchmark indicators

Hectare has been adopted as the standard unit of measurement. The following indicators of irrigation performance have been used in this report:

- Yield is expressed as tonnes per hectare (t/ha),
- Water applied is expressed as megalitres per hectare (ML/ha), and
- Yield WUE is expressed as tonnes per megalitre (t/ML).

Tonnes per hectare (t/ha)

The weight of fruit (t) produced per hectare (ha) can be used as a direct measure of production over a standard area. However, in isolation, this does not capture the optimal production capacity of a particular management unit in relation to the volume of water applied, or the quality of fruit produced in relation to end use specifications.

Megalitres per hectare (ML/ha)

The volume of water applied in megalitres (ML) per hectare (ha) can be used as a direct measure of water use for a standard unit of measurement. However it is not always a good indicator of WUE. For example, an irrigator that applies the lowest ML/ha may not be the most efficient water user. Similarly, the volume of water applied may not result in increased production or fruit quality. The volume of water applied per vine may also differ depending on the row and vine spacing, emitter spacing and output.

The volume of water derived via rainfall in each region can be estimated from historical BoM records. As a general rule of thumb, for every 100 mm that falls, this equates to 1.0 ML/ha.

Yield WUE = Y/I

Water use efficiency is defined in this study as the relationship between the yield (Y) produced at harvest, divided by the volume of irrigation (I) applied between budburst to harvest.

Yield is expressed as tonnes per hectare (t/ha), and volume of irrigation is expressed as megalitres of water applied per hectare (ML/ha).

Yield WUE is expressed as t/ML and is calculated by dividing 'Y' (t/ha) by the volume of water 'I' (ML/ha). This provides an indication of how efficiently each tonne of grapes is produced for each megalitre of water applied. This measure does not take into account parameters such as fruit quality.

Virtual WUE

Alternatively, a calculation such as megalitres used to produce a tonne of fruit (ML/t) can be used, and is calculated by dividing the volume of water (ML/ha) applied during the growing season by the yield (t/ha).

More commonly, litres used to produce a kilogram of fruit (L/Kg) are often quoted when calculating 'virtual' water use for different crops. To convert (ML/t) to litres per kilogram (L/kg), multiply by 1000.

Alternative WUE criteria

There are a number of other factors that may be assessed when looking at WUE that have not been addressed here. They include:

- End point use of fruit,
- Application efficiency (irrigation water applied less drainage losses). A high proportion of water may go directly to drainage where irrigation application practices are poorly understood or managed,
- A differentiation between 'standard' and 'deficit irrigation' application in different seasons,
- Rainfall and winter irrigation application is not included in the irrigation application figures,
- The minimum irrigation application required to limit the build-up of salinity is not identified, and
- The economic WUE ($/ML) is not assessed.

RESULTS AND DISCUSSION

Murray Valley wine region

Data received

No data was submitted for Semillon this season. Data was provided for Gordo instead. This will have an impact on the regional averages in 2012/13 compared to 2011/12.

A total of 43 irrigation data sets were received from Murray Valley wine growers. A summary of the data sets received is presented in **Appendix 2a.** A breakdown of data by variety, irrigation application method, own roots or rootstock, is presented in **Tables 1 to 3** and **Figure 9**.

Table 1 : Murray Valley irrigation data received by variety

Number of data sets	Variety				
	Gordo	Chardonnay	Shiraz	Cabernet Sauvignon	Total
	8	13	12	10	43

Table 2 : Murray Valley irrigation data received by application method (drip or low level sprinkler)

Number of data sets	Irrigation application method		
	Drip	Low level sprinkler	Total
	25	18	43

Table 3 : Murray Valley vines grown on own roots or rootstock

Number of data sets	Vines on own roots or rootstock		
	Own roots	Rootstock	Total
	9	34	43

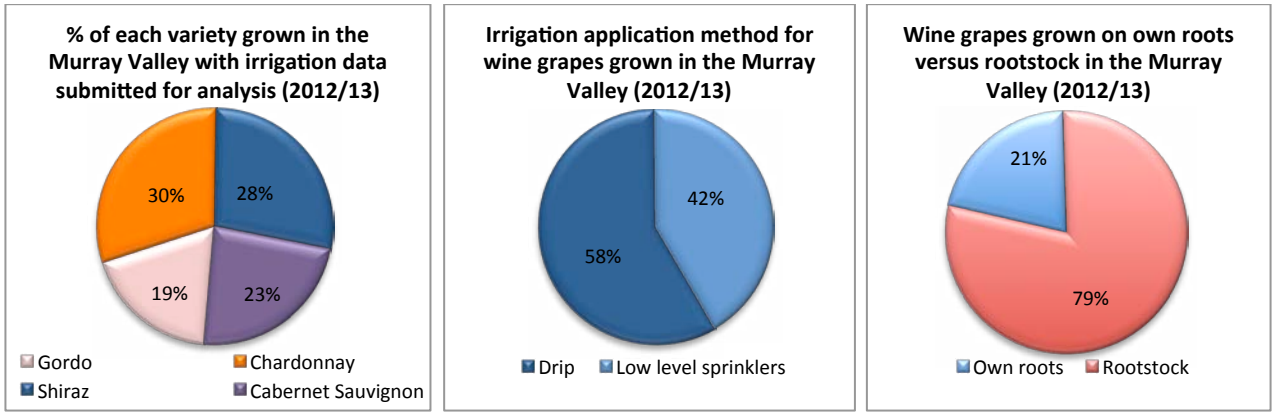

Figure 9 : Irrigation data by variety, application method, own roots or rootstock in the Murray Valley

Murray Valley data set

Key observations for season 2012/13 include:

- The yields across all varieties varied from 10.4 t/ha (Vineyard MV59 – Cabernet Sauvignon on own roots, low level sprinklers) to 51.1 t/ha (Vineyard MV73 – Gordo on Ruggeri rootstock, drip), with an average yield of 26.4 t/ha produced across all vineyards surveyed in the Murray Valley, see **Figure 10**.
  - The average production for each variety in 2012/13 was: Gordo 38.8 t/ha, Chardonnay 29.1 t/ha, Shiraz 21.2 t/ha and Cabernet Sauvignon 18.4 t/ha. Each variety yielded higher when compared to the 2011/12 season: Chardonnay 25.7 t/ha, Shiraz 19.9 t/ha and Cabernet Sauvignon 18.2 t/ha.
  - An average yield of 27.0 t/ha was produced on drip irrigated vineyards, compared to 25.1 t/ha on low level sprinkler irrigated vineyards in the Murray Valley. The average yields in 2011/12 were 21.6 t/ha on drip irrigated vineyards, and 23.4 t/ha on low level sprinkler irrigated vineyards respectively.

- The average irrigation applied across all varieties from budburst to leaf fall varied from 3.7 ML/ha to 13.7 ML/ha, see **Figure 11**.
  - The average irrigation applied was 7.7 ML/ha for drip and 8.2 ML/ha for low level sprinkler irrigated vineyards.
- On average, low level sprinkler irrigated vineyards used an additional 0.5 ML/ha (or 6% more water) than drip irrigated vineyards. However, they produced 1.9 t/ha (or 8%) less yield than drip irrigated vineyards in the Murray Valley wine region in season 2012/13.

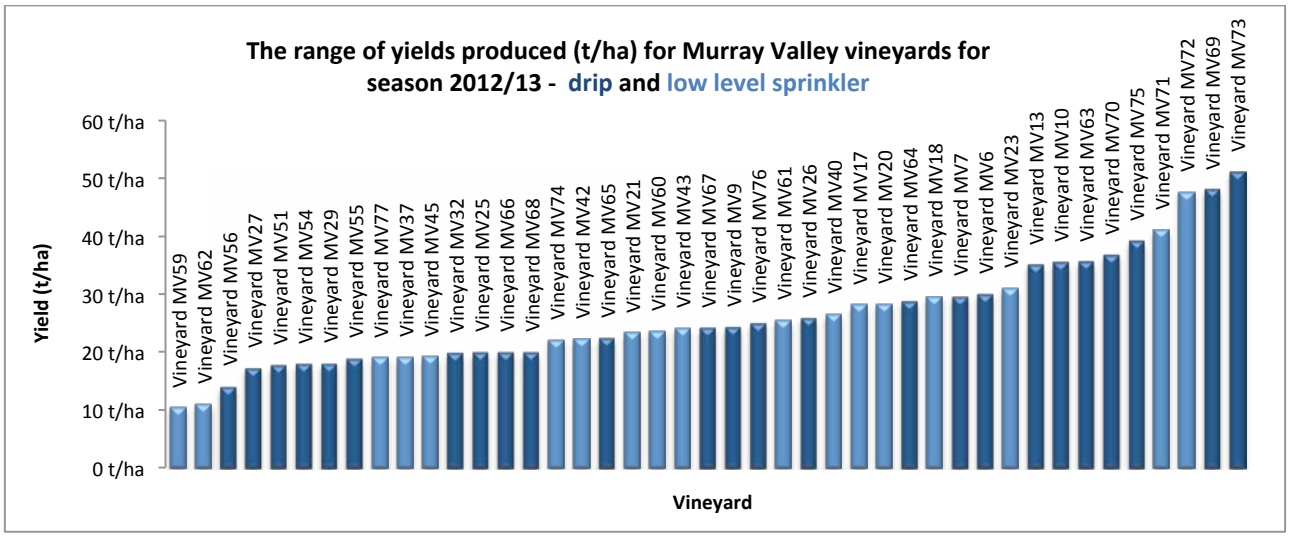

Figure 10 : The range of yields (t/ha) for Murray Valley vineyards (low level sprinkler marked in light blue)

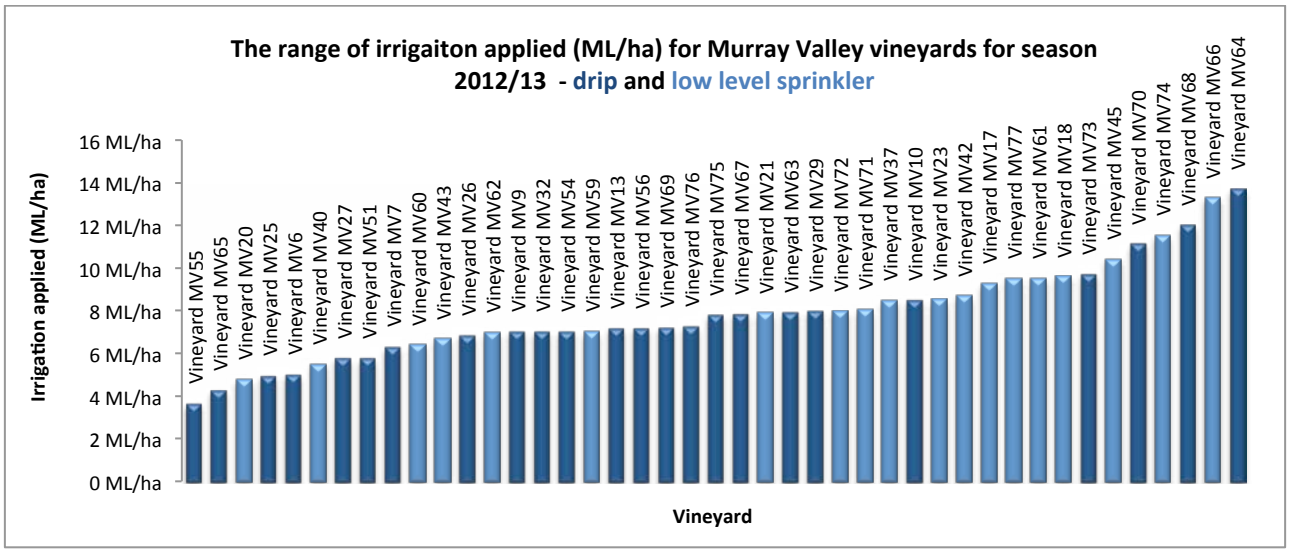

Figure 11 : Irrigation application for Murray Valley vineyards (low level sprinkler marked in light blue)

There is a broad range of both high and low yields (t/ha) produced where similar rates of irrigation (ML/ha) have been applied, see **Figure 12.**

As the rate of irrigation application increases, a similar increase in yield may not occur. Similarly, the vineyards applying the lowest volume of water (ML/ha) are not necessarily the most efficient users of water.

- For example, to produce a Shiraz yield of 20 t/ha, irrigation ranging from 5.0 ML/ha to 13.3 ML/ha (Vineyard MV25 - drip and MV66 – drip) was applied in 2012/13, a difference of 8.3 ML/ha. This indicates that there is the potential to reduce the volume of water applied or irrigation application method, with no detriment to production expected, in some instances.

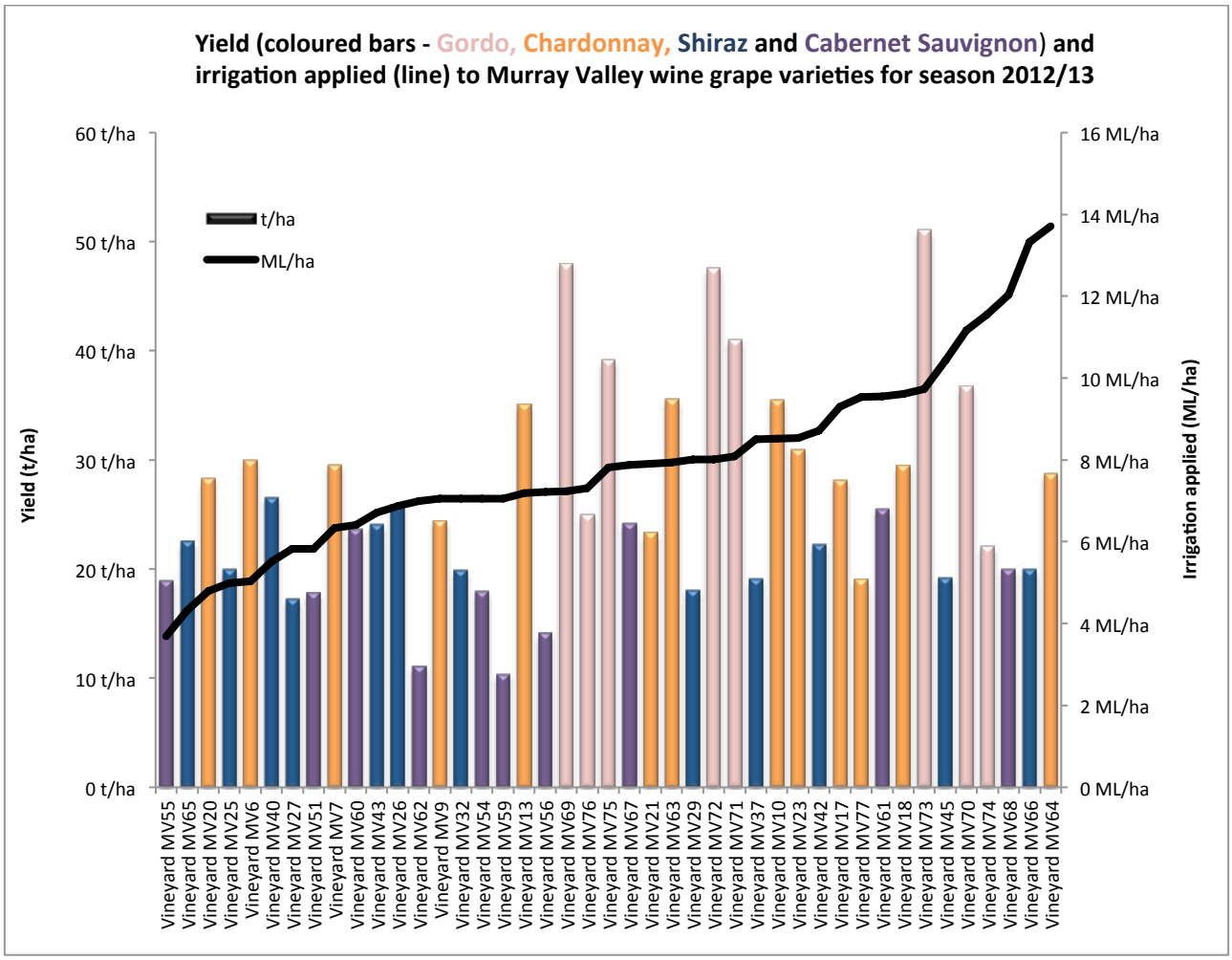

Figure 12 : The range of yields produced (t/ha) and irrigation applied (ML/ha) for Murray Valley vineyards

Yield water use efficiency (WUE)

Key Yield WUE benchmarks for season 2012/13 include:

- Yield WUE ranged from 1.5 ML/t (least efficient) to 6.6 t/ML (most efficient), with an average WUE of 3.5 t/ML for all vineyards surveyed (drip and low level sprinkler), see **Figure 13**.
  - **Drip irrigated:** Yield WUE for drip irrigated vineyards ranged from 1.5 t/ML (least efficient) to 6.6 t/ML (most efficient), with an average WUE of 3.7 t/ML.
  - **Low level sprinkler irrigated:** Yield WUE for low level sprinkler irrigated vineyards ranged from 1.5 t/ML (least efficient) to 5.9 t/ML (most efficient), with an average WUE of 3.2 t/ML.
  - Drip irrigated vineyards were on average 14% more efficient users of water than low level sprinkler irrigated vineyards.

