The Australian Wine Research Institute

Winemaking implications of drought
[Dealing with fruit from water-stressed vines]

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The purpose of this paper is to provide winemakers with information which can be used to make informed decisions when developing strategies to deal with grapes from water-stressed vines. However, scientific understanding of many factors remains incomplete and winemakers are, therefore, encouraged to seek information from as many sources as possible when making decisions on how best to process such fruit.

In a large number of Australia's grapegrowing areas, the 2007 harvest is proving to be a challenge in many respects, with winemakers dealing with not only the effects of frost, but with dry conditions and potentially hot weather as well. The relative importance of each of these influences on fruit quality and yield will vary, and should be assessed on a case-by-case basis.

Wineries are urged to make plans in advance according to their production capabilities and intended wine styles.

Sampling

- Dry conditions will exacerbate variation within a vineyard, so it is important to sample carefully and possibly to increase the frequency of sampling closer to the expected date of harvest. When sampling, take into account topographic differences; cropping levels (frost influence); and variations of soil types within a vineyard.

Ripeness

- Fruit can be expected to ripen earlier and reach elevated sugar levels more quickly, with lower than usual acidity levels.
    - The period during which fruit will be at optimum ripeness is likely to be shorter than usual.

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- Particularly with aromatic varieties, it is advisable to try to balance degree of sugar ripeness against desirable flavour profiles, which might be lost the longer the fruit is left on the vine.

Colour development

- Stress might lead to reduced berry size, and thus an increase in the surface area to volume ratio of the fruit. This will lead to an increase in the concentration of anthocyanins and tannins in the finished wine.

- Stress might also, however, reduce the accumulation of total phenolics and anthocyanins in the skins by up to 40%, which can counteract the concentration effect described above. Close observation of colour and tannin evolution during maceration and fermentation is, therefore, essential.

pH and acidity issues

- Vine stress might lead to greater than normal variation in the pH of musts and wines, and thus it will be important to assess each batch of fruit on a case-by-case basis. A general increase in pH compared to a 'typical' year may be expected, and in many situations the result of a given acid addition on pH and TA is likely to be more difficult to predict than in a 'typical' year.
    - It is not advisable to make acid additions based on the results obtained in previous years, but instead monitor the titratable acidity (TA) and pH of each batch of fruit. Make acid additions as early as possible to the must.

- Delaying additions or making small incremental additions is not advisable.
    - The risk of oxidation and growth of undesirable micro-organisms in the must is increased. Good management of pH is essential to reduce such problems.
    - The deposition of potassium bitartrate might happen more readily in musts and wines produced from water stress affected fruit, leading to a loss of acidity and potentially further pH increases if the musts and wines are held at high pH.

- Due to unusual pH, acidity and potassium ion composition, the buffering capacity of the must from stressed fruit might be greater than normal. It is essential to verify the

effect of all additions through analysis, after thoroughly mixing the tank. Further additions might be necessary.

- Early information indicates that some vineyards, especially in cooler areas, will experience low titratable acididity (and low concentrations of malic acid), coupled with low pH, (range 3.3 – 3.4).
    - If pH is adequate with a low total acid, additions should be based on sensory/taste profile, to reduce the risk of over-acidification.

- Malic acid levels might be lower than normal (<1 g/L), and when coupled with warmer temperatures and higher pH, might result in quicker onset of malolactic fermentation in some cases where alcohol concentration is not excessive.

    - It should be noted when making initial acid additions that the pH shift during malolactic fermentation, and the relative reduction in acid taste, will be lower in wines which had a lower starting concentration of malic acid.

    - MLF on skins and/or in the presence of residual sugar is considered undesirable and might result in higher VA levels.

White sensory profile

- 'Sweet and sour' flavours:
    - Some winemakers have commented on the negative impact of 'sweet and sour flavours', due to variation in ripening across a vineyard.

- Atypical ageing (ATA):
    - American[1] and European research in non-irrigated vineyards in cooler regions has suggested a link between 'ATA' and drought-induced vine stress. While this defect occurs primarily in white wines, the risk remains low, and the compounds thought responsible for 'ATA' sensory characters have never been detected in Australian wines.

[1] Martinson et al (2003)

- Aromatic varieties
    - Fruit from water-stressed vines is likely to contain a reduced concentration of the thiol precursors which are significant contributors to the varietal character of varieties such as Sauvignon Blanc.

Red sensory profile

- One study demonstrated that restricted water applied to Cabernet Sauvignon vines resulted in wines that had greater intensity of aromas described as ‘red/blackberry’, ‘jam/cooked berry’, ‘dried fruit/raisin’ and ‘fruitiness’, and decreased intensity of ‘vegetable’ and ‘capsicum’ aromas when compared to wines made from fully-irrigated vines.

Temperatures

- Reduced crop levels due to frost and drier and warmer conditions during summer might result in significantly advanced ripening including more rapid sugar accumulation, and earlier harvest dates. However, this might not be the case if the vine’s canopy size has also been reduced as a consequence of frost and/or water stress.

- Early indications are that ripening has been advanced by as much as four weeks.
    - This could mean that harvest dates for red grapes might be brought forward to a time when many wineries might still be processing the white grape intake, emphasising the need for pre-vintage planning.
    - Given the warmer conditions and earlier and shorter periods for harvesting fruit in optimal condition, it might also be expected that harvesting temperatures (both day and night) might be elevated. This would place an added strain on refrigeration capacity and winery’s ability to chill musts efficiently and quickly. Once again the importance of pre-vintage planning, including refrigeration capacity and load, is emphasised.

