Varietal choice for a warmer future

By Peter Dry[1] and Richard Smart[2]

The authors surveyed grape and wine producers across a range of regions to find out which alternative varieties they are considering for future plantings, asking them specifically if heat tolerance is one of the main reasons for considering those varieties. Drawing on that feedback the authors outline the varietal suggestions that those producers have identified as being worthy of consideration under climate change conditions.

INTRODUCTION

There is general acceptance in Australian wine regions that the climate has changed significantly in recent decades, and change is predicted to continue. This projected change has been recently quantified by Remenyi *et al.* (2020) for all Australian wine regions (geographical indications - GIs). Temperatures are projected to increase, as will the evaporative power of the atmosphere; rainfall changes will often be drier but depends on location. Advancement of grape maturity is just one indicator of the impact of climate change (CC), now apparent across all Australian regions and varieties to varying extents. It is generally accepted that CC is induced by atmospheric heating due to increased concentration of greenhouse gases such as CO_2 and methane which absorb solar radiation. These gases have increased due to human activities, primarily burning of fossil fuels, since the Industrial Revolution. As for other industries, the production and distribution of grapes and wine creates a 'carbon footprint'.

The phenological advancement is not confined to Australian wine regions and has been observed internationally. For example, until the 1950s, Riesling in Alsace (France) was normally harvested in the first two weeks of October; now it is most frequently harvested in the first week of September and even in late August (van Leeuwen *et al.* 2019). Similarly, the mean Brix-modelled harvest date of Merlot and Cabernet Sauvignon in Bordeaux for the 1981 to 2010 period was two and three weeks earlier, respectively, than for the 1951 to 1980 period (van Leeuwen *et al.* 2019). It is noteworthy that advanced maturity is a consequence of temperature-induced advancement in the date of veraison, not increased rate of ripening (Cameron *et al.* 2021). A recent study (Gambetta and Kurtural 2021) of Bordeaux and the Napa Valley questions if recent temperature increases are close to 'tipping points' for wine quality. Studies by Smart (unpublished) show that the trajectory of recent temperature changes for Australian regions is equally disturbing. Sadras and Moran (2012) illustrate a 'decoupling' of anthocyanin and sugar production at elevated temperatures. Analysis of data of Remenyi *et al.* (2020) by Smart (2021) suggests that such a warning may well be appropriate for future climates of Australian wine regions, especially for existing interior hot regions, and for existing warm regions such as the Barossa Valley.

Observations and projections such as those listed above should suffice to greatly disturb producers in the Australian grape and wine sector and their representative organisations. There are predictable impacts on regional reputations and varietal suitability. Some regions may lose reputation and others — perhaps not yet planted — may benefit. In the short term, this should encourage grape and wine producers to become involved in mitigation to reduce carbon emissions (Smart 2021). While such a program to achieve carbon neutrality in a moderate-term timeframe is possible, producers will contemplate other more immediate courses of action. These will eventually consist of two choices, as put succinctly by Lockshin and Smart (2020): either change varieties or change regions.

Aglianico

Grechetto

Verdicchio

Lagrein

[1]Emeritus Fellow, Australian Wine Research Institute and Adjunct Associate Professor, University of Adelaide, Belair, South Australia. Email: peterdry48@gmail.com
[2]Smart Viticulture, Glenroy, Victoria. Email: vinedoctor@smartvit.com.au

LIVING WITH A FUTURE WARMER CLIMATE

Adaptation strategies are also relevant and appropriate, indeed more so since climatic analyses of recent trends and vineyard phenology. The world wine industry has been characterised by a regional preference for varieties and, in some places, especially in Europe, this has created regions with distinguished reputations. However, regional specialisation in varieties has been weakened over the last several decades by widespread adoption, especially in the New World including Australia, of about 10 so-called 'international varieties', mainly French in origin.

To reduce adverse CC effects, some adaptation of viticultural practices may be useful. These include environmental control via vine shading, vineyard floor cover, heavy undervine mulching, rootstock choice, winter irrigation and application of sunscreen (Liz Riley, pers. comm.). However, widespread proof of such practices being practical and economical are lacking. What is evident already is that it is generally easier to change varieties than to change regions. Varietal change is the subject of this article. Fortunately, in Australia, we are not constrained by regulations or tradition, as is the case for European countries. Furthermore, we have relatively few regions where the variety is an important component of regional branding and reputation (such as Coonawarra with Cabernet Sauvignon, and Barossa Valley with Shiraz, for example). As a result, we have the possibility to change the varietal profile of regions through the introduction of more extensive planting of varieties that are more heat and drought tolerant than existing varieties. However, we have limited access to and experience with such varieties in our regions. This article aims to promote more varietal evaluation in Australia, particularly in warm to hot regions.

