Factors that influence quality need to be evaluated, but this is made difficult by the lack of easy determination techniques. Currently evaluation is done by the human senses of taste, sight and smell, which may vary from judge to judge and taster to taster.

In an ideal world chemical analysis of wines would be the best method of evaluation provided it could be linked to sensory evaluation. As technology continues to improve so will the possibilities of achieving reliable, accurate and quick method of measuring quality attributes.

In Australia there has been a lot of research on quality parameters in grapes, especially red grapes due to the increasing popularity of varieties such as Shiraz, Cabernet Sauvignon and Merlot. The discussion below is only a broad overview of some of the more obvious environmental and management factors that can influence quality parameters in wine grapes.

Not all wine produced in Australia is targeted at the premium market, therefore the quality required for winegrapes will vary depending on the wine style the winery is aiming for. This information required to grow grapes for a particular wine style will obviously come from the winery. An example is botrytised Semillon where growers are paid on the level of botrytised berries (low, medium or high) above the weight of one row of Semillon that is picked at a normal Baume (approx. 13).

**Shiraz in the Riverina**
The Wine Grapes Marketing Board represents the interests of 500 Riverina winegrape growers. The vineyards under its jurisdiction represent approximately 12,000 ha which produced 150,000 tonnes of grapes in the 1999 vintage. Shiraz accounted for 20% of this crush with a total area of 2,660 hectares.

Because Shiraz is a variety that varies in quality from year to year and can be manipulated by various management techniques, it was selected by the board to assess the variability amongst Riverina growers over the past two vintages. In conjunction with the GWRDC and NSW Agriculture this project has also been expanded to look at the effect of sugar accumulation and data shown in this paper will look at both projects. Also included are some results from canopy management trials undertaken by the board and the CRCV over a three-year period from 1995–1997.

Current quality aspects of grapes that are measured by wineries include:

**Soluble solids**
- usually expressed as Brix or Baume and indicates the measure of sugar in the grapes and the potential alcohol yield after fermentation
- it has been shown to be a useful indicator of ripeness and quality and therefore payment is adjusted accordingly. In the Riverina as part of the minimum price structure growers are paid an extra $10/Baume point above 12.5, with a ceiling of 14° Baume.

**Organic acids**
- these consist mainly of tartaric, malic and citric acids and usually measured by titration and thus the name TA
- development is usually dependent on photosynthesis and in general a lack of TA is due to low photosynthesis
- reduction in TA during maturation is related to the respiration rate of the berry and can be related to temperature

**pH**
- pH levels should be around 3.6 otherwise problems may arise
- high pH increases the activity of micro-organisms and causes wines to have problems with ageing

**Phenolics and anthocyanins**
- phenolics are responsible for the tannic component of wine which determines bitterness and unpleasant flavours
- anthocyanins are a major component in the colour of red wine and are usually measured in mg/g f.w.

**MOG**
- Matter other than grapes

The environment and viticultural practices play a large role in manipulating the five quality parameters mentioned above and Figure 1 demonstrates this in a diagrammatic form.

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**Figure 1. Environmental and viticultural inputs into grape composition. Source: Jackson & Lombard, 1993**
Environmental effects on quality parameters

Climate
Effect on soluble solids (SS)
• warmer temperatures invariably result in grapes with a higher SS
• photosynthesis is most efficient (90–100%) between the temperatures of 18–33°C and declines markedly as temperatures move above or below this mark.

The rate of ripening in the Riverina for the 1999 vintage is demonstrated in Figure 2. It varied greatly from vineyard to vineyard. The vineyards harvested later in the season did not necessarily produce better quality fruit.

Effects on acids and pH
• maturation of grape berries usually associated with a rise in juice pH and lowering of acid levels
• work undertaken by Kleiwer (1972) demonstrated that cool nights and warm day temperatures were able to reduce pH and increase acid levels when compared with warm days and nights
• this suggested daily temperature fluctuations are required to improve acid and pH levels

Effects on flavour and aroma
• The effect of temperature on these components is hard to quantify, but it has been shown in warmer climates to be less.