- Warmer conditions will also affect fruit composition during transport.
    - Undesirable microrganisms will proliferate under such conditions.
    - It is recommended that the concentration of SO_2 added to bins during transport be increased by up to 100% if fruit is harvested warm and is to be transported over long distances. Thorough mixing of SO_2 in the bins is essential.
    - Ensure that bins are sanitised between loads, and are covered during transport.
    - Ensure harvesters are cleaned and serviced regularly to lower risks of microbiological contamination.
    - Any uncontrolled microbiological activity can lead to the development of off-characters, and/or sluggish fermentations due to nutrient depletion.

Processing

- Depending on the time and conditions of harvest, more force might be required to remove fruit from the vine.
    - A consequence might be an increase in MOG concentration.

- Shrivelled fruit and small berries with a low juice volume make processing more difficult.
    - This can cause bridging in receival hoppers, wear and tear to stators and pumps in general, and blockages of must lines.
    - To assist pumping, keep initial free-run juice at reception in a separate holding tank near the crusher, and add back sparingly as the fruit is being crushed.
    - Where possible, transfer such fruit to fermenters which are closer to the crusher to avoid pumping over long distances, and avoid bends and angled pipe-work. It might be especially difficult to pump such musts through heat exchangers. All these factors contribute to friction and increase the risk of blockages.
    - If the must requires chilling, crush and transfer to tank; then either drain juice, chill and return; or chill using in-place chilling.

- Treat and manage each tank separately.
    - Fruit from difficult years requires more careful handling and attention throughout the winemaking process, and is, therefore, more labour intensive.

- More time might be needed to process (crush, press and drain) such fruit, so intake schedules need to allow adequate processing times to accommodate delays.
    - It might be advisable to consider using shorter pressing cycles. It might also be desirable to harvest earlier rather than later, to potentially avoid some of the problems discussed.

- Pressing to achieve yields comparable to previous years might not be advisable.
    - The volume of juice might be lower than 'typical', and longer pressing cycles will yield more extracted flavours with less desirable tannins.

Settling of white juice

- Juice from water stress affected fruit might also result in higher solids content, and could prove difficult to settle.

- Select enzymes which have clarifying and pectolytic capability
    - Ensure uniform and adequate dispersion of the enzyme throughout the must to ensure rapid action.
    - Make additions at both pressing and settling stages.
    - Settling might be improved if conducted over an extended period at two different temperature ranges: 24 h @ 8°-10°C, followed by 3–5 days at 2–4°C. The concentration of SO_2 should be adjusted taking into account the pH of that batch.

- If juices do not settle and no centrifugation or drum filtration is available:
    - perform a coarse racking after 24 h (to remove the heavy lees) and resettle with a sodium betonite at a rate of 0.3- 0.5 g/L, followed by settling at 2–4°C for 3–5 days. This will allow more time for better settling to occur, with less risk of negative sensory impacts and microbiological activity.

Fermentation

Drought-affected and/or very-ripe fruit will probably have elevated sugar concentration, and will yield a wine with high final alcohol content.

- Active dried wine yeast, if added to must after minimal or non-optimal preparation, might lack the capacity to ferment such juices to dryness, which will increase the risk of stuck fermentation, high volatile acidity, and delayed malolactic fermentation. The following points must be observed:
    - careful strain selection
    - adoption of best practice yeast propagation techniques
    - careful fermentation management (accurate and timely temperature control)
    - consideration of yeast nutrition, including nitrogen, air, and co-factors such as vitamins (see below).

- It is essential to measure free amino nitrogen (FAN) levels and adjust where necessary; a 'typical fermentation' to approximately 13% v/v alcohol will need a minimum of 150 mg/L as YAN[2]. Recent AWRI research suggests that a YAN of 250–350 mg/L can result in lower reductive off-flavours, and enhanced fruity flavours in Chardonnay.

- Excessive nitrogen addition, especially late in fermentation, should be avoided as excess N can become a substrate for later unwanted microbiological activity which might result in a marked reduction of wine quality.

- Spontaneous fermentation, or even low-level yeast activity in lees, will deplete valuable thiamine and other nutrients, which will in turn increase the risk of stuck fermentations.
    - Additions of thiamine chloride (and hydrochloride) can be made to aid the completion of problematic fermentations.

[2] Approx 4 ppm DAP is equivalent to 1 ppm as FAN.

The quality and style of finished wines

Due to factors of fruit composition, and the added difficulties of fruit and must handling and of making wines from water-stressed fruit, many resulting wines might be expected to age more quickly than those from 'typical' years. Winemakers might also find it more difficult to produce wines in a given style which is consistent with wines from previous years. Such wines might also be more susceptible to later unwanted microbiological activity, especially from *Brettanomyces* and *Acetobacter sp.*, if sound and careful winemaking is not performed. While important and recommended for all winemaking, when dealing with fruit from water-stressed vines particular emphasis should be placed on: pH/TA control; strategies that ensure complete primary fermentation, particularly with red wines; and strategies which deliver and maintain the highest possible ratio of free to total SO_2 throughout the winemaking process.

References

[1] Martinson, T; Cheng, L; Henick-Klink, T; Lakso, A; Acree, T and Pool, B (2003) Update on Atypical Aging research, 32nd Annual New York Industry Workshop