Timing of harvest is a key decision for winemakers

When is the best time to harvest?

The best time to harvest is when the compositional characteristics of the fruit are optimal for winemaking purposes, i.e. sugar, acid, colour, flavour and aroma, to produce a desired style of wine for the market. This is usually achieved by regular sampling and testing of grapes in the weeks leading up to harvest.

Why do the results from vineyard sampling near harvest sometimes differ to results in winery tanks?

The differences in observed and actual results might be a result of the natural variation that exists within the vineyard. Developing a robust sampling strategy that is able to best deal with this natural variation is critical to ensure that growers and winemakers are able to capture their ideal grape compositional parameters.

What causes variation in the vineyard?

Variation in a vineyard may be either temporal (season-to-season or throughout a season) or spatial (vine-to-vine within a vineyard, bunch-to-bunch within a vine, or berry to berry within a bunch). Spatial variability might enter a vineyard through differences in soil type, crop load, vine size, cluster position and exposure to sunlight (Wolpert *et al*. 1980).

How can I check my vineyard variability?

There have been significant advances over the past decade in the development of precision viticultural tools that have helped to characterise and quantify the extent of this variation within vineyards through the use of yield monitoring on harvesters, plant cell density (PCD), electromagnetic (EM) induction sensing, etc. (Proffitt *et al*. 2006). This knowledge, if available, has been important in determining where samples need to be collected to account for this inherent spatial variation in vineyards. Even with this information, deciding what to sample (berries or bunches) and how many positions across the vineyard, or 'harvest unit', to sample is critical in determining overall accuracy and how representative this sample is. This requires some knowledge of statistics, and in particular the term 'variation' and its quantification.

One way of quantifying variation is to express the standard deviation of a population as a percentage of the mean of the population. This is termed the per cent coefficient of variation (%CV), and is a useful way of expressing the variation observed in a population. In practical terms, if a single vineyard was sampled in 10 locations and sugar or ^{o}Brix levels measured in each of the 10 samples, the following numbers might be observed:

1	2	3	4	5	6	7	8	9	10
23.4	22.5	22.9	24.2	23.1	24.8	22.1	23.5	22.8	23.3

In this case, the mean (described as the sum of all the measurements divided by the total number of measurements recorded) would be 23.3, the range (lowest to highest number) would be 22.1 – 24.8, the standard deviation would be 0.79 and the %CV would be (0.79/23.3 x 100 = 3.4%). In real terms, if the whole vineyard were to be harvested at this time (before the grapes were able to ripen any more) there is a 95% chance that it will end up in the winery tank at a ^{o}Brix level somewhere between 21.7 and 24.8. But in practice, growers and winemakers collect samples from 10 random locations, combine them into an individual pooled sample, process and measure once, ending up with a single figure of around 23.3, but with no idea of the variation around this result.

Why do we need to know the variation?

This concept of variation is important, because there might be a situation where the mean is the same for two separate vineyards, but the variation can be greater in one compared to the other. To illustrate this, the two vineyards might have a mean sugar concentration of 23.3 ^{o}Brix, but one has a range of 21.1 – 24.8 (as per above; %CV=3.4), and the other has a range of, say, 19.6 – 27.0 (%CV=6.8)—imagine the potential berry flavour profiles differences between these two vineyards. Perhaps green negative characters persist in the lower ^{o}Brix berries, resulting in a delay of harvest until there is an absence of those negative flavour compounds. However, this would occur at a much higher berry ripeness than a less variable, more uniform, population. Also logically, when there is a more variable population, sampling is undertaken more intensively to have the same level of confidence in the mean result than for a less variable population.

What is better to sample: berries or bunches?

The key take home message is that it probably doesn't matter! Berry to berry variation is typically higher than that observed among bunches. As long as the selected sample is truly representative, with no bias introduced, and sampling approximately twice as many berries as bunches, the end result should be very similar. This is something that can be tested and refined by growers or winemakers by conducting similar experiments to determine the levels of variation within their particular sampling and testing protocols.

Do the differences extend to other compositional parameters such as pH, TA, anthocyanins, etc.?

While much of the discussion to date has focused on sugar (°Brix), it is important to note that other compositional parameters (e.g. pH, titratable acidity, anthocyanins, etc.) differ in their variance within the same vineyard. Compositional parameters such as titratable acidity and anthocyanin (colour) concentration in red wine grapes are much more variable than that observed in either °Brix or juice pH. Table 1 shows a summary of the typical between-vine variance (%CV) for each key wine grape compositional parameter and an example of a mean and typical standard deviation.

The %CVs listed in Table 1 were remarkably consistent across a range of different winegrape varieties and across a range of different growing regions and seasons. The lower %CVs observed in both °Brix and pH compared to those observed in TA, colour and phenolics suggests that separate sampling strategies may need to be considered depending on which compositional parameters are being measured. Another important trend to note is that these compositional attributes tended to become less variable as ripening advanced, indicating that grapes tend to become more uniform as ripening advances. This makes physiological sense as the accumulation of sugar and phenolic compounds, and the loss of organic acids tends to slow down as ripening advances.

So what does this all mean for practical sampling in the vineyard?

The development of a sampling strategy based on a detailed understanding of the variability in each winegrape compositional parameter is critical in delivering practical and accurate estimates within particular confidence and error limits to industry practitioners. When sampling for °Brix, in the absence of having detailed precision viticultural spatial data, a 20-bunch sample can provide an estimate of the mean for most vineyards (>84% of vineyards) with a 3.5% level of doubt (or error) or less. In sampling for total anthocyanins, a 40-bunch sample can provide an estimate of the mean for most vineyards (>84% of vineyards) with a 7.6% level of doubt (or error) or less.

Table 1. The typical vine-to-vine variability in winegrape compositional parameters at harvest, with an example of a mean and the standard deviation. These results are representative of various research work conducted throughout southeastern Australia over the past 20 years for the varieties Chardonnay, Semillon, Shiraz, Merlot, Cabernet Sauvignon and Grenache..

Compositional parameter	%CV	Example mean	Standard deviation
°Brix	3-9%	23.0	1.10
pH	2-5%	3.6	0.14
TA (g/L)	8-15%	6.0	0.72
Colour (mg/g FW)	13-33%	1.2	0.18
Phenolics (au/g FW)	13-27%	1.8	0.27

Finally, although appropriate sampling strategies can be designed to obtain an accurate estimate of compositional attributes for a particular parcel of grapes, post-harvest changes might also occur in compositional parameters such as pH, TA and anthocyanins, and these need to be recognised in understanding where errors occur between observed and actual results in the real world (Krstic *et al.* 2001 and Krstic 2003). Contact Mark Krstic at the AWRI for further information (email: mark.krstic@awri.com.au) GW