Reducing berry raisining in the vineyard: a case study in small-scale, on-farm research

Nathan Scarlett

Rathbone Wine Group
262 Lorimer Street, Port Melbourne, Vic 3207

Brief summary

Berry raisining reduces yields and has a negative impact on fruit composition. Anecdotal evidence suggests that berry raisining imparts a 'dead fruit' character in wine and contributes to higher potential alcohol. This report is a case study of a small-scale trial in the Grampians and Yarra Valley (Victoria) wine regions aiming to mitigate this problem. Initial trials in vintage 2007 suggested that (specific) supplementary nutrition applied at veraison could help reduce berry raisining. Further trials in 2009 extended on the previous trial and considered newer anti-stress options. The 2009 results confirm that application of certain foliar products can reduce berry raisining and basal leaf senescence. Larger, scientifically robust trials are planned.

Introduction

Production of quality winegrapes aligned to meet winery specifications is a common precept of winegrowing. Viticultural adaption to changing seasonal conditions is important to enable grapevines to consistently produce commercially acceptable fruit. In periods of high evapotranspiration (ET), irrigation is important to maintain fruit integrity and vine function for ripening.

Over recent seasons, (undesirable) berry raisining has emerged in some regions. To address this periodic issue, consideration was given to whether water deficit or other environmental stress factors (such as heat spikes) were contributing factors. Consequently, two vineyards within the Grampians and Yarra Valley applied a small-scale trial to test whether additional irrigation, nutrition or anti-stress agents may reduce berry raisining and vine stress. The aim of this study was to determine whether cost-effective adaption techniques exist, which help to mitigate environmental stress and aid the delivery of high quality winegrapes to winery specifications.

The approach taken is set out in this article.

Preliminary

The founder of modern agriculture[6], Justus von Liebig (c.1840), helped to develop the 'Law of the minimum', a principle which can be usefully applied to the development of a trial program. Liebig's law states "that yield is proportional to the amount of the most limiting nutrient, whichever nutrient it may be". This general agricultural law has universal relevance. For instance, if the vines were affected by Eutypa lata, then that would be the first stress agent to address, prior to more 'small refinements', such as anti-stress/nutritional programs. Liebig's law suggests an understanding of nutritional (and general health) status and seasonal demands (nutritional sinks).

Step 1 – Literature Review

Berry raisining is distinctly different to late-season dimpling, which can sometimes be viewed favourably. Vascular tissue breakdown appears to be a factor in late-season berry raisining[1,2,4], and research is improving understanding of late-season xylem and phloem capability.

Rapid expansion of the grape berries at veraison stretches and can break xylem tracheids[2]. Xylem discontinuity at veraison can change the water status and movement of important minerals – research showed that Ca^{2+} levels were not increasing after veraison, however, K^+ levels did. Therefore, there could be an elemental involvement/deficiency component to such issues.

New analytical techniques are being researched, and it has already been found that xylem conduits remain intact and functional in post-veraison berries, but noted that other factors causing resistance to sap flow in post-veraison xylem may be at play[1]. Berry transpiration could account for an average of a 15-milligram loss in fresh weight per day with losses well before the berries are suitable for harvesting, even under adequate irrigation[4]. Altered berry water states, combined with possible evaporative losses, could also contribute to undesirable sugar concentration (higher Baume) late in the season. Vascular breakdown may be guided via genetic and evolutionary processes, which are beyond the scope of this research.

It remains possible that recent hot summers, combined with continued dry conditions, could be contributing to the phenomenon[7]. Recent seasons have highlighted the impact of variable ripening conditions. 'Heat spikes' (c.>35°C) have become a seasonal issue in many regions and are associated with sometimes detrimental physiological implications[5]. From 10°C ambient temperature, respiration rates double every 10°C, whereas at 40°C, the entire day's photosynthates would be required to support respiration energy demands[3]. Extreme temperature will denature catalytic enzymes necessary for respiration[5] and berry respiration can also metabolise organic acids (such as malic acid), which cause falls in berry malate ratios during hot conditions.

Hot conditions and subsequent high respiration rates obviously impact berry composition (and potentially raisin occurrence) and indicate the need to consider nutritional supplementation to assist cell function as a component of stress mitigation.

Summary

- Research shows the potential role of nutritional support for physiology affected by heat.
- Anti-stress products may have a role.
- Additional irrigation may assist in reducing berry raisining.