The WUE of producing wine grapes via drip and low level sprinkler irrigation is presented in **Table 4.**

Table 4 : Average Yield WUE for drip and low level sprinkler irrigated vineyards in the Murray Valley

Yield WUE	Drip irrigated	Low level sprinklers irrigated	Difference
Most efficient	6.63 t/ML	5.94 t/ML	0.69 t/ML (10%)
Average	**3.73 t/ML**	**3.22 t/ML**	**0.51 t/ML (14%)**
Least efficient	1.50 t/ML	1.48 t/ML	0.03 t/ML (2%)
Difference between most and least efficient	5.1 t/ML (77%)	4.5 t/ML (75%)	

The spread of Yield WUE figures is presented in **Figure 13** and discussed below:

- **Most efficient - Vineyard MV69:** (Gordo on 99 Richter/Dogridge, drip irrigated, sandy loam) was the most efficient water user in the region, with 6.6 tonnes of grapes produced for every ML of water applied. An average of 7.2 ML/ha was applied and 48.0 t/ha of Gordo was produced in 2012/13.
- **Least efficient - Vineyard MV59:** (Cabernet Sauvignon on own roots, low level sprinkler irrigated, clay) is the least efficient water user, with only 1.5 tonnes of grapes produced for every ML of water applied. An average of 7.0 ML/ha was applied and 10.4 t/ha of Cabernet Sauvignon was produced in 2012/13.
- Vineyard MV6 (Chardonnay on Ramsey, drip irrigated, sandy clay loam), Vineyard MV20 (Chardonnay on Kober 5BB, low level sprinkler irrigated, sandy clay loam), Vineyard MV69 (Gordo on 99 Richter/Dogridge, drip irrigated, sandy loam) and Vineyard MV72 (Gordo on Paulsen 1103, low level sprinkler irrigated, sandy clay loam) are in the top 10% of Yield WUE for the region.
- Vineyard MV55 applied the lowest volume of water per hectare (3.7 ML/ha) and produced a crop of 19.0 t/ha with a WUE of 5.1 t/ML (the seventh most efficient vineyard).
- Vineyard MV64 applied the highest volume of water per hectare (13.7 ML/ha) and produced a crop of 28.8 t/ha, with a WUE of 2.1 t/ML (the ninth least efficient vineyard).

Table 5 : Most and least efficient vineyards by variety in the Murray Valley

Variety	WUE	Vineyard	Own roots or rootstock	Irrigation method	Yield t/ha	Irrigation applied ML/ha	WUE t/ML
Gordo	Most efficient	Vineyard MV69	Richter 99/ Dogridge	Drip	48.0 t/ha	7.2 ML/ha	6.6 t/ML
	Least efficient	Vineyard MV74	Dogridge	Low level sprinklers	22.1 t/ha	11.6 ML/ha	1.9 t/ML
Chardonnay	Most efficient	Vineyard MV6	Ramsey	Drip	30.0 t/ha	5.0 ML/ha	6.0 t/ML
	Least efficient	Vineyard MV77	Paulsen 1103	Low level sprinklers	19.0 t/ha	9.5 ML/ha	2.0 t/ML
Shiraz	Most efficient	Vineyard MV65	Own roots	Drip	22.5 t/ha	4.3 ML/ha	5.2 t/ML
	Least efficient	Vineyard MV66	Own roots	Drip	20.0 t/ha	13.3 ML/ha	1.5 t/ML
Cabernet Sauvignon	Most efficient	Vineyard MV55	Own roots	Drip	19.0 t/ha	3.7 ML/ha	5.1 t/ML
	Least efficient	Vineyard MV59	Own roots	Low level sprinklers	10.4 t/ha	7.0 ML/ha	1.5 t/ML

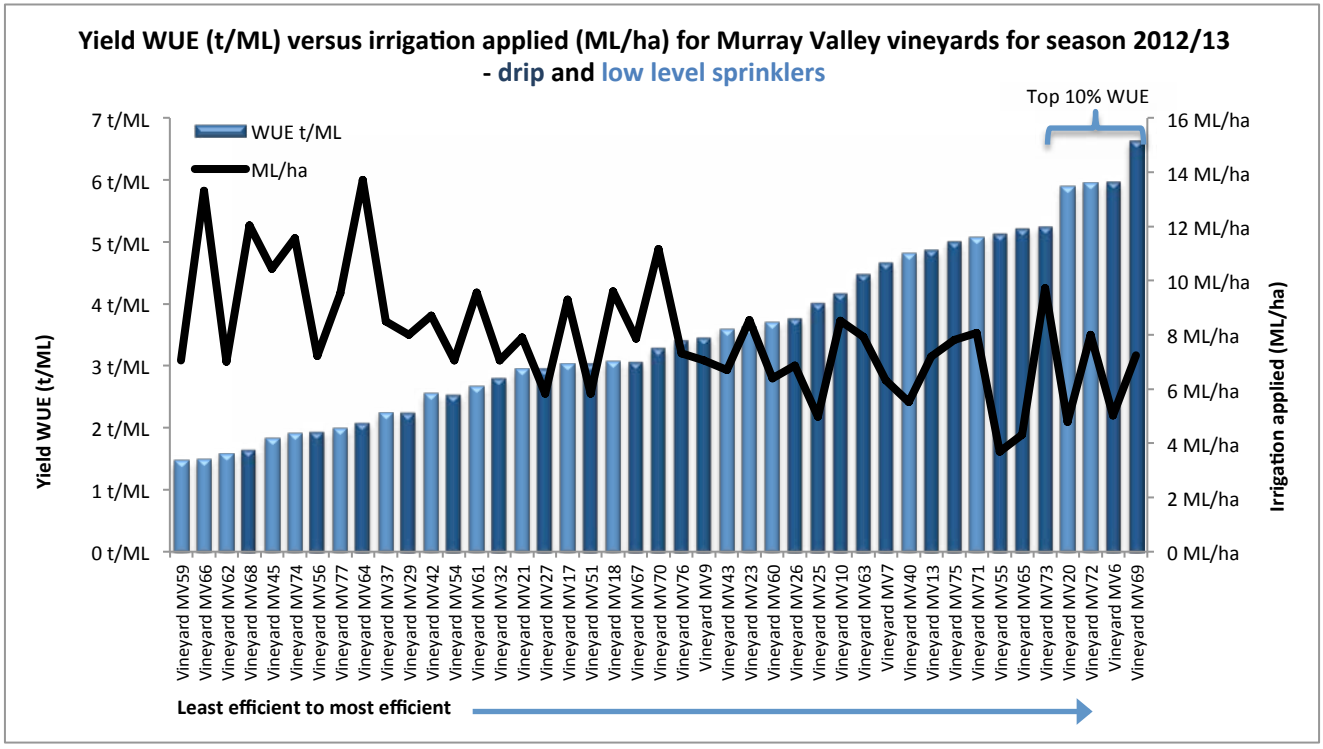

Figure 13 : The range of Yield WUE values (t/ML) for vineyards in the Murray Valley in season 2012/13

Observations by growth stage

Key observations for each growth stage for 2012/13 include:

- **Drip irrigation:** An average of 7.7 ML/ha was applied during the growing season, with approximately 13% applied from bud burst to flowering, 36% applied between fruit set and veraison, 33% applied between veraison and harvest, and 18% applied post harvest and prior to leaf fall.
- **Low level sprinkler irrigation:** An average of 8.2 ML/ha was applied during the growing season, with approximately 20% applied from bud burst to flowering, 34% applied between fruit set and veraison, 28% applied between veraison and harvest, and 18% applied post harvest and prior to leaf fall.

Table 6 : Average irrigation applied at key growth stages by irrigation method in the Murray Valley

Irrigation application	Bud burst (EL 4) - Flowering (EL 26)	Fruit set (EL 27) - Veraison (EL 35)	100% veraison (EL 36) - Harvest (EL 38)	Post Harvest (EL 41) - End of leaf fall (EL 47)	Total
Drip	1.0 ML/ha	2.8 ML/ha	2.6 ML/ha	1.4 ML/ha	**7.7 ML/ha**
Low level sprinklers	1.7 ML/ha	2.8 ML/ha	2.3 ML/ha	1.5 ML/ha	**8.2 ML/ha**

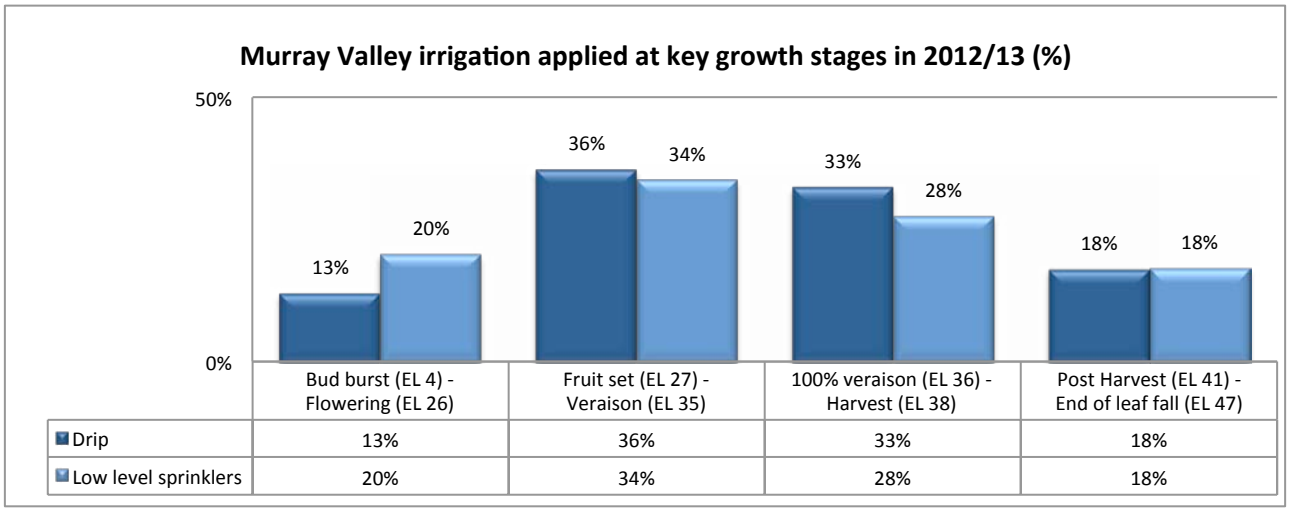

Figure 14 : Average irrigation applied at key wine grape growth stages (%) in the Murray Valley

Observations by variety

Average irrigation applied for each variety was: Gordo (8.9 ML/ha), Chardonnay (8.1 ML/ha), Shiraz (7.5 ML/ha) and Cabernet Sauvignon (7.4 ML/ha), see **Figure 15**.

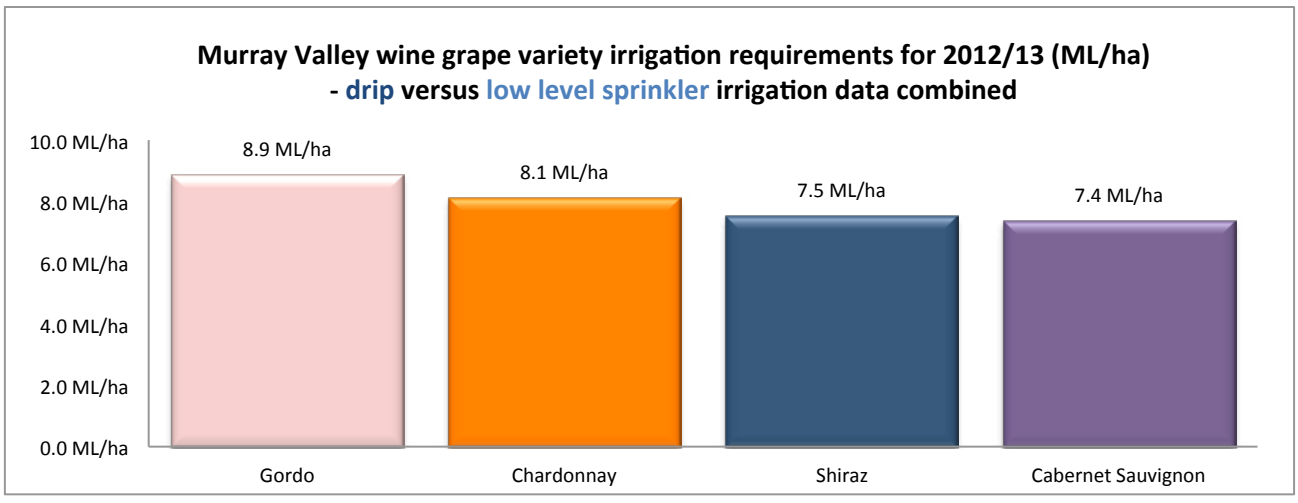

Figure 15 : Average irrigation applied by variety (ML/Ha) in the Murray Valley

Average irrigation applied by variety, and drip versus low level sprinkler irrigation is presented in **Figure 16**. For all varieties a greater volume of water was applied using low level sprinklers, Gordo (0.6 ML/ha or 6%), Chardonnay (0.3 ML/ha or 4%), Shiraz (0.8 ML/ha or 10%) and Cabernet Sauvignon (0.2 ML/ha or 3%).

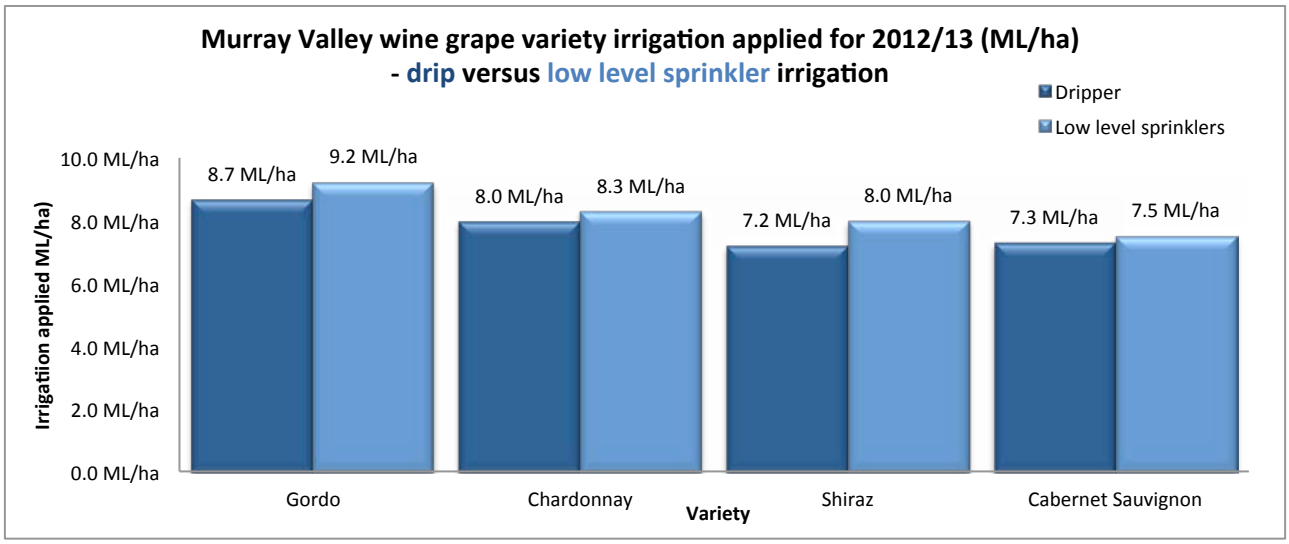

Figure 16 : Average irrigation applied at key wine grape growth stages (ML/ha) in the Murray Valley

The average irrigation applied at key growth stages by variety is presented in **Table 7**

Table 7 : Average irrigation applied at key growth stages by variety in the Murray Valley

Variety	Bud burst (EL 4) - Flowering (EL 26)	Fruit set (EL 27) - Veraison (EL 35)	100% veraison (EL 36) - Harvest (EL 38)	Post Harvest (EL 41) - End of leaf fall (EL 47)	Total
Gordo	1.7 ML/ha	3.4 ML/ha	2.8 ML/ha	1.0 ML/ha	**8.9 ML/ha**
Chardonnay	1.3 ML/ha	2.5 ML/ha	2.6 ML/ha	1.8 ML/ha	**8.1 ML/ha**
Shiraz	1.2 ML/ha	2.6 ML/ha	2.2 ML/ha	1.5 ML/ha	**7.5 ML/ha**
Cabernet Sauvignon	1.1 ML/ha	3.0 ML/ha	2.1 ML/ha	1.1 ML/ha	**7.4 ML/ha**

- The average irrigation applied for wine grape varieties in the Murray Valley in season 2012/13 was:
  - Approximately 8.1 ML/ha to 8.9 ML/ha for white varieties:
    - 15% to 18% of the water budget applied from bud burst to flowering,
    - 31% to 38% applied between fruit set and veraison,
    - 32% applied between veraison and harvest, and
    - 11% to 22% applied post harvest and prior to leaf fall.
  - Approximately 7.4 ML/ha to 7.5 ML/ha for red varieties:
    - 15% to 16% of the water budget applied from bud burst to flowering,
    - 35% to 41% applied between fruit set and veraison,
    - 29% applied between veraison and harvest, and
    - 16% to 20% applied post harvest and prior to leaf fall.

Observations by own roots or rootstock

The wine grape varieties studied in this project were planted on a range of different rootstocks, or on their own roots. The average irrigation applied for own roots versus rootstocks (all) for each variety is presented in **Figure 17.**

Given the range of rootstocks used and the low sampling size per variety, it is not possible to make comparisons between own rooted vines and vines planted onto specific rootstocks.

General observations include:

- **Gordo** planted onto Schwarzmann or Ruggeri 140 (1 data set), Paulsen 1103 or Dogridge (3 data sets) rootstock. Average irrigation applied was 8.9 ML/ha. No vines were planted on their own roots.
- **Chardonnay** planted onto Ruggeri 140 or Kober 5BB or Schwarzmann (1 data set), Paulsen 1103 (3 data sets), Ramsey (7 data sets) rootstock. Average irrigation applied was 8.1 ML/ha. No vines were planted on their own roots.
- **Shiraz** planted onto Ramsey or Paulsen 1103 or Kober 5BB (1 data set), Schwarzmann (4 data sets) rootstock. Overall, Shiraz planted on rootstocks (6.9 ML/ha) used 1.4 ML/ha (or 17%) less water compared to own roots (8.4 ML/ha). Shiraz planted on rootstocks (21.6 t/ha) produced an additional 0.8 t/ha (or 4%) greater yield compared to Shiraz planted on own roots (21.0 t/ha).
- **Cabernet Sauvignon** planted onto Ramsey or K51-40 or SO4 (1 data set), Schwarzmann (3 data sets) rootstock. Overall, Cabernet Sauvignon planted on rootstocks (8.1 ML/ha), used 1.9 ML/ha (or 30%) more water compared to own roots (6.2 ML/ha). Cabernet Sauvignon planted on rootstocks (21.6 t/ha) produced an additional 7.9 t/ha (or 58%) greater yield compared to Cabernet Sauvignon planted on own roots (14.0 t/ha).