Furthermore, there is limited experimental information available on both heat and drought tolerance and, so, we are forced to rely here on anecdotal evidence. However, we acknowledge the studies over several decades by CSIRO Horticulture at Merbein, Victoria (Kerridge *et al.* 1987a,b,c,d, 1988, Clingeleffer 1985, Clingeleffer and Davis 2011). The Variety Selector Tool (hosted by Wine Australia), created by Clingeleffer and Davis to assist variety choice for hot inland regions (https://grapevinevariety.com/), is a relatively recent source of information.

Negroamaro

Vermentino

Varieties originating from the hot regions of the Iberian Peninsula or the Mediterranean coast could be expected to have potential and, for this reason, such varieties have already been planted in some Australian regions. However, the viticultural traits of heat and drought tolerance will not sell wine. We need varieties that have suitable compositional traits and can produce suitable wine styles under hot conditions, e.g. good acid retention, low pH and good colour for reds, as well as the ability to produce a desirable flavour profile.

Later ripening has been proposed as a desirable characteristic to allow a greater chance of escaping high temperature – but this may not be the most important trait of varieties suited to a hot climate (Peter Clingeleffer, pers. comm.). However, it is not difficult to find quality varieties that ripen later than many of the main varieties in our warm to hot regions.

PRESENT COMMERCIAL EXPERIENCE WITH NEW VARIETIES

Fortunately, some individual growers and winemakers in Australia have been proactive with regards to varietal importation and experimentation and, thus, we are able to draw on this experience. To this end, we conducted an email survey of grape and wine producers in a range of regions. They were asked which varieties they are considering for future plantings in their region with respect to vine performance and wine style/quality. We particularly asked if heat tolerance (as perceived, based on visual performance) is one of the main criteria being considered? We requested that they listed varieties that are alternative or emerging because very few of the current main varieties in Australia can be considered heat tolerant.

The extent to which the chosen varieties have already been planted in Australia provides an indication of current market demand. Therefore, the number of wine producers in each region was determined using the informative website Vinodiversity (www.vinodiversity.com), managed by Darby Higgs. Then we calculated the percentage share located in hot, warm and cool regions (refer to Iland *et al.* (2017) for methodology of regional classification based on mean January temperature, modified from the earlier paper of Smart and Dry (1980)). The Riverland is representative of hot regions, the Barossa Valley of warm and Coonawarra of cool. Also, to determine the potential wine quality and consumer acceptance of wines in both hot and warm regions, the results of the Australian Alternative Varieties Wine Shows (https://www.aavws.com) in 2019, 2020 and 2021 were analysed. In the following summaries, for some varieties, there is reference to the total number of medals awarded for wine producers in either hot or warm regions in those three years.

In the varietal suggestions that follow, we have reiterated grower observations of heat tolerance and drought tolerance. We recognise that these are subjective observations but still worthy of documentation.

SUGGESTIONS FOR HOT REGIONS

The most favoured varieties were Vermentino, Fiano and Arinto for white wines, and Nero d'Avola, Montepulciano and Grenache for reds.

Vermentino is relatively late for a white variety (picked at same time as the last Shiraz in the Hunter Valley). It has good yield and heat tolerance but may have some sunburn of bunches. On own roots, it is not particularly drought tolerant. Acidity is good (but this can drop in heatwaves). Wines are popular with consumers and easy to sell. There are currently 152 wine producers in Australia (37% are in hot regions). The number of medals awarded was 26 (including three gold).

Fiano is also relatively late for a white variety (picked at same time as Shiraz in McLaren Vale). It generally has good yield and performs well under hot conditions. It has thick skin and loose bunches, but its shoots are prone to wind damage. Fiano has good acidity and flavour and low pH but has been said to ripen too quickly in very hot regions. It can produce premium wine in warm to hot regions with good consumer appeal. The range of styles is better than for Chardonnay for Australia because it has more fruit character and texture, without the need for oak, and has less disease. It is currently being planted extensively in Australia with 134 wine producers (34% in hot regions). The number of medals awarded was 19 (including four gold).

Arinto is a relative newcomer to Australia: there are currently only 17 wine producers in Australia (53% in hot regions). Arinto is more correctly known as Arinto de Bucelas in order to avoid confusion with several other varieties with 'Arinto' in their names, e.g. Arinto Branco syn. Loureiro and Arinto do Dão syn. Malvasia Fina. It is an old variety (known since the early 18th century) and appears to be restricted to Portugal (4450ha in 2010), mainly in the Estramadura region near Lisbon where it was first grown before subsequently spreading to other regions. It is now widely planted in Portugal from the cool north (Vinho Verde) to the hot south (Alentejo). With mid-season maturity, it is a good performer in hot regions. Wines are fresh with crisp acidity, lemon, lime and green apple notes and have consumer appeal. This variety has great potential in hot regions. A gold medal was awarded to a hot climate producer at the 2021 AAVWS.