Effect on colour
• colour in red grapes is partly temperature-dependent
• evidence suggests that temperatures too cold or too warm are associated with poor colour
• optimum synthesis of anthocyanins range between 17–26°C
• cool night temperatures of 15–20°C promotes good skin colouration compared to 25–30°C

Irrigation/rainfall
• rainfall post-veraison plus associated humidity predisposes grapes to berry splitting. Diseased fruit can cause difficulties for winemakers, which can result in lower quality wines. The threat of rain may cause growers to pick early and thus provide immature grapes for processing
• water stress does not always induce ripening but it can enhance phenols in juice and anthocyanins in skin (Table 1)
• increased water availability has been shown to increase potassium and pH levels in the must and wine, and may reduce colour and content of anthocyanins

Soils
Soils may affect the quality of wine grapes in a number of ways such as:
• the moisture availability to the plant due to its moisture retaining capacity
• nutrient availability
• the micro-climate due to its heat retaining and light reflecting capacity
• the root growth due to its penetrability.

Management effects on quality parameters
Nutrition
Nitrogen
• often associated with high vigour, which may alter the leaf to fruit ratios, increase humidity, and reduce the sunlight penetration to inner leaves and berries
• vines grown under high nitrogen conditions have higher vegetative growth, more petiole nitrogen, and more acidity
• in the winemaking process, if high nitrogen levels are found, it can reduce soluble solids and colour in the must
• high nitrogen has also been shown to induce rots thus affecting quality

Potassium
• the presence of potassium has been linked to acids and pH in wine; musts that tend to contain high amounts of potassium also have high pH levels and malate levels
• it has also been associated with low colour in red wines

Yield
• The traditional way of describing the effect of yield on quality is the higher the yield the poorer the quality
• this is not always necessarily true as Figure 3 demonstrates. Vineyards H & C indicate that there can still be high colour grapes with a reasonable yield
• it must be stated that if an optimal yield for a particular quality standard exists it will vary due to the cultivar, climatic and other environmental factors, intensity of planting, canopy management and pruning

Pruning and canopy management
• The major purpose of dormant pruning is to regulate crop size, generally the more nodes that are left on spurs or canes, the higher the yield
• summer pruning is performed to thin out shoots and/or to reduce shoot length for increased leaf exposure
• increasing leaf exposure tends to increase the content of anthocyanins and phenolics in the berries and research has shown that exposure of berries tends to be more

| Table 1. Water usage from trial in 1998 and 1999 vintages in the Riverina |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Irrigation type | 1998 colour (mg/g f.w.) | 1999 colour (mg/g f.w.) | 1998 water use (ML/ha) | 1999 water use (ML/ha) |
| Drip            | 0.85             | 0.86             | 5.44             | 3.86             |
| Flood           | 0.71             | 0.89             | 7.6              | 5.4              |
| Furrow          | 0.84             | 0.85             | 6.09             | 6.3              |
important than leaves to improve colour and flavour

- canopy management trials undertaken in the Riverina over a three year period (1995–97) failed to find any good improvements in grape colour, although the fourth year the vines did differentiate with minimal prune producing the best colour berries (Table 2)
- rate of maturity and harvest date were more influenced by yield than the training system. The fluctuations experienced by the different yields of the training systems (ballerina, hedge and minimal) was explained by the number of buds retained at pruning and/or the number of bunches per vine at harvest.

**Conclusion**

There is a wide range of external factors such as climate, soil, geography and management, which have been shown to modify vine growth parameters. These include flower initiation, set, yield, vegetative growth, micro-climate and disease incidence. These can all modify the physiology of the berry to change its composition and ultimately the quality of the wine produced.

From the summaries of three different trials undertaken in the Riverina on Shiraz over the past six years, yield is not always a good indicator of quality with evidence to show that higher yields can still produce adequate Baume and colour to suit a winemaker’s requirements. Although Baume bonuses are now part of the payment schedule for grapes in the Riverina, further incentives for growers to produce grapes that meet the winery specifications are needed.

Each region needs to investigate the effect of environment and management techniques on each variety and training system to obtain information for an optimal yield but still produce the quality required for the winery, and also to be able to return an economic crop. Close communication with between wineries and growers is required to do this.

**Table 2. Effect of canopy management on the Brix and berry colour in the Riverina**

<table>
<thead>
<tr>
<th></th>
<th>1997</th>
<th>1998</th>
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</thead>
<tbody>
<tr>
<td>Soluble solids (Brix)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hedge</td>
<td>22.06</td>
<td>28</td>
</tr>
<tr>
<td>Ballerina</td>
<td>23.02</td>
<td>26.2</td>
</tr>
<tr>
<td>Minimal</td>
<td>22.87</td>
<td>26</td>
</tr>
<tr>
<td>Berry Colour (mg/g f.w.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hedge</td>
<td>0.68</td>
<td>0.84</td>
</tr>
<tr>
<td>Ballerina</td>
<td>0.70</td>
<td>1.02</td>
</tr>
</tbody>
</table>

**References**