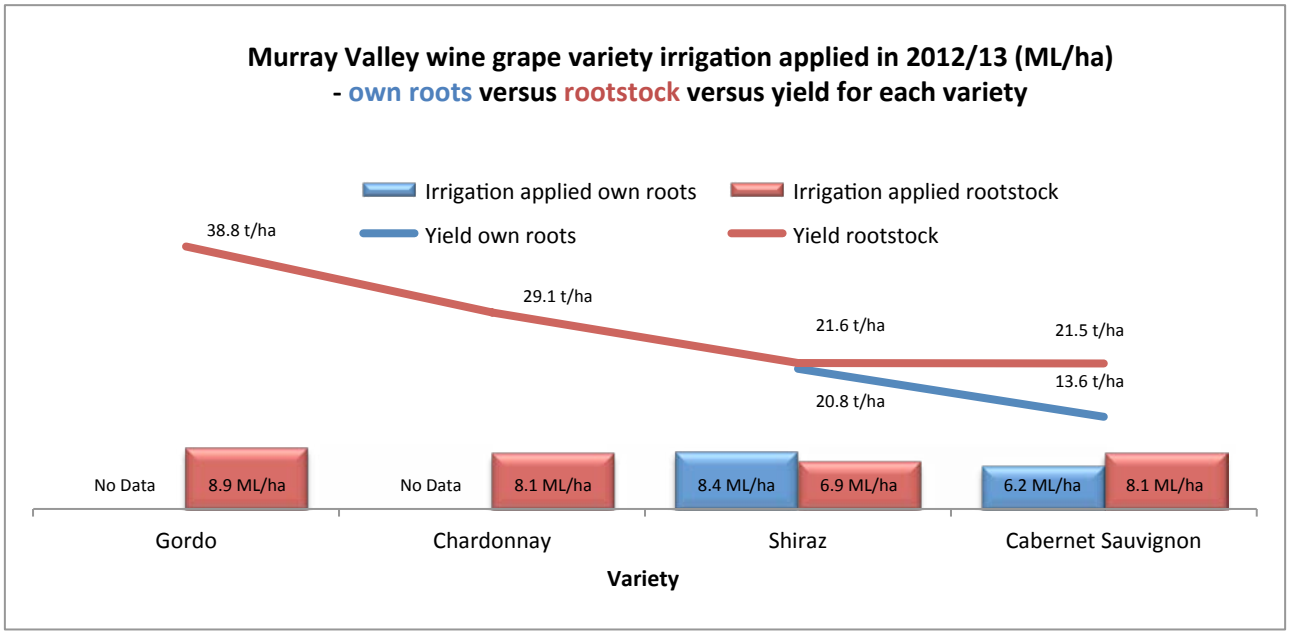

Figure 17 : Own roots or rootstock average irrigation applied in the Murray Valley in season 2012/13

Riverina wine region

A total of 43 irrigation data sets were received from Riverina wine growers. A summary of the data sets received is presented in **Appendix 2b.** A breakdown of data by variety, irrigation application method, own roots or rootstock is presented in **Tables 8 to 10** and **Figure 18**.

Data received

Only one data set was submitted for furrow irrigated vineyards this season. Therefore, no comparisons can be made between seasons for this irrigation application method.

Table 8 : Riverina irrigation data received by variety

Number of data sets	Variety				
	Semillon	Chardonnay	Shiraz	Cabernet Sauvignon	Total
	8	10	17	8	43

Table 9 : Riverina irrigation data received by application method (drip or furrow)

Number of data sets	Irrigation application method		
	Drip	Furrow	Total
	42	1	43

Table 10 : Riverina vines grown on own roots or rootstock

Number of data sets	Vines on own roots or rootstock		
	Own roots	Rootstock	Total
	26	17	43

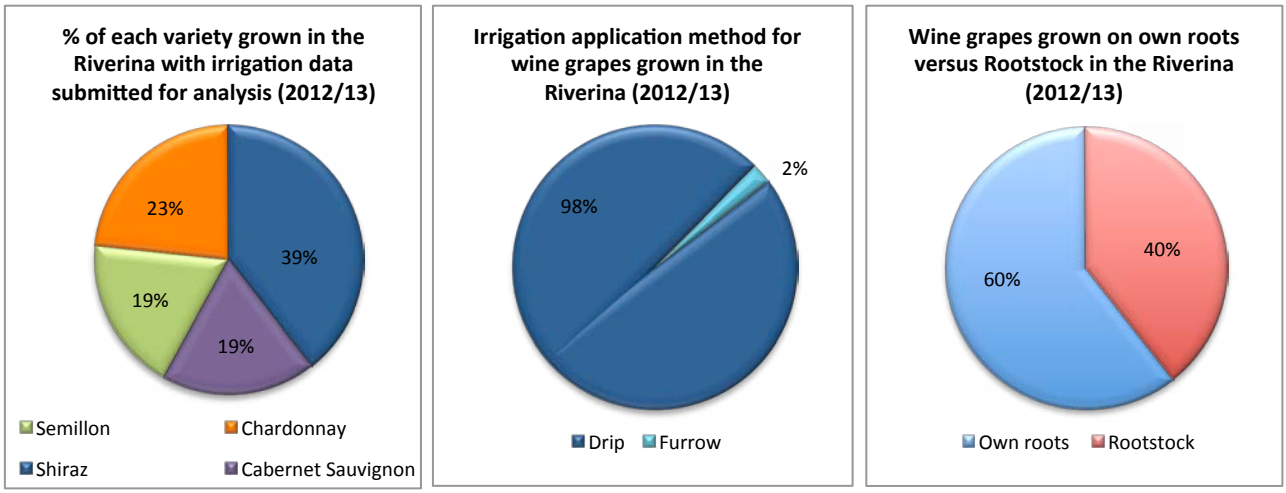

Figure 18 : Irrigation data by variety, application method, own roots or rootstock in the Riverina

Riverina data set

Key observations for season 2012/13 include:

- The yields across all varieties varied from 6.0 t/ha (Vineyard R63 – Cabernet Sauvignon on own roots, drip irrigated) to 26.1 t/ha (Vineyard R43 - Semillon on rootstock, drip irrigated), with an average yield of 14.9 t/ha produced across all vineyards surveyed in the Riverina, see **Figure 19**.
  - The average production for each variety was: Semillon 20.4 t/ha, Chardonnay 14.0 t/ha, Shiraz 15.0 t/ha and Cabernet Sauvignon 10.5 t/ha. Semillon and Shiraz yielded higher on average and Chardonnay and Cabernet Sauvignon yielded lower when compared to the 2011/12 season: Semillon 14.7 t/ha, Chardonnay 14.7 t/ha, Shiraz 9.7 t/ha and Cabernet Sauvignon 12.0 t/ha.

  - An average yield of 14.9 t/ha was produced in 2012/13 compared to 13.0 t/ha in 2011/12; an increase of 1.9 t/ha across all varieties on drip irrigated vineyards in the Riverina.

- The average irrigation applied across all varieties from budburst to leaf fall varied from 1.3 ML/ha to 6.4 ML/ha, see **Figure 20.**
  - The average irrigation applied was 4.0 ML/ha for drip. Only one data set was submitted for furrow and it is not possible to present an average for this irrigation application method in season 2012/13.

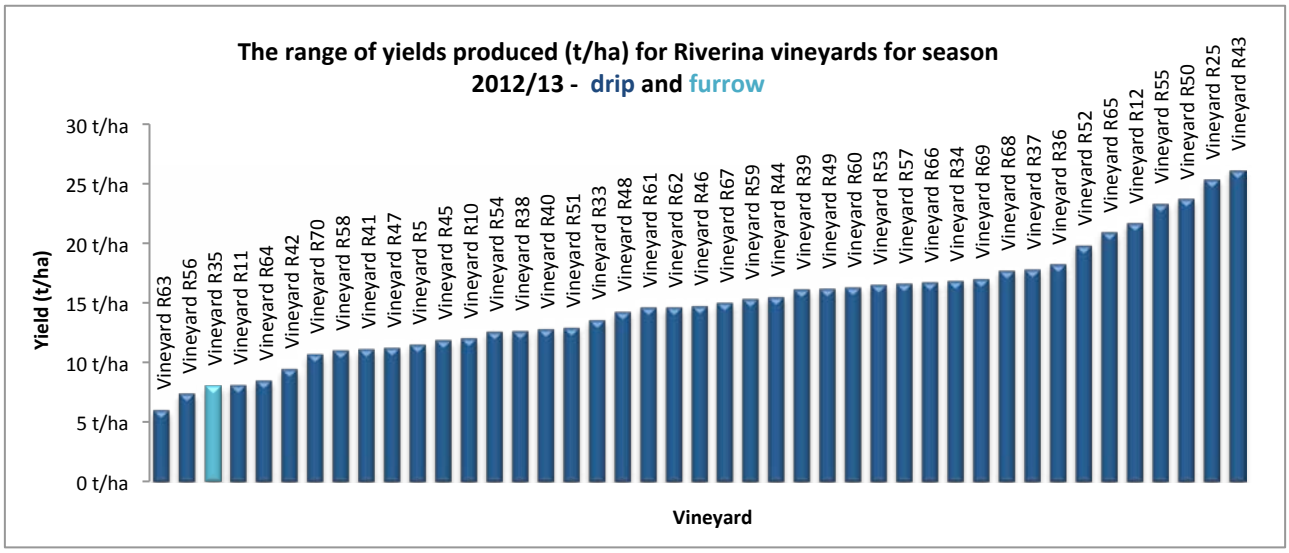

Figure 19 : The range of yields (t/ha) for Riverina vineyards (furrow marked in teal)

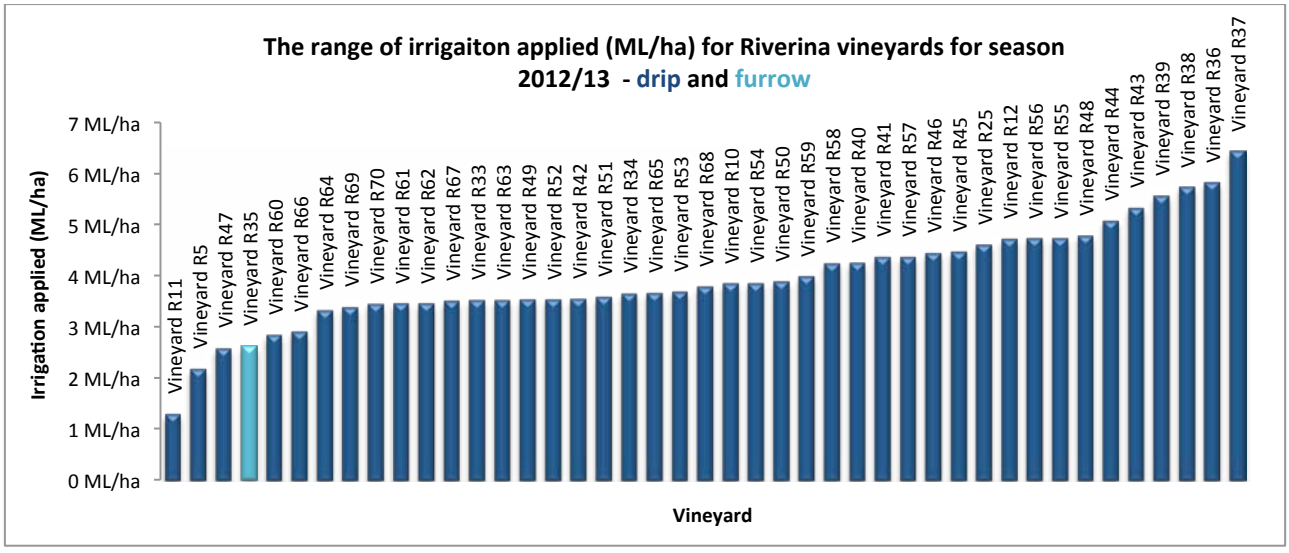

Figure 20 : The range of irrigation applied (ML/ha) for Riverina vineyards (furrow marked in teal)

There is a broad range of both high and low yields (t/ha) produced where similar rates of irrigation (ML/ha) have been applied, see **Figure 21**. As the rate of irrigation application increases, a similar increase in yield may not occur. Similarly, the vineyards applying the lowest volume of water (ML/ha), are not necessarily the most efficient users of water.

- For example, to produce a Cabernet Sauvignon yield of 12.6 t/ha, irrigation ranging from 3.9 ML/ha to 5.7 ML/ha (Vineyard R38 and R54 – both drip irrigated) was applied in 2012/13, a difference of 1.8 ML/ha. This indicates that there is the potential to reduce the volume of water applied, with no detriment to production expected, in some instances.

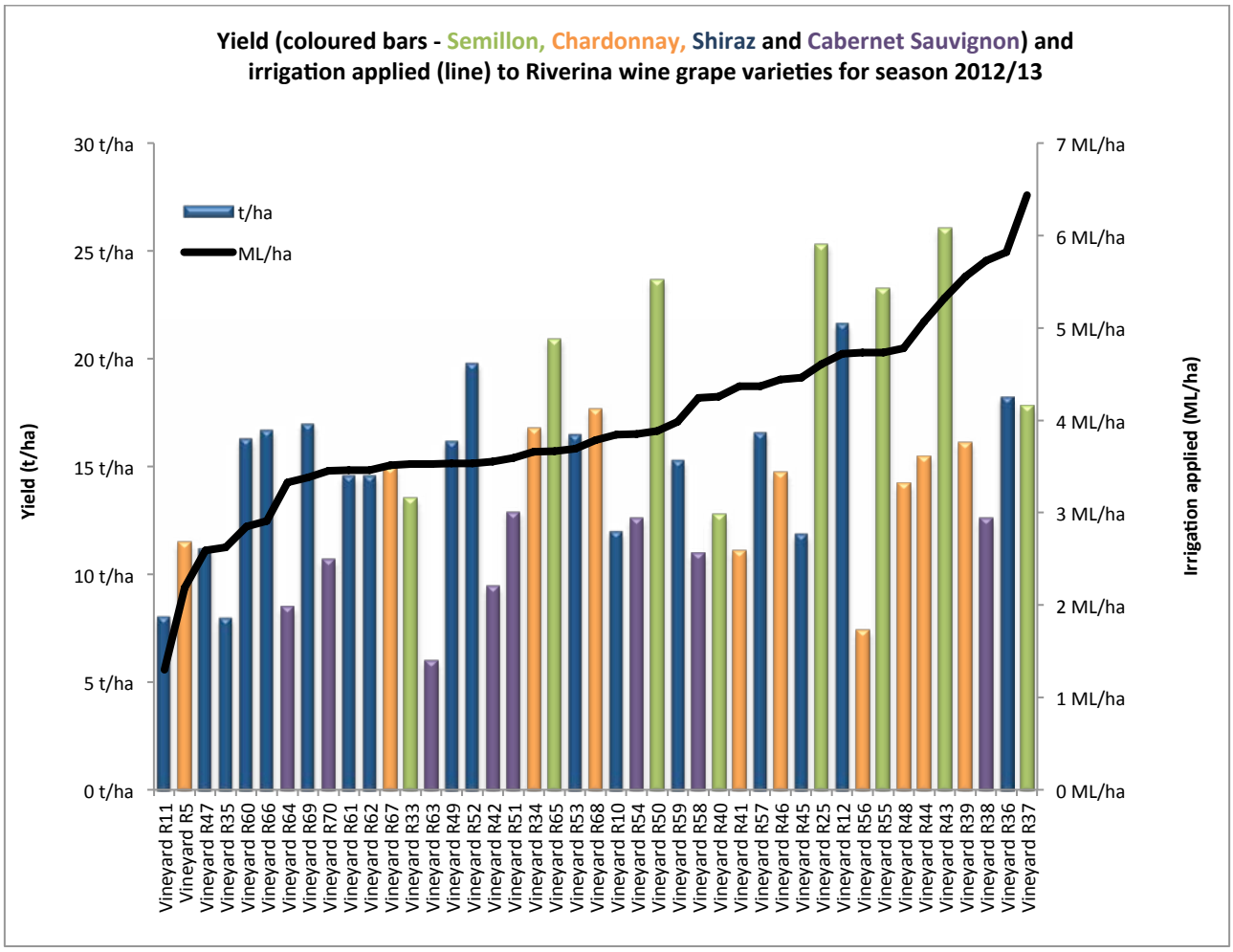

Figure 21 : The range of yields produced (t/ha) and irrigation applied (ML/ha) for Riverina vineyards

Yield water use efficiency (WUE)

Key Yield WUE benchmarks for season 2012/13 include:

- Yield WUE ranged from 1.6 ML/t (least efficient) to 6.2t/ML (most efficient), with an average WUE of 3.9 t/ML for all vineyards surveyed (drip and furrow).

The water use efficiency of producing wine grapes via drip irrigation is presented in **Table 11.**

Table 11 : Average Yield WUE for drip irrigated vineyards in the Riverina for each season

Yield WUE	Drip irrigated 2011/12	Drip Irrigated 2012/13
Most efficient	9.2 t/ML	6.2 t/ML
Average	**5.0 t/ML**	**3.9 t/ML**
Least efficient	2.1 t/ML	1.6 t/ML
Difference between most and least efficient	7.1 t/ML (77%)	4.7 t/ML (75%)

The spread of WUE figures is presented in **Figure 22** and discussed below:

- **Most efficient - Vineyard R11:** (Shiraz on Ramsey rootstock, drip irrigated) was the most efficient water user, with 6.2 tonnes of grapes produced for every ML of water applied. An average of 1.3 ML/ha was applied and 8.1 t/ha was produced on this vineyard in the 2012/13 growing season.