Other whites favoured for hot regions include Greco and Pecorino**. Greco** is late ripening with high acidity and good heat tolerance. Yield can be low, and thin-skinned berries are prone to splitting. Wines have good flavour and texture. There are only eight wine producers in Australia (50% in hot regions). **Pecorino** is a new introduction to Australia: early experience in the Hunter Valley indicates that it has high acidity, good yield, and attractive wines.

Nero d'Avola has mid-season maturity with moderate to high yield (it may require yield control), good heat tolerance, average irrigation requirement (less than for French varieties), and good acidity. Its medium-bodied, well-flavoured wines are generally made for early drinking and have good

Nero d'Avola

Montepulciano

Fiano

consumer appeal. Recent planting expansion has resulted in 73 wine producers in Australia (20% in hot regions). The number of medals awarded was 10.

Montepulciano has 76 wine producers in Australia (26% in hot regions). Its expansion in area may be due in part to its heat tolerance. 'Monte' has late maturity, good yield, low risk of sunburn, average disease tolerance and berries with a thick and tough skin. Its wines have good acidity and colour, dark fruits and medium body with good consumer appeal. The number of medals awarded was seven (including two gold).

Other red wine varieties favoured for hot regions included: **Tinto Cão** (good heat tolerance but low yield, high acidity, good colour); **Souzão** (very good acidity and colour); **Rondinella** (good yield, late maturity); **Corvina** (late maturity, high acidity); **Lagrein**; **Touriga Nacional**; **Graciano** (moderate acidity, low pH, good colour and tannins, good for blending, 56 wine producers in Australia with 20% in hot regions); and **Carignan** (late maturity, high yield). Note: there are at least 22 wine producers who claim to use Carignan in Australia. However, reports on the performance of Carignan in Australia should be treated with caution. In South Australia, any 'Carignan' planted before 1966 (or propagated from vines planted before 1966) is likely to be Paraletta (syn. Bonvedro) or even Mourvedre (Dry and Dry 2014).

Although **Durif** was not mentioned in the survey responses, wines from hot regions have good consumer appeal. At the 2021 AAVWS, 10 medals including two gold were awarded to hot region Durif wines. There are now 104 Durif wine producers in Australia (20% in hot regions). Note: Petite Sirah and other spelling variants thereof are inappropriate synonyms of Durif in Australia and should be avoided. Plantings of 'Petite Sirah' in California are a mixture of Durif and Peloursin and 'Petite Sirah' is only allowed as a valid synonym in the USA for historical reasons (Dry 2017).

SUGGESTIONS FOR WARM REGIONS

The most favoured varieties were Fiano, Vermentino, Grenache Blanc and Clairette for white wines, and Nero d'Avola, Montepulciano, Mataro, Grenache, Lagrein and Mencia for reds.

Fiano: half of the present wine producers are found in warm regions, and the wines have great consumer appeal (as in Italy), irrespective of style. The number of medals awarded to warm region producers was 74 (including nine gold).

Vermentino also has half of its present wine producers in warm regions. It is easy to grow, has low disease incidence (even in wet years) and high value return per unit of irrigation water. It can be harvested at relatively low Baume. Wines are fresh without 'green' character and have good flavour. The number of medals awarded was 30 (including two gold).

Grenache Blanc is a relatively new introduction to Australia (released from quarantine in the early 2010s). However, despite limited experience here, it has great potential. It is well-suited to warm to hot regions is easy to grow with good heat tolerance (although bunches need some sun protection). Wines have good texture but only moderate acidity with good consumer

appeal (particularly as a major component in blends). A 2020 Grenache Blanc (Tscharke Gnadenfrei) from the Barossa Valley was awarded 'Best Organic or Biodynamic Wine of Show' at 2021 Royal Melbourne Wine Show.

Clairette is relatively late for a white variety and is heat tolerant with good yield. Although it has been grown in Australia for a long time there are only four known wine producers at present. It is good for blending with higher acid varieties such as Picpoul.

Other whites favoured for warm regions included: **Picpoul** (good acidity, late ripening), **Roussanne** (good heat tolerance and acidity), **Gros Manseng** (good acidity, late ripening), and **Pinot Gris** (good flavour at low Brix, good yield).

Nero d'Avola is used for excellent red wines in warm regions, with great consumer appeal. The number of medals awarded was 35 (including seven gold). Sixty percent of the present wine producers are found in warm regions.