Unshrivelled Shrivelled

Step 2 – Develop a trial (Year 1 – Nutrition Trial (2007) in Grampians)

A basic nutritional trial was developed to give preliminary results which may guide us in the future towards larger, statistically valid designs.

Materials and methods:

- Four treatments (one control), replicated three times. Applied in aqueous solution (4-litre water) at label rates as a 1000L per hectare equivalent foliar application (via a backpack spray) at EL 35. Fertilisers selected specifically for nutritional composition.
- At harvest, two bunches per vine randomly selected, placed in a plastic bag and frozen. Frozen berries plucked from bunch and allocated to 'shrivelled/raisin' and 'turgid' as seen below.
- Maturity analysis also taken.

Results

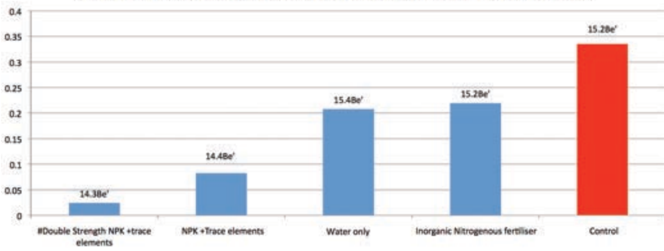
2007 Results

Initial results in Graph 1 suggested that berry raising could be reduced by supplementary nutrition and additional water. The graph above identifies a trend where all treatments reduce raisin berry levels compared to the control. Applying water alone halved the number of raisined berries per bunch compared to the control, indicating that lack of water is a contributing factor to berry raisining. A low-analysis, NPK (with trace elements) fertiliser had the best results, particularly when the rate was doubled.

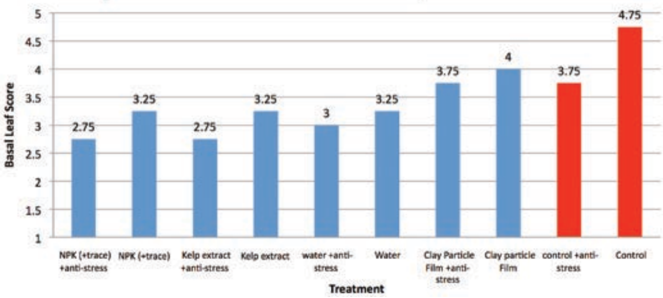
Step 3 – Year 2 Extended Program (2009) in Grampians and Yarra Valley

Following on 2007, the trial extended to two regions (Grampians and Yarra Valley), and included 'anti-stress' products. A similar trial design to 2007 was applied (treatments applied at EL 35 – sprayed

Graph 1 - Percentage (%) Raisin per Bunch - Feb 2007 Grampians Shiraz



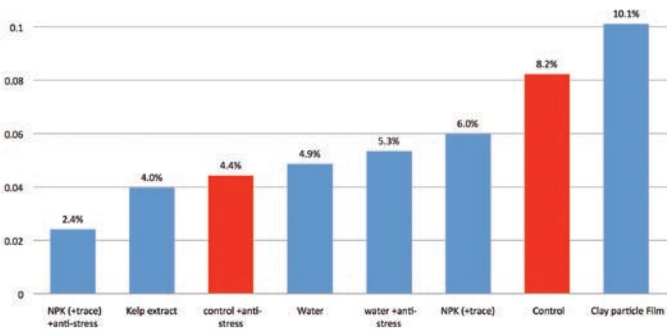
Graph 2 - Basal Leaf Retention - Grampians March 2009



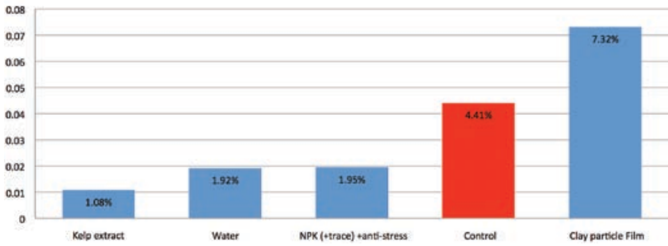
twice at 1000L/ha equivalent, 4L/vine, two weeks apart), however, due to time/resources limitations, treatment replication was not included. In the Grampians, treatments were repeated in conjunction with a foliar application of an anti-stress agent applied before a heat spike at EL 34.