- **Least efficient - Vineyard R56:** (Chardonnay on Ramsey rootstock, drip irrigated) was the least efficient water user, with only 1.6 tonnes of grapes produced for every ML of water applied. An average of 4.7 ML/ha was applied and 7.4 t/ha of Chardonnay (own roots) was produced on this vineyard in the 2012/13 growing season.
- Vineyard R11, Vineyard R50, Vineyard R52, Vineyard R60, Vineyard R65 and Vineyard R66 and are in the top 10% of Yield WUE for the region.
- Vineyard R11 applied the lowest volume of water per hectare (1.3 ML/ha) and produced a crop of 8.1 t/ha with a WUE of 6.2 t/ML (the most efficient vineyard).
- Vineyard R37 applied the highest volume of water per hectare (6.4 ML/ha) and produced a crop of 17.8 t/ha, with a WUE of 2.8 t/ML (the ninth least efficient vineyard).

Table 12 : Most and least efficient vineyards by variety in the Riverina

Variety	WUE	Vineyard	Own roots or rootstock	Irrigation method	Yield t/ha	Irrigation applied ML/ha	WUE t/ML
Semillon	Most efficient	Vineyard R50	Own Roots	Drip	23.7 t/ha	3.9 ML/ha	6.1 t/ML
	Least efficient	Vineyard R37	Own Roots	Drip	17.8 t/ha	6.4 ML/ha	2.8 t/ML
Chardonnay	Most efficient	Vineyard R5	Ramsey	Drip	11.5 t/ha	2.2 ML/ha	5.3 t/ML
	Least efficient	Vineyard R56	Ramsey	Drip	7.4 t/ha	4.7 ML/ha	1.6 t/ML
Shiraz	Most efficient	Vineyard R11	Ramsey	Drip	8.1 t/ha	1.3 ML/ha	6.2 t/ML
	Least efficient	Vineyard R45	Rootstock	Drip	11.9 t/ha	4.5 ML/ha	2.7 t/ML
Cabernet Sauvignon	Most efficient	Vineyard R51	Own Roots	Drip	12.9 t/ha	3.6 ML/ha	3.6 t/ML
	Least efficient	Vineyard R63	Own Roots	Drip	6.0 t/ha	3.5 ML/ha	1.7 t/ML

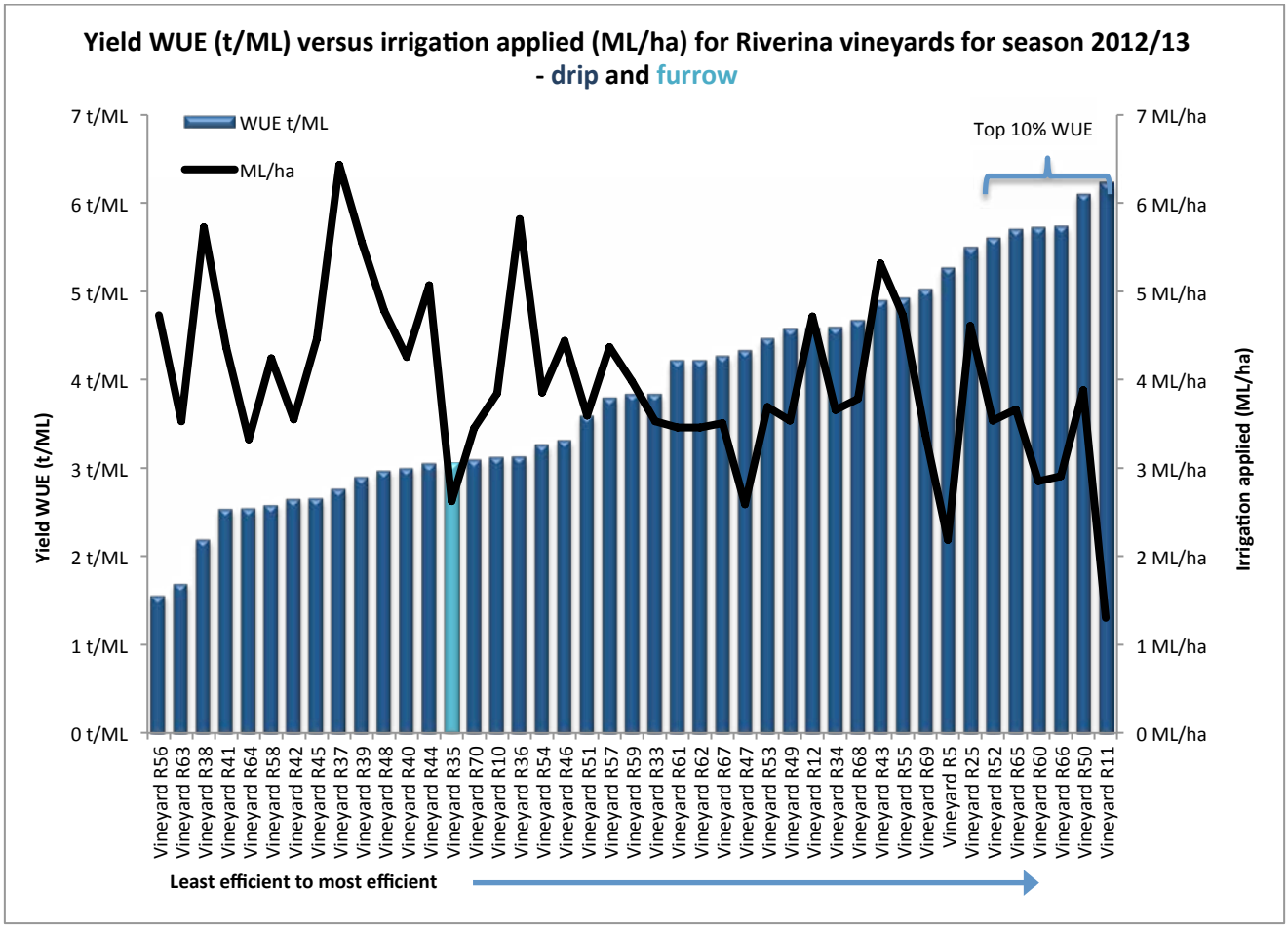

Figure 22 : The range of Yield WUE values (t/ML) for vineyards in the Riverina in season 2012/13

Observations by growth stage

Key observations for each growth stage for 2012/13 include:

- **Drip irrigation:** An average of 4.0 ML/ha was applied during the growing season, with approximately 23% of the water budget applied from bud burst to flowering, 35% applied between fruit set and veraison, 21% applied between veraison and harvest, and 21% applied post harvest and prior to leaf fall.

Table 13 : Average irrigation applied at key growth stages by irrigation method in the Riverina

Irrigation application	Bud burst (EL 4) - Flowering (EL 26)	Fruit set (EL 27) - Veraison (EL 35)	100% veraison (EL 36) - Harvest (EL 38)	Post Harvest (EL 41) - End of leaf fall (EL 47)	Total
Drip	0.9 ML/ha	1.4 ML/ha	0.8 ML/ha	0.9 ML/ha	**4.0 ML/ha**

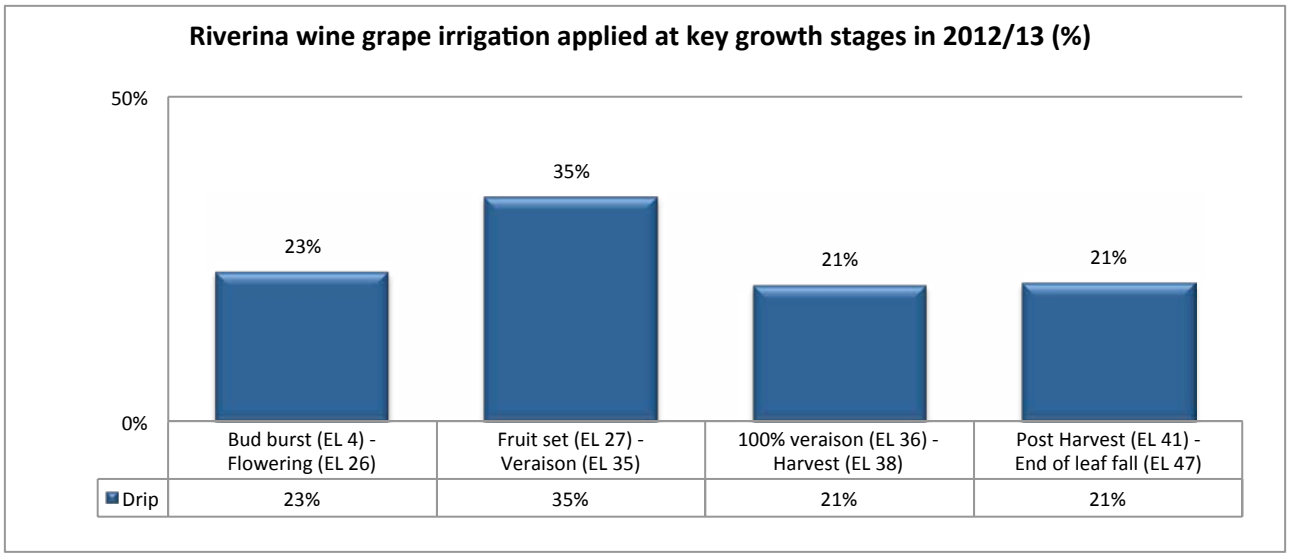

Figure 23 : Average irrigation applied at key wine grape growth stages (%) in the Riverina

Observations by variety

Average irrigation applied for each variety was: Semillon (4.6 ML/ha), Chardonnay (4.2 ML/ha), Shiraz (3.6 ML/ha) and Cabernet Sauvignon (3.9 ML/ha), see **Figure 24**.

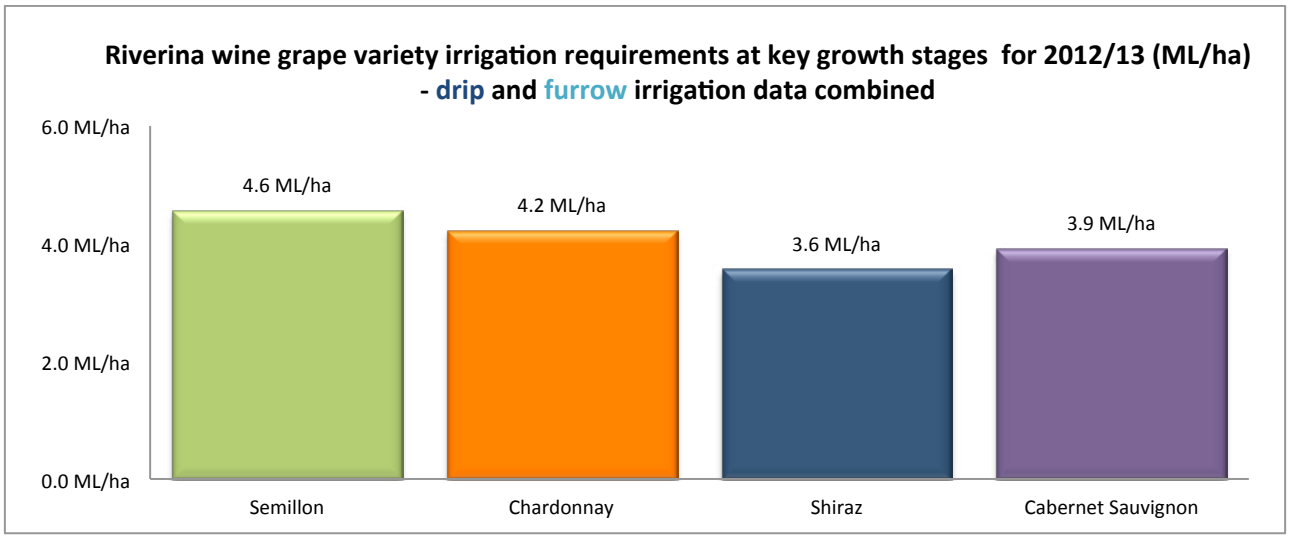

Figure 24 : Average irrigation applied by variety (ML/Ha) in the Riverina

The average irrigation applied at key growth stages by variety is presented in **Table 14**

Table 14 : Average irrigation applied at key growth stages by variety in the Riverina

Variety	Bud burst (EL 4) - Flowering (EL 26)	Fruit set (EL 27) - Veraison (EL 35)	100% veraison (EL 36) - Harvest (EL 38)	Post Harvest (EL 41) - End of leaf fall (EL 47)	Total
Semillon	1.1 ML/ha	1.6 ML/ha	1.0 ML/ha	0.9 ML/ha	**4.6 ML/ha**
Chardonnay	0.8 ML/ha	1.6 ML/ha	0.9 ML/ha	0.9 ML/ha	**4.2 ML/ha**
Shiraz	0.9 ML/ha	1.2 ML/ha	0.8 ML/ha	0.7 ML/ha	**3.6 ML/ha**
Cabernet Sauvignon	1.0 ML/ha	1.2 ML/ha	0.8 ML/ha	0.9 ML/ha	**3.9 ML/ha**

- The average irrigation applied for wine grape varieties in the Riverina in season 2012/13 was:
  - Approximately 4.2 ML/ha to 4.6 ML/ha for white varieties:
    - 19% to 23% of the water budget applied from bud burst to flowering,
    - 35% to 38% applied between fruit set and veraison,
    - 21% to 22% applied between veraison and harvest, and
    - 20% to 22% applied post harvest and prior to leaf fall.
  - Approximately 3.6 ML/ha to 3.9 ML/ha for red varieties:
    - 25% of the water budget applied from bud burst to flowering,
    - 31% to 34% applied between fruit set and veraison,
    - 20% to 21% applied between veraison and harvest, and
    - 20% to 24% applied post harvest and prior to leaf fall.

Observations by own roots or rootstock

Due to the low number of data sets submitted for varieties planted onto rootstocks in 2012/13, observations regarding own roots versus rootstocks cannot be presented this season.

REGIONAL COMPARISONS

Average water applied by application method

The average water application for all varieties in the Murray Valley was 7.9 ML/ha compared to 4.0 ML/ha in the Riverina, a difference of 3.9 ML/ha (49%) in season 2012/13.

- By comparison, the average water application for all varieties in the Murray Valley was 5.1 ML/ha compared to 3.0 ML/ha in the Riverina; a difference of 2.1 ML/ha (or 41%) in season 2011/12.

The average yield for all varieties in the Murray Valley was 26.4 t/ha compared to 14.9 t/ha in the Riverina; a difference of 11.5 t/ha (or 44%). While the Murray Valley applied almost twice the volume of water per hectare, a similar increase in yield was also achieved in season 2012/13.

- The average yield for all varieties in the Murray Valley was 22.2 t/ha compared to 12.8 t/ha in the Riverina; a difference of 9.4 t/ha (or 42%). Similarly, while the Murray Valley applied more water per hectare, a similar increase in yield was also achieved in season 2011/12.

The average water application for drip irrigated vineyards was 7.7 ML/ha in the Murray Valley and 4.0 ML/ha in the Riverina, across all varieties. Murray Valley vineyards used on average 3.7 ML/ha (or 48%) more water per hectare and produced 11.9 t/ha (or 44%) more yield, see **Figure 25.**

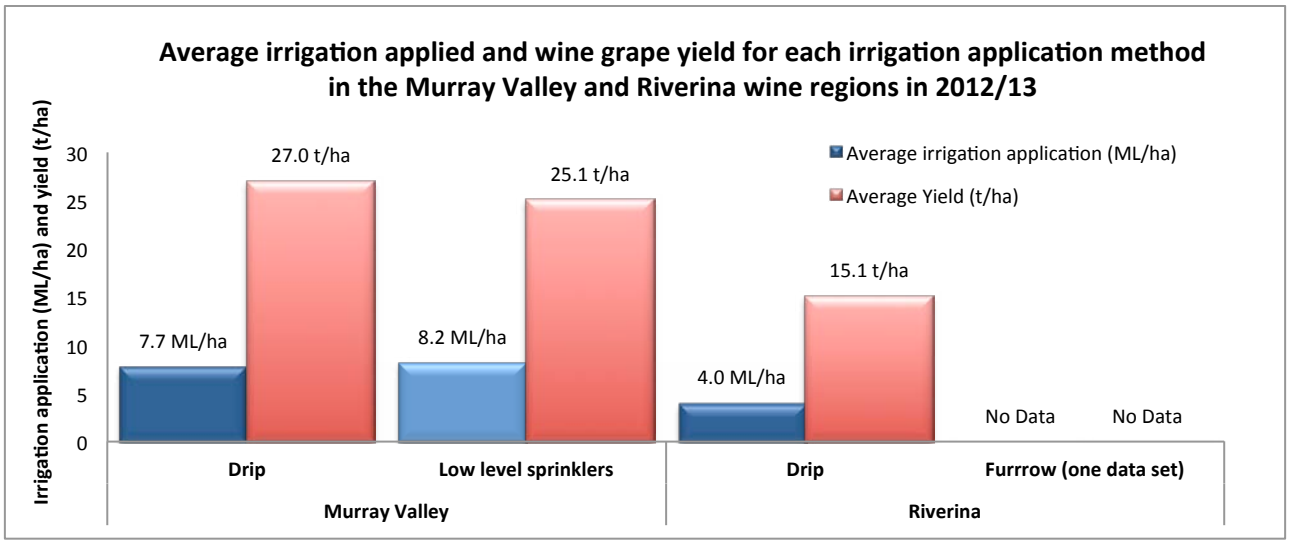

Figure 25 : Average irrigation applied and wine grape yield for each irrigation method in each region

Average irrigation applied and yield produced for each variety

The average water applied and yield produced for each variety in 2012/13 are:

- **Gordo:** The average water applied for Gordo was 8.9 ML/ha and the average yield produced was 38.8 t/ha in the Murray Valley.
- **Semillon:** The average water applied for Semillon was 4.6 ML/ha and the average yield produced was 20.4 t/ha in the Riverina.
- **Chardonnay:** The average water applied for Chardonnay was 8.1 ML/ha in the Murray Valley compared to 4.2 ML/ha in the Riverina, a difference of 3.9 ML/ha (or 48%). The average yield produced for Chardonnay was 29.1 t/ha in the Murray Valley compared to 14.0 t/ha in the Riverina, a difference of 15.1 t/ha (or 52%).
- **Shiraz:** The average water applied for Shiraz was 7.5 ML/ha in the Murray Valley compared to 3.6 ML/ha in the Riverina, a difference of 3.9 ML/ha (or 53%). The average yield produced for Shiraz was 21.2 t/ha in the Murray Valley compared to 15.0 t/ha in the Riverina, a difference of 6.2 t/ha (or 29%).