Montepulciano is said to be the most heat tolerant variety currently planted in the Barossa Valley. It is late ripening with appealing wines. The number of medals awarded was 36 (including three gold). Fifty-seven percent of its wine producers are found in warm regions.

Mataro is an old variety in Australia but it is having a modest resurgence, perhaps due to its heat tolerance and late maturity. It is probably most useful in blends. The number of medals awarded was 12 (including three gold).

Grenache (Noir) is also an old variety in Australia. It has good heat tolerance and good yield but is susceptible to disease. Wine colour and flavour may be negatively impacted by excess yield; nevertheless, high-quality wines can be produced with the right site and good management. Wines have good consumer appeal and recognition.

Lagrein: The number of medals awarded was 10 (including three gold). Wines have good colour and flavour. Forty percent of the 46 wine producers are found in warm regions.

Mencia has performed well in warm regions where it ripens in late February/early March. A relatively recent introduction to Australia (released from quarantine in the late 2000s), there are currently 13 wine producers. Its potential is good; wines are floral and medium-bodied with consumer appeal.

Although Durif and Aglianico were not mentioned in the survey responses, wines from warm regions have good quality**. Durif** wines received 13 medals (including three gold). One-third of its wine producers are found in warm regions. **Aglianico** has 41 wine producers in Australia (56% in warm regions). It has good heat tolerance, late maturity (mid-April at McLaren Vale), good water use efficiency and wines are elegant and savoury. The number of medals awarded was 12 (including four gold).

Other red wine varieties favoured for warm regions included: **Negroamaro** (good acidity but prone to sunburn), **Cinsaut** (good heat tolerance and acidity, mid-season), **Graciano**, **Touriga Nacional** (good colour, very floral, consumer appeal but susceptible to water stress) and **Malbec** (early maturity, good heat tolerance, good colour and consumer appeal).

SUGGESTIONS FOR COOL REGIONS

In this case, the prevailing view was that, as the climate gets warmer, producers will increase planting of later-ripening mainstream varieties such as **Shiraz**, **Cabernet Sauvignon**, **Grenache** and others such as **Nebbiolo**. One cool region producer commented that they are "…*committed to **Pinot Noir** and are focussed on the long-term success of this variety*". Nevertheless, they are "…*extremely conscious of the impact that climate change will have in years to come on our ability to produce premium Pinot and, therefore, we are constantly amending and evolving our viticultural practices to help safeguard against more extreme growing conditions*". In a similar vein, another producer said that "… *they see a long-term future for our current varieties and are not currently looking at heat tolerant varieties despite likely continuing warming in all regions … relying on regional spread of our own and contracted vineyard holdings to adapt to climate change as it is occurring*". This producer is currently more concerned about "…*negative impacts on the quality potential and sustainability of our grape supply [caused by] changing rainfall patterns (continuing decline in winter rainfall and increase in summer rainfall and humidity*)". Nevertheless, there is increasing interest in **Fiano**, **Lagrein**, **Mencia** and **Montepulciano** which have already shown great promise in some cool regions. Other varieties mentioned included **Aligote**, **Grechetto**, **Grenache Blanc**, **Petite Arvine**, **Saperavi** and **Verdicchio**.

CONCLUSIONS

Variety choice is one of the most effective means to mitigate the negative effects of global warming. Because of the strong climate x variety interaction, which is internationally recognised and strongly evident in Australia, any change in climate suggests a need for change in variety. Based on the experience thus far in warm to hot regions, we can identify varieties that are more heat-tolerant than existing mainstream varieties and, at the same time, are able to produce wines that are acceptable to consumers. We recognise, however, that consumers and producers need some time to become adjusted to new variety names and styles, such is the influence of the present tendency to use fewer 'international varieties' in Australia and elsewhere (Anderson 2016).

There are other implications of a rapid change in variety use in Australia, such as availability of planting material. For many of the above varieties, we have little knowledge of the attributes of different clones. Nursery operators and vine improvement groups may need to increase mother-vine source plantings and check virus and trunk disease status. Over and above this, changing of varieties may lead to an increase in demand for grafted plants, making the control of trunk disease in rootstock cuttings even more important (Smart 2022).

It is highly likely that there are many more varieties, not yet in Australia, that possess such desirable attributes for a warmer future. It is somewhat ironic that 40 years ago we identified a need for increased planting of dedicated table wine varieties in Australia (Dry and Smart 1980) – at a time when more than 70% of Australian white table wine production was based on Sultana, Muscat Gordo Blanco, Doradillo, Palomino and Pedro Ximenez (Dry and Gregory 1988). *Plus ça change, plus c'est la même chose.*

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