Under periods of heat and water deficit, grapevines can prematurely senesce, therefore, to try to gauge whether treatments may be reducing stress, basal leaf retention was counted.

Graph 3 - Raisin berries per Bunch - Grampians March 2009



Graph 4 - Raisin Berries per Bunch - Yarra Valley Febuary 2009



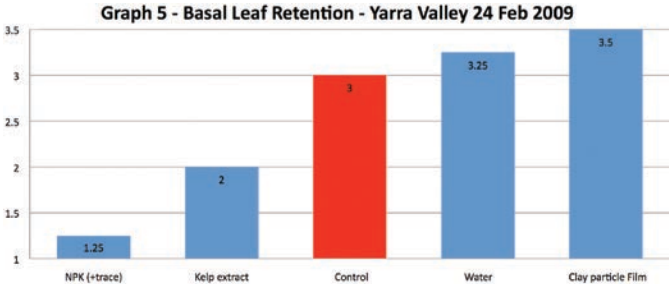
2009 Grampians results

Graph 2 shows the results for basal leaf senescence. The Key is as follows: 5 = absent, 4 = yellow/brown, 3 = yellowing, 2 = pale green and 1 = green. Lower scores indicate better retention and leaf colour of basal leaves. The graph shows all treatments had reduced basal leaf senescence compared to the control vines in the Grampians, Vic, 2009.

Graph 3 shows the reduction in raisined berries per bunch in the Grampians, Vic. Results identify a general reduction in raisined berries per bunch compared to the control vine, with the exclusion of the 'Clay particle film' treatment.

Nb. Data does not exist for treatments; 'kelp extract + anti-stress' and 'clay particle + anti-stress'.

Graph 5 - Basal Leaf Retention - Yarra Valley 24 Feb 2009



2009 Yarra Valley results

Graph 4 shows the reduction of raisined berries per bunch in the Yarra Valley, Vic. Results show, with the exclusion of 'clay particle film', all treatments reduced berry raisin levels compared to control.

Graph 5 shows the results for basal leaf senescence. The Key is: 5 = absent, 4 = yellow/brown, 3 = yellowing, 2 = pale green and 1 = green. The graph shows that NPK (+ trace element) fertiliser and Kelp extract reduced basal leaf senescence (reduced stress symptoms) compared to the control. Results identify that neither 'water' nor 'clay particle film' helped reduce stress symptoms in the Yarra Valley, therefore the vines were not under water 'deficit' stress.

Summary

- Results show that *Kelp extract* and *NPK* have shown positive effects to reduce berry raisining and to retain basal leaves.
- *Water* had mostly positive effects, but less significant than *Kelp extract* and *NPK + trace elements.*
- The positive influence of the 'water' treatment against 'control' treatments confirmed suspicions the vines may have been in water deficit. The benefits of water have been greater in the Grampians vineyard where supplementary irrigation reserves are very limited.
- The *Anti-stress* agent appears to amplify the positive response when applied with the fertiliser/kelp extract.

Conclusions and future research

The expression of berry raisining could be a response to climatic influences such as heat spikes, and therefore if current climate projections are correct, these events will continue and possibly become more regular. These project outcomes suggest the potential for mitigation exists, but further research (on a greater scale than done here) is required to refine and confirm approaches to help manage berry raisining. Future research aims to extend on these small-scale findings to a large-scale, statistically valid trial with greater measurement types and scientific rigor.

Appendices: Details of products

a) NPK (+trace elements): 15% nitrogen, 2.5% phosphorus, 25% potassium, 2.4% sulphur, 1.5% magnesium, 0.04% iron, 0.02% manganese, 0.02% zinc, 0.011% copper, 0.01% boron, 0.0012% molybdenum.
b) Kelp extract (organic product) with plant growth regulators – cytokinens, auxins, 0.02% nitrogen, (P^2O^5) <1%: phosphorous, 4.3% potassium plus trace levels of Na, Cl, Ca, Mg, S, Zn, Mo, Al, B, Co Cu, Fl, Fe, I, Mn, Hg, Ni, Se, Ag, V.
c) Anti-stress: 97% glycine betaine.
d) Clay particle film: 95% kaolin 5% other (inert) properties.

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Nathan Scarlett works as a technical viticulturist for the Rathbone Wine Group and can be contacted at nscarlett@rathbonewinegroup.com.

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