- **Cabernet Sauvignon:** The average water applied for Cabernet Sauvignon was 7.4 ML/ha in the Murray Valley compared to 3.9 ML/ha in the Riverina, a difference of 3.5 ML/ha (or 47%). The average yield produced for Cabernet Sauvignon was 18.4 t/ha in the Murray Valley compared to 10.5 t/ha in the Riverina, a difference of 7.9 t/ha (or 43%).

The average volume of irrigation applied and the subsequent yield achieved for each variety is presented in **Figure 26 and 27.**

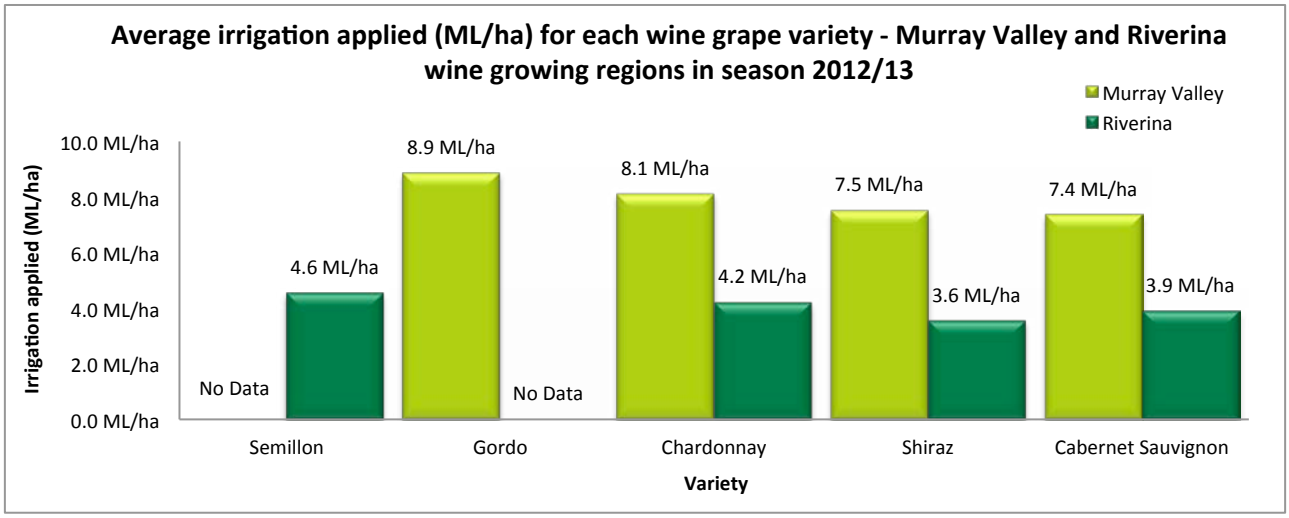

Figure 26 : Average irrigation applied (ML/ha) for each wine grape variety in each region

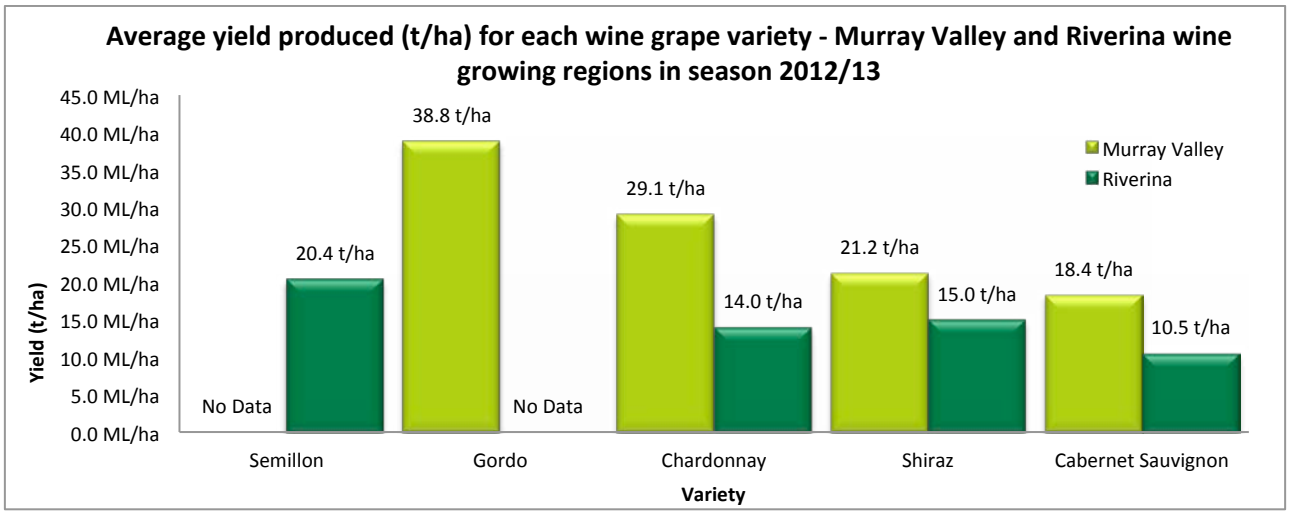

Figure 27 : Average yield produced (t/ha) for each wine grape variety in each region

Average Yield WUE for each region

The average Yield WUE for the Murray Valley is 3.5 t/ML compared to 3.9 t/ML in the Riverina, a difference of 0.4 t/ML (11%). The average Yield WUE for the Murray Valley was 4.7 t/ML compared to 4.6 t/ML in the Riverina, a difference of 0.1 t/ML (or 3%) in season 2011/12.

The differences for individual varieties for each region are:

- **Gordo:** The average Yield WUE in the Murray Valley was 4.6 t/ML.
- **Semillon:** The average Yield WUE in the Riverina was 4.6 t/ML.
- **Chardonnay:** The average Yield WUE in the Murray Valley was 3.9 t/ML compared to 3.5 t/ML in the Riverina, a difference of 0.4 t/ML (9%). Chardonnay was grown with greater efficiency in the Murray Valley in season 2012/13.

- **Shiraz:** The average Yield WUE in the Murray Valley was 3.1 t/ML compared to 4.4 t/ML in the Riverina, a difference of 1.2 t/ML (or 40%). Shiraz was grown with greater efficiency in the Riverina in season 2012/13.
- **Cabernet Sauvignon:** The average Yield WUE in the Murray Valley was 2.7 t/ML compared to 2.7 t/ML in the Riverina, a difference of 0.0 t/ML (0%). Cabernet Sauvignon was grown with the same efficiency for both regions in season 2012/13.

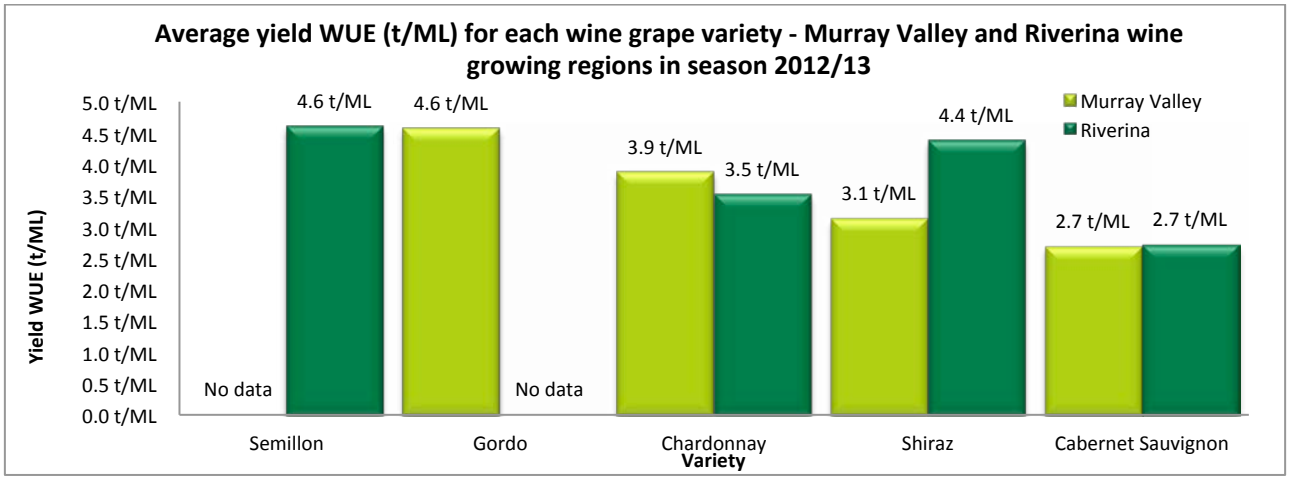

Figure 28 : Average Yield WUE (t/ML) for each wine grape variety in each region

Virtual water

The term 'virtual water' is sometimes used to measure the amount of water required to produce a unit of a particular product, normally expressed as litres per kilogram (L/kg).

An average of 336 L of water is used to produce every kg of grapes in the Murray Valley.

- An average of 312 L of water was used for drip irrigation.
- An average of 369 L of water was used for low level sprinkler irrigation.
- An additional 57 L/kg of water is used to produce the same volume of wine grapes if they are irrigated using low level sprinklers in the Murray Valley.

An average of 286 L of water is used to produce every kg of grapes in the Riverina.

- An average of 285 L of water was used for drip irrigation.

The WUE in L/kg for each variety in each region is presented in **Figure 29.**

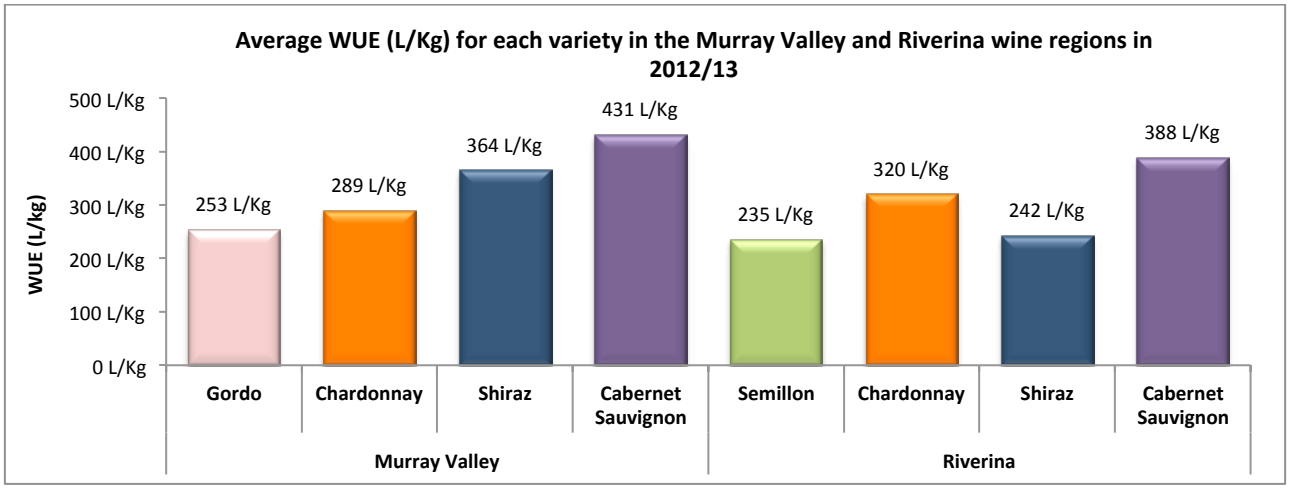

Figure 29 : The average 'virtual' water requirement for each variety (L/kg)

Relationships between irrigation applied and yield

Murray Valley

The relationship between the volume of water applied (ML/ha) and the yield produced (t/ha) is positive but weak for drip irrigated vineyards, and stronger in the low level sprinkler irrigated vineyards in the Murray Valley. This indicates a high level of scatter in the drip irrigated vineyards (many vineyards did not produce greater yield in relation to the volume of water applied). Conversely, there was a stronger correlation between these parameters for the vineyards irrigated using low level sprinklers, see **Figure 30 and 31.**

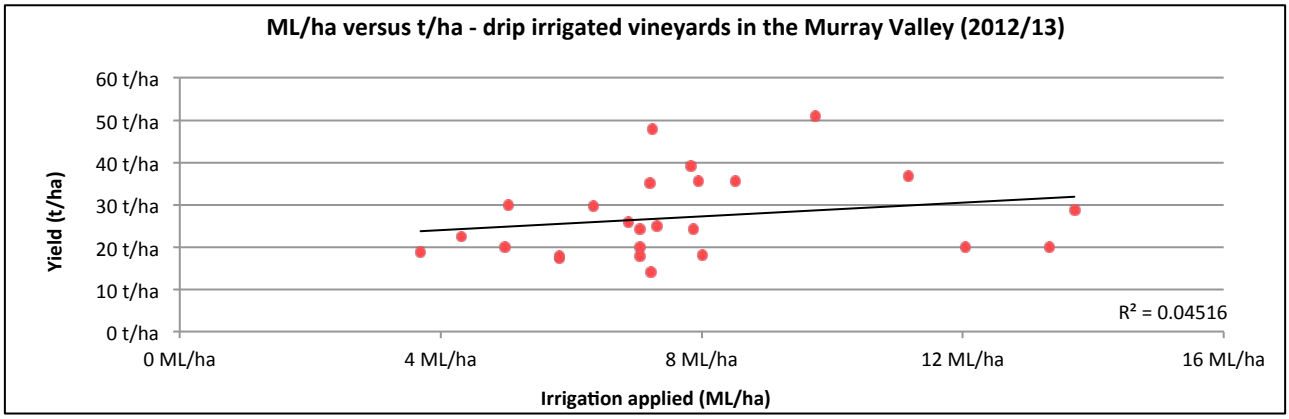

Figure 30 : Irrigation applied versus yield for drip irrigated vineyards in the Murray Valley

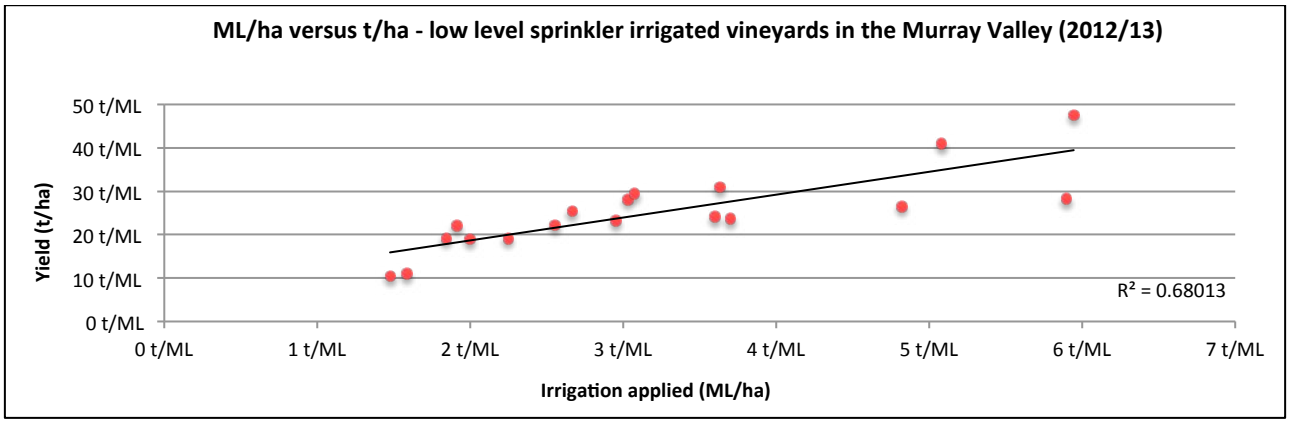

Figure 31 : Irrigation applied versus yield for low level sprinkler irrigated vineyards in the Murray Valley

Riverina

A similar trend is apparent for the Riverina drip irrigated vineyards, where a positive but weak correlation exists between the volume of water applied and the yield produced, see **Figure 32.**

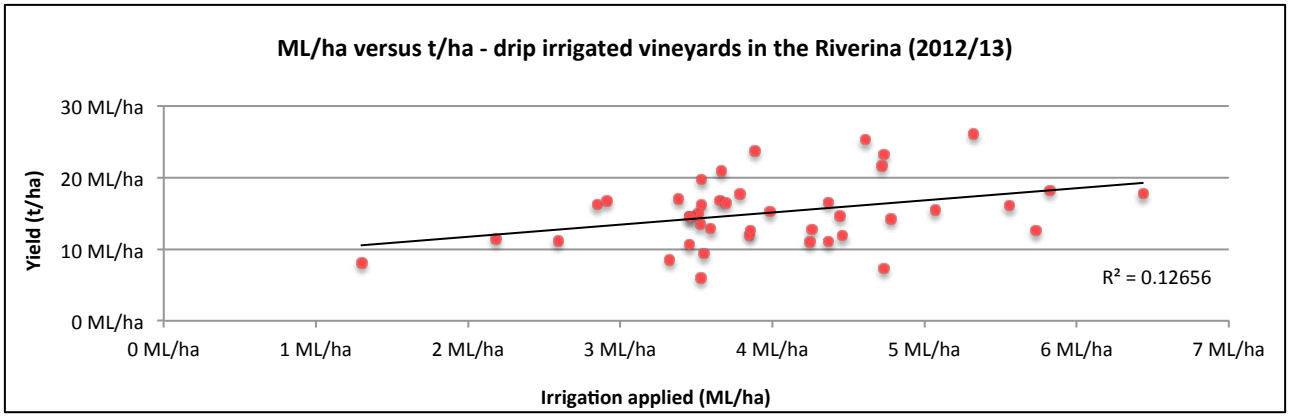

Figure 32 : Irrigation applied versus yield for drip irrigated vineyards in the Riverina

CONCLUDING REMARKS

This is the second year of the water use efficiency study and it builds on each region's knowledge of the benchmark Yield WUE for a number of different varieties, and irrigation application methods. It also provides a platform to discuss the different ways growers can improve their WUE and demonstrate continual improvement, with the potential for time and cost savings.

As with last season, there was a broad range of yields produced at similar rates of irrigation application rates. This indicates that there is the potential to reduce the volume of water applied, or change the irrigation application method, with no detriment to production expected, in some instances.

Similarly, 22 of the 43 growers in the Murray Valley and 23 of the 43 growers in the Riverina had lower Yield WUE scores than the average and this indicates that a number of wine growers may have the capacity to improve irrigation efficiencies. This would be dependent on the capacity of each grower to improve Yield WUE, while ensuring that fruit is produced 'fit for purpose' and that quality parameters are preserved.

This may, or may not, result in increased vineyard profitability (economic WUE was not assessed in this study). In some cases there may be limitations on achieving further efficiencies due to the irrigation infrastructure in place. Additional efficiencies are expected if drainage past the root zone is monitored closely.

The study highlights that the average Yield WUE in the Murray Valley and Riverina are very similar, based on the comparative volume of irrigation applied and the subsequent yield that is produced in each region.

Thank you to the wine growers from the Murray Valley and Riverina who contributed eighty six data sets for the 2012/13 season. Without your support, it would not be possible to provide these regional Yield WUE benchmarking results.

RETALLACK VITICULTURE PTY LTD

MARY RETALLACK
Managing Director / Viticulturist
Macintosh HD:Users:RetallackViti:Documents:Retallack Viticulture:RV Clients:MVWI:WUE:WUE 2013:Rmjr110713 MVWI&Riverina WUE Report 2012-13.docx

Appendix 1a

Bureau of Meteorology weather data for Mildura Airport for season 2012/13

wine growing for the future

BoM Weather Data for Murray Valley wine region – Mildura Airport

Table 1: Mildura Airport weather station – daily rainfall (mm) for season 2012/13

Mildura Airport weather station: daily rainfall (mm)												
Season	2012						2013					
Day	July	August	September	October	November	December	January	February	March	April	May	June
1st	0	0	0	0	0.4	0.6	0	0	0	0	0	16.2
2nd	0	0	0	0	0	0.2	0	0	0	0	0	4.4
3rd	0	0	0	0	0	0	0	0	0	0	0	0
4th	0	0	0	0	0	0.2	0	0	0	0	0	0.2
5th	0	0	0	0	0	0	0	0	0	0	0	0
6th	0	0	0	2.4	0.8	0	0	0	0	0	0	0
7th	0	0	0.8	0	1.8	0	0	0	0	0	0	0
8th	0	0	0	0	0	0	0	0	0	0	0	0
9th	0	4.2	0	0	0	0	0	0	0	0	0	0
10th	10.4	0	0	0	0	0	0	0	0	0	0	0
11th	5.8	0	0	1	0	0	0	0	0	0	0	0
12th	10	0	0	2.6	0	0	0	0	0	0	0	5.8
13th	12.8	0	0.8	0	0	0	0	0	0	0	4.4	3.8
14th	0	0.2	0	0	0	0	1.2	0.8	0	0	0	1
15th	0.4	0	0	0	0	2	0	0	0	0	0.8	0
16th	0	0.4	0	0	0.6	0	0	0	0	0	2	0.2
17th	0	6	0	0	0	0	0	0	0	0	0	0
18th	0	3	11.2	0	0	0	0	0	0	0	0	0.2
19th	0	0	0	0	0	0	0	0	0	0	0	0
20th	0.4	0	0	0	0	1.4	0	0.2	0	0	0	0
21st	0.2	0	0	0	0	0	0	0	0	0	0	0
22nd	0	0.4	0	0	0	0	0	0	0	2.8	9.2	1
23rd	0	1.8	0	0	0	0	0	0.2	0	0	5.8	0
24th	0	0.8	0	0	0	0	0	0	0	0	0	1
25th	0	0	0	0	0	0	0	0	0	0	0	0
26th	1.2	0.2	0	0	0	0	0	0	0	0	0	0
27th	0	0	0	0	0.4	0	0	4.4	0	0	0	0
28th	0.2	0	0	0	0	0	0	9	10.4	0	0	0
29th	0	0	0.4	0	0	0	0		0	1.4	0	0
30th	0	0	0	0	0.6	0	0		0	2	2	0
31st	0	0		0		0	0		0.4		5	
Monthly total	**41.4 mm**	**17.0 mm**	**13.2 mm**	**6.0 mm**	**4.6 mm**	**4.4 mm**	**1.2 mm**	**14.6 mm**	**10.8 mm**	**6.2 mm**	**29.2 mm**	**33.8 mm**
Season total	**182 mm**											

NB: Daily rainfall above 25mm is highlighted in blue

Table 2: Mildura Airport weather station – mean monthly rainfall (mm)

Mildura Airport weather station: mean monthly rainfall (mm)												
Month	Season 2002/03	Season 2003/04	Season 2004/05	Season 2005/06	Season 2006/07	Season 2007/08	Season 2008/09	Season 2009/10	Season 2010/11	Season 2011/12	Season 2012/13	Long Term Mean
July	5.6	14.2	22.0	39.8	30.8	22.8	19.6	11.8	25.6	15.2	41.4	26.2
August	13.8	55.2	25.0	21.2	6.0	2.2	34.2	8.2	28.8	20.8	17.0	26.0
September	7.0	6.8	9.8	39.0	9.8	3.2	2.0	30.4	54.8	7.2	13.2	26.9
October	5.0	33.6	3.8	63.0	0.0	8.4	3.0	10.8	88.8	27.6	6.0	30.0
November	19.8	17.0	42.0	27.2	7.0	29.2	42.6	65.6	103.6	43.4	4.6	26.2
December	66.0	89.4	28.4	15.0	3.6	19.2	34.8	13.2	141.0	61.8	4.4	25.4
January	0.2	3.0	23.8	4.6	56.4	19.4	0.8	8.4	129.4	12.6	1.2	21.8
February	36.8	0.8	3.2	1.2	3.2	0.0	0.0	19.8	192.6	36.6	14.6	22.4
March	0.0	0.6	3.6	24.6	15.8	11.4	24.0	35.8	122.0	64.2	10.8	20.4
April	0.6	0.0	3.4	17.8	35.4	4.8	21.8	18.8	12.6	4.0	6.2	17.8
May	28.0	7.0	3.0	6.4	25.0	15.8	9.4	51.2	14.2	2.6	29.2	25.1
June	22.0	30.8	35.6	11.4	2.0	14.4	37.0	14.6	10.6	8.0	33.8	22.6
Annual rainfall	**205 mm**	**258 mm**	**204 mm**	**271 mm**	**195 mm**	**151 mm**	**229 mm**	**289 mm**	**924 mm**	**304 mm**	**182 mm**	**291 mm**
Monthly rainfall versus long term mean	***-86 mm***	***-32 mm***	***-87 mm***	***-20 mm***	***-96 mm***	***-140 mm***	***-62 mm***	***-2 mm***	***633 mm***	***13 mm***	***-108 mm***	

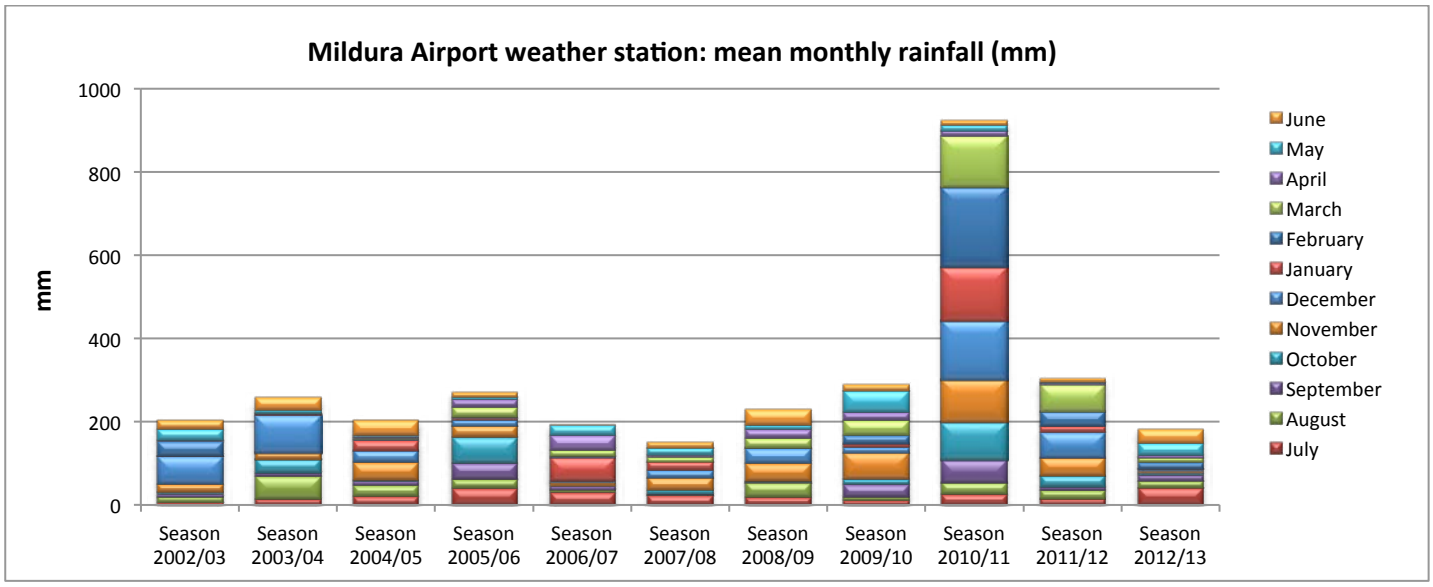

Figure 1 : Mildura Airport weather station – mean monthly rainfall (mm)

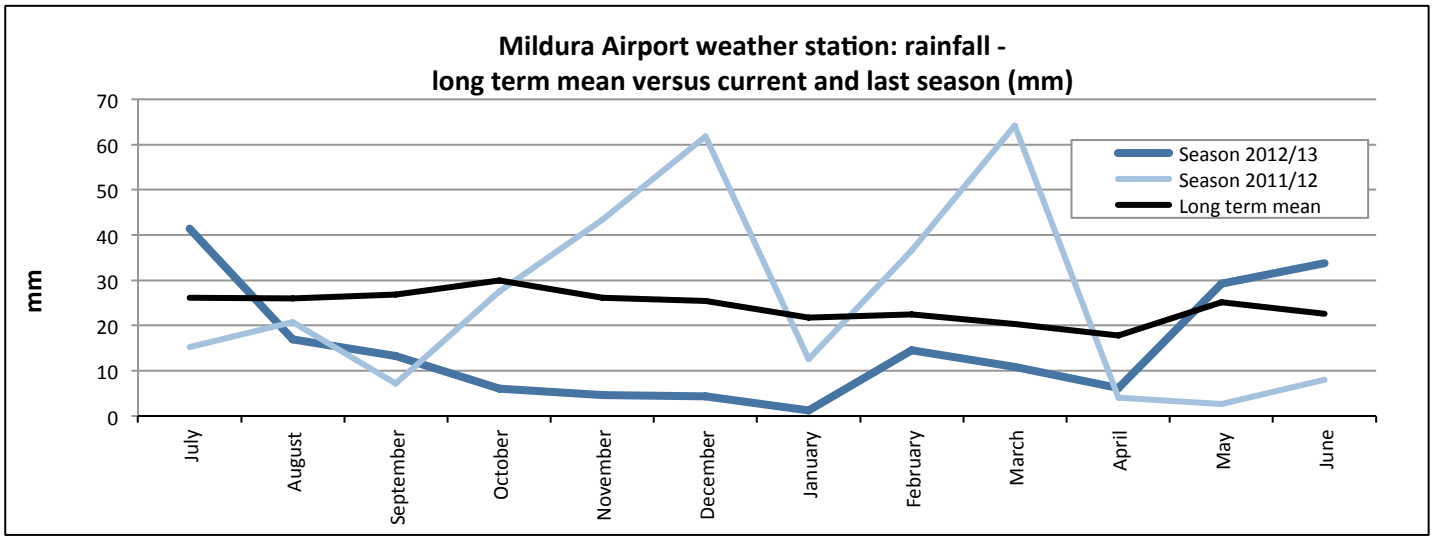

Figure 2 : Mildura Airport weather station – long term mean rainfall versus current and last season (mm)

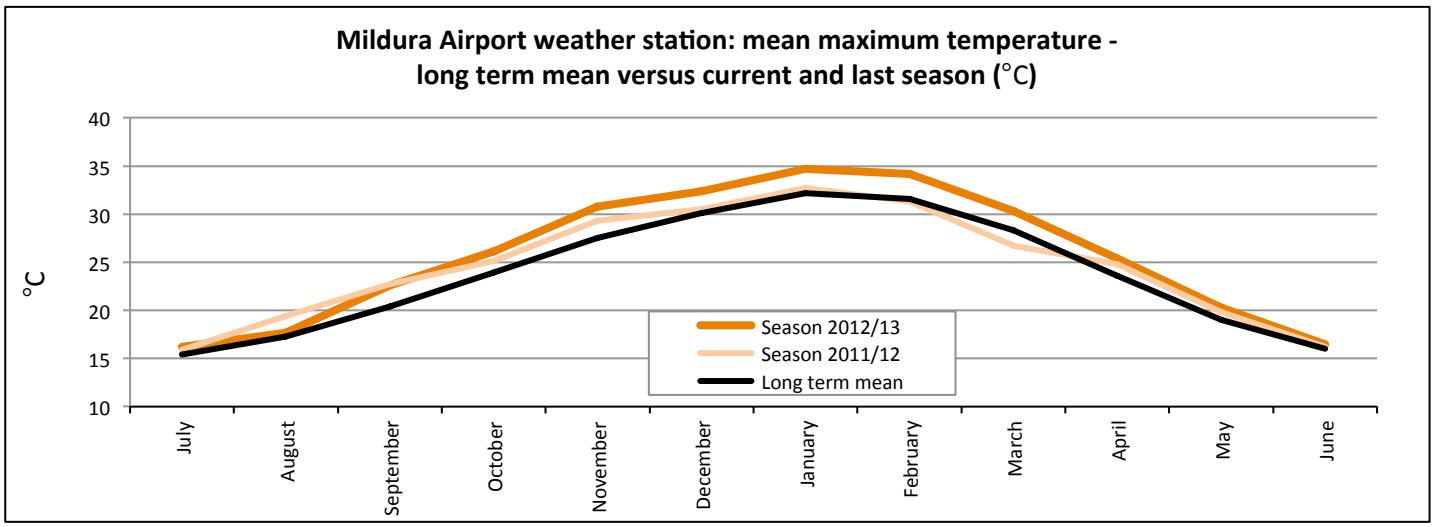

Figure 3 : Mildura Airport weather station – long term mean max temperature versus current and last season (°C)

Appendix 1b

Bureau of Meteorology weather data for Griffith Airport for season 2012/13

wine growing for the future

BoM Weather Data for Murray Valley wine region – Griffith Airport

Table 1: Griffith Airport weather station – daily rainfall (mm) for season 2012/13

Griffith Airport weather station: daily rainfall (mm)												
Season	2012						2013					
Day	July	August	September	October	November	December	January	February	March	April	May	June
1st	0.6	0	1	0	0	0	0	0	1	0	0	5.6
2nd	2.6	0	0	0	0.2	3.4	0	0.4	0	0	0	22.2
3rd	0	0	0	0	0	0	0	0	0	0	0	0
4th	0.2	0	0	0	0	0	0	0	0	0	0	0
5th	0.2	0	0	0	0	0	0	0	0	0	0	0
6th	0	0	0	0		0	0	0	0	0	0	0
7th	0	0	0	0	27.6	0	0	0	0	0	0	0
8th	0	0	0	0	66.6	0	0	0	0	0	1.8	0
9th	0	2.8	0	0	0	0	0	0	0	0	0	0
10th	9.8	0	0	0	0	0	0	0	0	0	0	0
11th	8.6	0	0	2	0	0	0	0	0	0	0	0
12th	0.8	0	0	8	0	0	0	0	0	0	0	6.6
13th	3.8	0	1.8	0	0	0	0	0	0	0	12.2	2
14th	0	0	0	0	0	0	0	0.4	0	0	1	0.6
15th	0.2	0	0	0	0	0.2	0	0	0	0	0.4	0
16th	0	0	0	0	0.4	3.8	0	0.2	0	0	0.8	0
17th	0	8.2	0	0	0	0	0	0	0	0	0	0.2
18th	0	8.8	0.6	0	0	0	0	0	0	0	0	0
19th	0.4	0	0.4	0	0	0	0	0	0	0	0	0
20th	0	0	0	0	0	1.2	0	0	0	0	0	0.4
21st	0.2	0.2	0	0	0	0	0	0	0.2	0	0	0
22nd	0	0	0	0.4	0	0	0	2.6	6.4	0.6	0.2	0
23rd	0	2.4	0	0	0	0	0	0	0	0		0
24th	0	6	0	0	0	0	0	0	0	0	0	0
25th	0	0.6	0	0	0	0	0	0	0	0	0	0.2
26th	1.6	0	0	0	0	0	0	0	0	0	0	0
27th	0.8	0	0	0	0	0	0	1	0	0	0	0
28th	0.8	0.2	0	0	0.8	0	0	44	17.4	0	0	0
29th	0	0	1	0	0	0	0		5.8	0	0	0.8
30th	0.2	0	0	0		0	0		0	1	0	0.4
31st	0	0		0		0	0		1.4		9.4	
Monthly total (mm)	**30.8 mm**	**29.2 mm**	**4.8 mm**	**10.4 mm**	**95.6 mm**	**8.6 mm**	**0.0 mm**	**48.6 mm**	**32.2 mm**	**1.6 mm**	**25.8 mm**	**39.0 mm**
Season total (mm)	**327 mm**											

NB: Daily rainfall above 25mm is highlighted in blue

Table 2: Griffith Airport weather station – mean monthly rainfall (mm)

Griffith Airport weather station: mean monthly rainfall (mm)												
Month	Season 2002/03	Season 2003/04	Season 2004/05	Season 2005/06	Season 2006/07	Season 2007/08	Season 2008/09	Season 2009/10	Season 2010/11	Season 2011/12	Season 2012/13	Long Term Mean
July	8.8	39.4	19.2	39.6	41.6	28.8	28.8	23.4	40.2	29.8	30.8	33.4
August	3.8	66.1	31.6	44.6	2.2	4.8	14.6	13.2	47.0	52.6	29.2	36.1
September	21.4	12.6	7.8	40.2	12.2	2.2	23.0	19.4	54.4	17.8	4.8	32.4
October	0.0	43.2	11.0	94.4	0.0	10.0	19.6	19.0	102.6	16.0	10.4	39.5
November	4.4	15.0	40.4	45.4	17.2	97.4	49.8	27.8	74.6	43.4	95.6	34.7
December	4.0	51.0	26.4	28.0	0.6	76.4	41.4	77.6	68.0	23.8	8.6	32.8
January	12.2	17.0	3.6	15.8	13.2	35.6	2.8	8.6	43.6	47.2	0.0	33.0
February	47.0	5.4	34.2	3.0	2.4	12.4	19.2	41.8	134.4	55.4	48.6	29.7
March	0.2	1.2	4.6	10.6	14.4	8.4	6.8	64.0	40.6	212.6	32.2	36.7
April	11.2	17.0	9.2	10.8	12.0	2.2	21.4	20.8	25.0	34.6	1.6	27.4
May	13.2	24.4	2.0	1.2	37.4	6.6	4.0	62.6	36.2	15.4	25.8	34.1
June	15.0	24.8	61.4	33.6	13.2	40.0	74.8	20.8	16.6	12.2	39.0	33.4
Annual rainfall (mm)	**141 mm**	**317 mm**	**251 mm**	**367 mm**	**166 mm**	**325 mm**	**306 mm**	**399 mm**	**683 mm**	**561 mm**	**327 mm**	**403.2 mm**
Monthly rainfall versus long term mean	***-262 mm***	***-86 mm***	***-152 mm***	***-36 mm***	***-237 mm***	***-78 mm***	***-97 mm***	***-4 mm***	***280 mm***	***158 mm***	***-77 mm***	

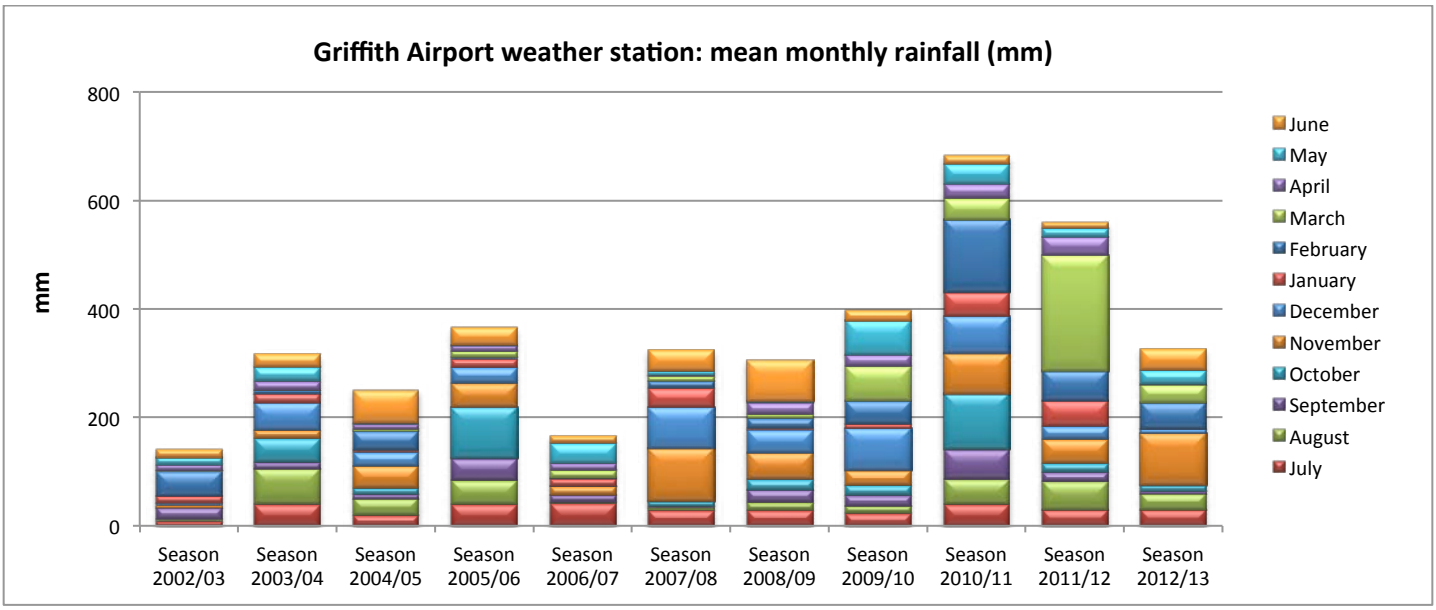

Figure 1 : Griffith Airport weather station – mean monthly rainfall (mm)

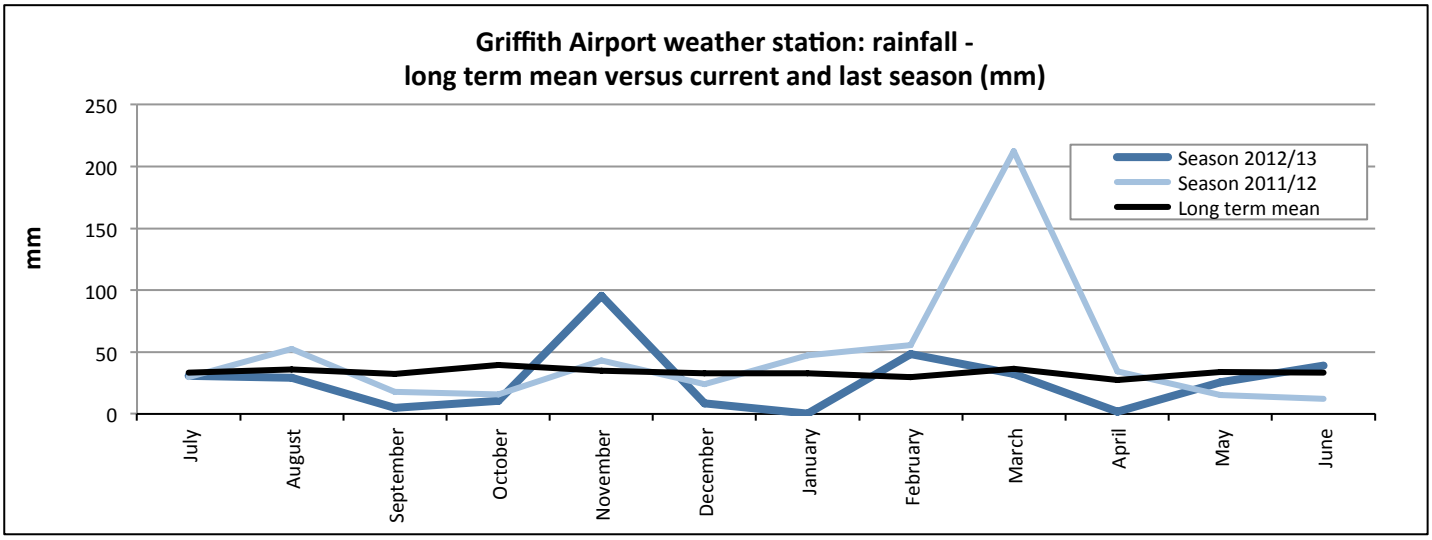

Figure 2 : Griffith Airport weather station – long term mean rainfall versus current and last season (mm)

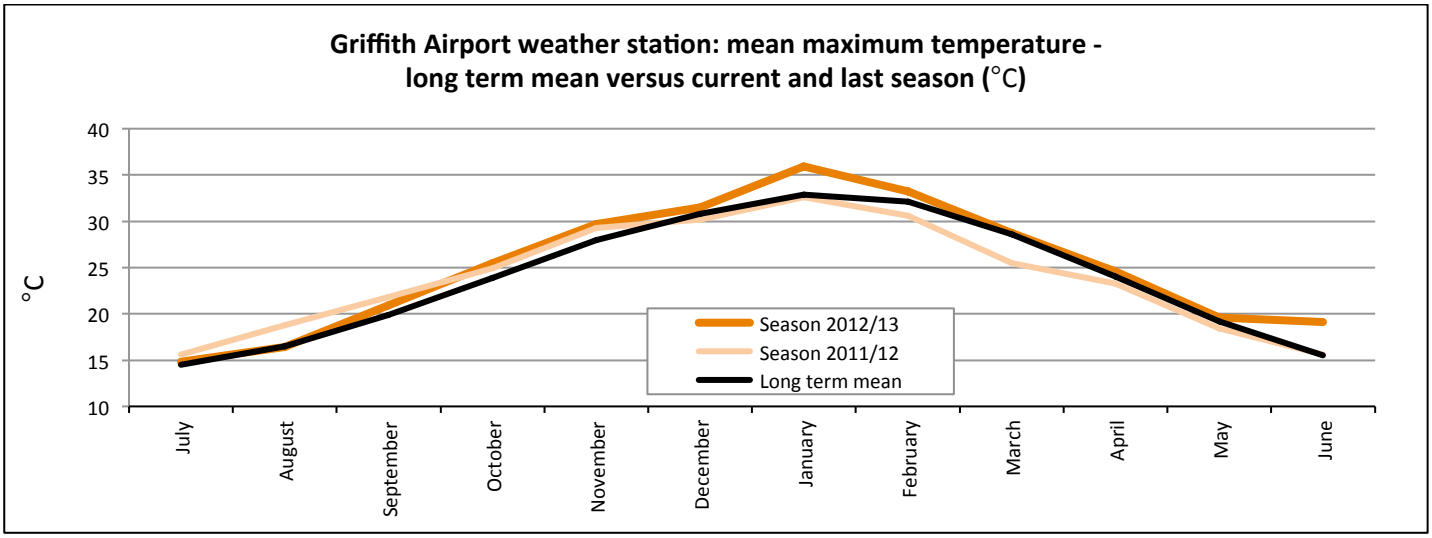

Figure 3 : Griffith Airport weather station – long term mean max temperature versus current and last season (°C)

Appendix 2a

Murray Valley irrigation data for season 2012/13

wine growing for the future

Table 1: Murray Valley wine region irrigation data set for season 2012/13

WUE Project Grower ID	Rootstock	MVWI WUE 2012/13											
		Varieties	t/ha	Irrigation	WUE for key phenological periods				ML/ha	WUE L/Kg	WUE t/ML	Soil Type	Comments
					Budburst EL 4 - flowering EL 26	Fruitset EL 27 - veraison EL 35	100% veraison EL 36 - Harvest EL 38	Post Harvest EL 41 - end of leaf fall EL 47					
Vineyard MV6	Ramsey	Chardonnay	30.0 t/ha	Drip	0.2 ML/ha	0.9 ML/ha	2.2 ML/ha	1.7 ML/ha	5.0 ML/ha	168 L/Kg	6.0 t/ML	Sandy Clay Loam	Existing code used
Vineyard MV7	Ramsey	Chardonnay	29.6 t/ha	Drip	0.2 ML/ha	1.0 ML/ha	2.9 ML/ha	2.2 ML/ha	6.3 ML/ha	214 L/Kg	4.7 t/ML	Loamy Clay	Existing code used
Vineyard MV9	Schwarzmann	Chardonnay	24.4 t/ha	Drip	0.9 ML/ha	4.0 ML/ha	1.7 ML/ha	0.4 ML/ha	7.0 ML/ha	289 L/Kg	3.5 t/ML	Sandy Loam	Existing code used
Vineyard MV10	Paulsen 1103	Chardonnay	35.5 t/ha	Drip	1.0 ML/ha	3.7 ML/ha	2.0 ML/ha	1.8 ML/ha	8.5 ML/ha	240 L/Kg	4.2 t/ML	Sandy Clay Loam	Existing code used
Vineyard MV13	Ramsey	Chardonnay	35.1 t/ha	Drip	0.8 ML/ha	1.6 ML/ha	2.6 ML/ha	2.2 ML/ha	7.2 ML/ha	205 L/Kg	4.9 t/ML	Sandy Loam	Existing code used
Vineyard MV17	Ruggeri 140	Chardonnay	28.2 t/ha	Low level sprinklers	1.6 ML/ha	3.1 ML/ha	1.3 ML/ha	3.4 ML/ha	9.3 ML/ha	330 L/Kg	3.0 t/ML	Sandy Loam	Existing code used
Vineyard MV18	Ramsey	Chardonnay	29.5 t/ha	Low level sprinklers	1.5 ML/ha	3.3 ML/ha	3.0 ML/ha	1.9 ML/ha	9.6 ML/ha	326 L/Kg	3.1 t/ML	Sandy Clay Loam	Existing code used
Vineyard MV20	Kober 5BB	Chardonnay	28.3 t/ha	Low level sprinklers	1.0 ML/ha	1.7 ML/ha	0.6 ML/ha	1.5 ML/ha	4.8 ML/ha	170 L/Kg	5.9 t/ML	Sandy Clay Loam	Existing code used
Vineyard MV21	Ramsey	Chardonnay	23.3 t/ha	Low level sprinklers	2.1 ML/ha	1.4 ML/ha	3.4 ML/ha	1.0 ML/ha	7.9 ML/ha	339 L/Kg	2.9 t/ML	Clay Loam	Existing code used
Vineyard MV23	Paulsen 1103	Chardonnay	31.0 t/ha	Low level sprinklers	1.5 ML/ha	3.4 ML/ha	1.8 ML/ha	1.8 ML/ha	8.5 ML/ha	275 L/Kg	3.6 t/ML	Sandy Clay Loam	Existing code used
Vineyard MV25	Own roots	Shiraz	20.0 t/ha	Drip	1.2 ML/ha	0.4 ML/ha	2.3 ML/ha	1.1 ML/ha	5.0 ML/ha	249 L/Kg	4.0 t/ML	Heavy Clay	Existing code used
Vineyard MV26	Schwarzmann	Shiraz	25.9 t/ha	Drip	0.7 ML/ha	2.3 ML/ha	2.2 ML/ha	1.7 ML/ha	6.9 ML/ha	266 L/Kg	3.8 t/ML	Sandy Loam	Existing code used
Vineyard MV27	Schwarzmann	Shiraz	17.3 t/ha	Drip	0.4 ML/ha	1.2 ML/ha	2.6 ML/ha	1.7 ML/ha	5.8 ML/ha	336 L/Kg	3.0 t/ML	Clay Loam	Existing code used
Vineyard MV29	Schwarzmann	Shiraz	18.1 t/ha	Drip	1.1 ML/ha	4.9 ML/ha	0.5 ML/ha	1.5 ML/ha	8.0 ML/ha	443 L/Kg	2.3 t/ML	Sandy Clay Loam	Existing code used
Vineyard MV32	Schwarzmann	Shiraz	19.9 t/ha	Drip	0.9 ML/ha	4.0 ML/ha	1.7 ML/ha	0.4 ML/ha	7.0 ML/ha	354 L/Kg	2.8 t/ML	Sandy Loam	Existing code used
Vineyard MV37	Paulsen 1103	Shiraz	19.1 t/ha	Low level sprinklers	2.2 ML/ha	3.9 ML/ha	1.2 ML/ha	1.2 ML/ha	8.5 ML/ha	445 L/Kg	2.2 t/ML	Clay Loam	Existing code used
Vineyard MV40	Kober 5BB	Shiraz	26.6 t/ha	Low level sprinklers	1.2 ML/ha	2.4 ML/ha	1.0 ML/ha	1.0 ML/ha	5.5 ML/ha	208 L/Kg	4.8 t/ML	Loam	Existing code used
Vineyard MV42	Own roots	Shiraz	22.3 t/ha	Low level sprinklers	1.6 ML/ha	2.5 ML/ha	3.3 ML/ha	1.3 ML/ha	8.7 ML/ha	392 L/Kg	2.6 t/ML	Sandy Loam	Existing code used
Vineyard MV43	Ramsey	Shiraz	24.1 t/ha	Low level sprinklers	0.7 ML/ha	2.2 ML/ha	2.6 ML/ha	1.2 ML/ha	6.7 ML/ha	278 L/Kg	3.6 t/ML	Sandy Loam	Existing code used
Vineyard MV45	Own roots	Shiraz	19.2 t/ha	Low level sprinklers	1.8 ML/ha	3.0 ML/ha	2.6 ML/ha	3.1 ML/ha	10.4 ML/ha	544 L/Kg	1.8 t/ML	Sandy Loam	Existing code used

Table 2: Murray Valley wine region irrigation data set for season 2012/13 - continued

WUE Project Grower ID	Rootstock	MVWI WUE 2012/13												
		Varieties	t/ha	Irrigation	WUE for key phenological periods				ML/ha	WUE L/Kg	WUE t/ML	Soil Type	Comments
					Budburst EL 4 - flowering EL 26	Fruitset EL 27 - veraison EL 35	100% veraison EL 36 - Harvest EL 38	Post Harvest EL 41 - end of leaf fall EL 47					
Vineyard MV51	Ramsey	Cabernet Sauvignon	17.8 t/ha	Drip	0.4 ML/ha	1.2 ML/ha	2.6 ML/ha	1.7 ML/ha	5.8 ML/ha	327 L/Kg	3.1 t/ML	Sandy Clay Loam	Existing code used
Vineyard MV54	Schwarzmann	Cabernet Sauvignon	18.0 t/ha	Drip	0.9 ML/ha	4.0 ML/ha	1.7 ML/ha	0.4 ML/ha	7.0 ML/ha	392 L/Kg	2.6 t/ML	Sandy Loam	Existing code used
Vineyard MV55	Own roots	Cabernet Sauvignon	19.0 t/ha	Drip	0.5 ML/ha	0.9 ML/ha	1.4 ML/ha	0.9 ML/ha	3.7 ML/ha	195 L/Kg	5.1 t/ML	Sandy Clay Loam	Existing code used
Vineyard MV56	Own roots	Cabernet Sauvignon	14.1 t/ha	Drip	0.9 ML/ha	2.5 ML/ha	2.4 ML/ha	1.5 ML/ha	7.2 ML/ha	512 L/Kg	2.0 t/ML		Existing code used
Vineyard MV59	Own roots	Cabernet Sauvignon	10.4 t/ha	Low level sprinklers	0.9 ML/ha	4.0 ML/ha	1.7 ML/ha	0.4 ML/ha	7.0 ML/ha	678 L/Kg	1.5 t/ML	Clay	Existing code used
Vineyard MV60	Schwarzmann	Cabernet Sauvignon	23.7 t/ha	Low level sprinklers	1.5 ML/ha	2.3 ML/ha	1.6 ML/ha	0.9 ML/ha	6.4 ML/ha	270 L/Kg	3.7 t/ML	Sandy Clay Loam	Existing code used
Vineyard MV61	K51-40	Cabernet Sauvignon	25.5 t/ha	Low level sprinklers	1.7 ML/ha	3.3 ML/ha	2.0 ML/ha	2.6 ML/ha	9.6 ML/ha	375 L/Kg	2.7 t/ML	Sandy Loam	Existing code used
Vineyard MV62	Own roots	Cabernet Sauvignon	11.1 t/ha	Low level sprinklers	1.6 ML/ha	3.7 ML/ha	1.1 ML/ha	0.6 ML/ha	7.0 ML/ha	631 L/Kg	1.6 t/ML	Clay Loam	Existing code used
Vineyard MV63	Ramsey	Chardonnay	35.6 t/ha	Drip	1.1 ML/ha	3.1 ML/ha	3.1 ML/ha	0.6 ML/ha	7.9 ML/ha	223 L/Kg	4.5 t/ML	Sandy Clay Loam	New code
Vineyard MV64	Ramsey	Chardonnay	28.8 t/ha	Drip	1.7 ML/ha	4.0 ML/ha	5.1 ML/ha	2.9 ML/ha	13.7 ML/ha	477 L/Kg	2.1 t/ML	Sandy Loam	New code
Vineyard MV65	Own roots	Shiraz	22.5 t/ha	Drip	0.8 ML/ha	0.5 ML/ha	2.0 ML/ha	0.9 ML/ha	4.3 ML/ha	192 L/Kg	5.2 t/ML	Heavy Clay	New code
Vineyard MV66	Own roots	Shiraz	20.0 t/ha	Drip	1.6 ML/ha	4.5 ML/ha	4.4 ML/ha	2.8 ML/ha	13.3 ML/ha	666 L/Kg	1.5 t/ML	Loam clay	New code
Vineyard MV67	Schwarzmann	Cabernet Sauvignon	24.2 t/ha	Drip	1.0 ML/ha	3.0 ML/ha	3.1 ML/ha	0.8 ML/ha	7.9 ML/ha	325 L/Kg	3.1 t/ML	Sandy Clay Loam	New code
Vineyard MV68	SO4	Cabernet Sauvignon	20.0 t/ha	Drip	1.7 ML/ha	5.0 ML/ha	3.7 ML/ha	1.6 ML/ha	12.0 ML/ha	602 L/Kg	1.7 t/ML	loam	New code
Vineyard MV69	Richter 99/Dogridge	Gordo	48.0 t/ha	Drip	1.6 ML/ha	1.7 ML/ha	2.6 ML/ha	1.3 ML/ha	7.2 ML/ha	151 L/Kg	6.6 t/ML	Sandy Loam	New code
Vineyard MV70	Dogridge	Gordo	36.8 t/ha	Drip	1.7 ML/ha	5.3 ML/ha	2.1 ML/ha	2.0 ML/ha	11.2 ML/ha	304 L/Kg	3.3 t/ML	Loam Limestone	New code
Vineyard MV71	Paulsen 1103	Gordo	41.1 t/ha	Low level sprinklers	3.0 ML/ha	2.1 ML/ha	2.6 ML/ha	0.3 ML/ha	8.1 ML/ha	197 L/Kg	5.1 t/ML	Loam Limestone	New code
Vineyard MV72	Paulsen 1103	Gordo	47.6 t/ha	Low level sprinklers	1.8 ML/ha	4.6 ML/ha	1.4 ML/ha	0.3 ML/ha	8.0 ML/ha	168 L/Kg	5.9 t/ML	Sandy Clay Loam	New code
Vineyard MV73	Ruggeri	Gordo	51.1 t/ha	Drip	1.0 ML/ha	5.5 ML/ha	2.2 ML/ha	1.0 ML/ha	9.7 ML/ha	191 L/Kg	5.2 t/ML	Sandy Clay Loam	New code
Vineyard MV74	Dogridge	Gordo	22.1 t/ha	Low level sprinklers	1.8 ML/ha	2.5 ML/ha	5.1 ML/ha	2.2 ML/ha	11.6 ML/ha	523 L/Kg	1.9 t/ML	Clay loam	New code
Vineyard MV75	Schwarzmann	Gordo	39.2 t/ha	Drip	1.0 ML/ha	3.1 ML/ha	3.2 ML/ha	0.5 ML/ha	7.8 ML/ha	200 L/Kg	5.0 t/ML	Sandy Clay Loam	New code
Vineyard MV76	Paulsen 1103	Gordo	25.0 t/ha	Drip	1.7 ML/ha	2.0 ML/ha	3.3 ML/ha	0.4 ML/ha	7.3 ML/ha	293 L/Kg	3.4 t/ML	Sandy Clay Loam	New code
Vineyard MV77	Paulsen 1103	Chardonnay	19.0 t/ha	Low level sprinklers	2.7 ML/ha	1.1 ML/ha	4.3 ML/ha	1.4 ML/ha	9.5 ML/ha	501 L/Kg	2.0 t/ML	Sandy Loam	New code

Appendix 2b

Riverina irrigation data for season 2012/13

wine growing for the future

Table 1: Riverina wine region irrigation data set for season 2012/13

WUE Project Grower ID	Rootstock	Riverina WUE 2012/13										
		Varieties	t/ha	Irrigation	WUE for key phenological periods				ML/ha	WUE L/Kg (calculated)	WUE t/ML (calculated)	Comments
				Drip or Furrow	Budburst EL 4 - flowering EL 26	Fruitset EL 27 - veraison EL 35	100% veraison EL 36 - Harvest EL 38	Post Harvest EL 41 - end of leaf fall EL 47				
Vineyard R5	Ramsey	Chardonnay	11.5 t/ha	Drip	0.7 ML/ha	0.8 ML/ha	0.5 ML/ha	0.2 ML/ha	2.2 ML/ha	190 L/Kg	5.3 t/ML	Existing code used
Vineyard R10	Ramsey	Shiraz	12.0 t/ha	Drip	0.8 ML/ha	1.4 ML/ha	1.3 ML/ha	0.4 ML/ha	3.8 ML/ha	320 L/Kg	3.1 t/ML	Existing code used
Vineyard R11	Ramsey	Shiraz	8.1 t/ha	Drip	0.0 ML/ha	0.2 ML/ha	1.0 ML/ha	0.2 ML/ha	1.3 ML/ha	160 L/Kg	6.2 t/ML	Existing code used
Vineyard R12	Ramsey	Shiraz	21.6 t/ha	Drip	1.9 ML/ha	2.2 ML/ha	0.4 ML/ha	0.3 ML/ha	4.7 ML/ha	218 L/Kg	4.6 t/ML	Existing code used
Vineyard R25	Own Roots	Semillon	25.3 t/ha	Drip	1.4 ML/ha	2.0 ML/ha	0.8 ML/ha	0.4 ML/ha	4.6 ML/ha	182 L/Kg	5.5 t/ML	Existing code used
Vineyard R33	Paulsen 1103	Semillon	13.5 t/ha	Drip	0.8 ML/ha	1.3 ML/ha	0.9 ML/ha	0.5 ML/ha	3.5 ML/ha	260 L/Kg	3.8 t/ML	New code
Vineyard R34	Ramsey	Chardonnay	16.8 t/ha	Drip	0.8 ML/ha	1.4 ML/ha	1.0 ML/ha	0.5 ML/ha	3.7 ML/ha	217 L/Kg	4.6 t/ML	New code
Vineyard R35	Own Roots	Shiraz	8.0 t/ha	Furrow	1.1 ML/ha	0.9 ML/ha	0.7 ML/ha	0.0 ML/ha	2.6 ML/ha	327 L/Kg	3.1 t/ML	New code
Vineyard R36	Own Roots	Shiraz	18.2 t/ha	Drip	1.0 ML/ha	1.7 ML/ha	1.8 ML/ha	1.3 ML/ha	5.8 ML/ha	319 L/Kg	3.1 t/ML	New code
Vineyard R37	Own Roots	Semillon	17.8 t/ha	Drip	1.2 ML/ha	2.0 ML/ha	2.2 ML/ha	1.2 ML/ha	6.4 ML/ha	361 L/Kg	2.8 t/ML	New code
Vineyard R38	Own Roots	Cabernet Sauvignon	12.6 t/ha	Drip	1.1 ML/ha	1.5 ML/ha	1.8 ML/ha	1.3 ML/ha	5.7 ML/ha	454 L/Kg	2.2 t/ML	New code
Vineyard R39	Own Roots	Chardonnay	16.1 t/ha	Drip	0.9 ML/ha	2.0 ML/ha	0.5 ML/ha	2.1 ML/ha	5.6 ML/ha	344 L/Kg	2.9 t/ML	New code
Vineyard R40	Own Roots	Semillon	12.8 t/ha	Drip	1.1 ML/ha	2.1 ML/ha	0.6 ML/ha	0.5 ML/ha	4.3 ML/ha	332 L/Kg	3.0 t/ML	New code
Vineyard R41	Ramsey	Chardonnay	11.1 t/ha	Drip	0.8 ML/ha	2.4 ML/ha	0.6 ML/ha	0.5 ML/ha	4.4 ML/ha	393 L/Kg	2.5 t/ML	New code
Vineyard R42	Rootstock	Cabernet Sauvignon	9.4 t/ha	Drip	0.6 ML/ha	1.1 ML/ha	1.3 ML/ha	0.5 ML/ha	3.6 ML/ha	376 L/Kg	2.7 t/ML	New code
Vineyard R43	Rootstock	Semillon	26.1 t/ha	Drip	0.9 ML/ha	1.8 ML/ha	1.9 ML/ha	0.8 ML/ha	5.3 ML/ha	204 L/Kg	4.9 t/ML	New code
Vineyard R44	Rootstock	Chardonnay	15.5 t/ha	Drip	0.6 ML/ha	1.8 ML/ha	1.9 ML/ha	0.8 ML/ha	5.1 ML/ha	327 L/Kg	3.1 t/ML	New code
Vineyard R45	Rootstock	Shiraz	11.9 t/ha	Drip	0.6 ML/ha	1.9 ML/ha	1.4 ML/ha	0.5 ML/ha	4.5 ML/ha	375 L/Kg	2.7 t/ML	New code
Vineyard R46	Rootstock	Chardonnay	14.7 t/ha	Drip	0.5 ML/ha	1.7 ML/ha	1.4 ML/ha	0.8 ML/ha	4.4 ML/ha	301 L/Kg	3.3 t/ML	New code
Vineyard R47	Rootstock	Shiraz	11.2 t/ha	Drip	0.3 ML/ha	0.8 ML/ha	1.0 ML/ha	0.5 ML/ha	2.6 ML/ha	231 L/Kg	4.3 t/ML	New code
Vineyard R48	Rootstock	Chardonnay	14.2 t/ha	Drip	0.7 ML/ha	1.8 ML/ha	1.5 ML/ha	0.8 ML/ha	4.8 ML/ha	336 L/Kg	3.0 t/ML	New code
Vineyard R49	Own Roots	Shiraz	16.2 t/ha	Drip	0.8 ML/ha	1.1 ML/ha	0.6 ML/ha	1.0 ML/ha	3.5 ML/ha	218 L/Kg	4.6 t/ML	New code
Vineyard R50	Own Roots	Semillon	23.7 t/ha	Drip	0.9 ML/ha	1.3 ML/ha	0.7 ML/ha	1.0 ML/ha	3.9 ML/ha	164 L/Kg	6.1 t/ML	New code
Vineyard R51	Own Roots	Cabernet Sauvignon	12.9 t/ha	Drip	0.8 ML/ha	1.1 ML/ha	0.6 ML/ha	1.0 ML/ha	3.6 ML/ha	278 L/Kg	3.6 t/ML	New code
Vineyard R52	Own Roots	Shiraz	19.8 t/ha	Drip	0.8 ML/ha	1.1 ML/ha	0.6 ML/ha	1.0 ML/ha	3.5 ML/ha	178 L/Kg	5.6 t/ML	New code
Vineyard R53	Own Roots	Shiraz	16.5 t/ha	Drip	0.9 ML/ha	1.2 ML/ha	0.6 ML/ha	1.0 ML/ha	3.7 ML/ha	224 L/Kg	4.5 t/ML	New code
Vineyard R54	Own Roots	Cabernet Sauvignon	12.6 t/ha	Drip	0.9 ML/ha	1.2 ML/ha	0.6 ML/ha	1.1 ML/ha	3.9 ML/ha	306 L/Kg	3.3 t/ML	New code
Vineyard R55	Own Roots	Semillon	23.3 t/ha	Drip	0.9 ML/ha	1.4 ML/ha	0.7 ML/ha	1.7 ML/ha	4.7 ML/ha	203 L/Kg	4.9 t/ML	New code
Vineyard R56	Ramsey	Chardonnay	7.4 t/ha	Drip	0.9 ML/ha	1.4 ML/ha	0.7 ML/ha	1.7 ML/ha	4.7 ML/ha	639 L/Kg	1.6 t/ML	New code
Vineyard R57	Own Roots	Shiraz	16.6 t/ha	Drip	1.0 ML/ha	1.6 ML/ha	0.7 ML/ha	1.0 ML/ha	4.4 ML/ha	263 L/Kg	3.8 t/ML	New code

wine growing for the future

Table 1: Riverina wine region irrigation data set for season 2012/13 - continued

WUE Project Grower ID	Rootstock	Riverina WUE 2012/13										
		Varieties	t/ha	Irrigation	WUE for key phenological periods				ML/ha	WUE L/Kg (calculated)	WUE t/ML (calculated)	Comments
				Drip or Furrow	Budburst EL 4 - flowering EL 26	Fruitset EL 27 - veraison EL 35	100% veraison EL 36 - Harvest EL 38	Post Harvest EL 41 - end of leaf fall EL 47				
Vineyard R58	Own Roots	Cabernet Sauvignon	11.0 t/ha	Drip	1.1 ML/ha	1.5 ML/ha	0.7 ML/ha	1.0 ML/ha	4.2 ML/ha	386 L/Kg	2.6 t/ML	New code
Vineyard R59	Own Roots	Shiraz	15.3 t/ha	Drip	1.0 ML/ha	1.4 ML/ha	0.7 ML/ha	0.9 ML/ha	4.0 ML/ha	260 L/Kg	3.8 t/ML	New code
Vineyard R60	Own Roots	Shiraz	16.3 t/ha	Drip	0.6 ML/ha	1.0 ML/ha	0.5 ML/ha	0.8 ML/ha	2.8 ML/ha	175 L/Kg	5.7 t/ML	New code
Vineyard R61	Own Roots	Shiraz	14.6 t/ha	Drip	1.2 ML/ha	1.1 ML/ha	0.4 ML/ha	0.8 ML/ha	3.5 ML/ha	237 L/Kg	4.2 t/ML	New code
Vineyard R62	Own Roots	Shiraz	14.6 t/ha	Drip	1.3 ML/ha	1.0 ML/ha	0.3 ML/ha	0.8 ML/ha	3.5 ML/ha	237 L/Kg	4.2 t/ML	New code
Vineyard R63	Own Roots	Cabernet Sauvignon	6.0 t/ha	Drip	1.3 ML/ha	1.1 ML/ha	0.3 ML/ha	0.8 ML/ha	3.5 ML/ha	588 L/Kg	1.7 t/ML	New code
Vineyard R64	Own Roots	Cabernet Sauvignon	8.5 t/ha	Drip	1.2 ML/ha	1.0 ML/ha	0.3 ML/ha	0.8 ML/ha	3.3 ML/ha	391 L/Kg	2.6 t/ML	New code
Vineyard R65	Own Roots	Semillon	20.9 t/ha	Drip	1.3 ML/ha	1.0 ML/ha	0.3 ML/ha	1.0 ML/ha	3.7 ML/ha	175 L/Kg	5.7 t/ML	New code
Vineyard R66	Own Roots	Shiraz	16.7 t/ha	Drip	1.1 ML/ha	0.7 ML/ha	0.3 ML/ha	0.7 ML/ha	2.9 ML/ha	174 L/Kg	5.7 t/ML	New code
Vineyard R67	Ramsey	Chardonnay	15.0 t/ha	Drip	1.3 ML/ha	1.0 ML/ha	0.3 ML/ha	0.9 ML/ha	3.5 ML/ha	234 L/Kg	4.3 t/ML	New code
Vineyard R68	Schwarzmann	Chardonnay	17.7 t/ha	Drip	0.9 ML/ha	1.5 ML/ha	0.4 ML/ha	0.9 ML/ha	3.8 ML/ha	214 L/Kg	4.7 t/ML	New code
Vineyard R69	Own Roots	Shiraz	17.0 t/ha	Drip	0.8 ML/ha	1.3 ML/ha	0.4 ML/ha	0.9 ML/ha	3.4 ML/ha	199 L/Kg	5.0 t/ML	New code
Vineyard R70	Own Roots	Cabernet Sauvignon	10.7 t/ha	Drip	0.8 ML/ha	1.3 ML/ha	0.4 ML/ha	0.9 ML/ha	3.5 ML/ha	323 L/Kg	3.1 t/ML	New code

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