Can the production of low alcohol wines start in the vineyard?

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In theory, it should be possible to delay sugar accumulation in grape berries relative to other compositional changes during ripening to achieve wines of lower alcohol concentration without any untoward effects on flavour and structure. This article provides evidence for the proposition that vine balance might be the key to achieving good synchronisation of sugar accumulation and 'flavour' ripening. It also reviews the effect of vineyard practices that reduce leaf area to fruit weight to slow down sugar accumulation which have had variable effects on fruit composition and wine quality.

INTRODUCTION

The earlier onset of ripening and higher sugar concentration in the last decade or so has been attributed to a warmer climate, lower yields, improved vineyard management practices, improved clones and delayed harvest to achieve more full-bodied wines. The resulting higher alcohol wines have, in some cases, attracted negative responses from various quarters. Although the technology now exists to lower wine alcohol content post-fermentation, it would be useful to start the process in the vineyard.

The rate of sugar accumulation in berries is largely determined by the ratio of leaf area to fruit weight (LA/FW)[1]. However, flavour and phenolic ripeness might be independent of LA/FW. Vine balance can be defined as being achieved when vegetative vigour and fruit load are in equilibrium and consistent with high fruit quality[2]. Yield-to-pruning-weight ratio (Y/P) is commonly used as an index of vine balance—with values in the range 5:1 to 10:1 generally considered to be optimal. However, lower values might be appropriate for certain varieties and cool climate regions[3]. Vines that are not balanced in the sense that vegetative vigour is too high relative to fruit load, i.e., under-cropped, might cause berry sugar to reach an unacceptably high concentration by the time that flavour or phenolic ripeness is judged to be optimal for a particular wine style. The following two studies on Cabernet Sauvignon in California are used to support this proposition.

THE EFFECTS OF VINE BALANCE

The purpose of the first study was to examine how Y/P influenced the accumulation of key aroma compounds during berry ripening in commercial vineyards at Lodi, Sonoma and Napa[4]. Approximately three weeks after fruitset, vines were bunch thinned to achieve three crop levels: 'under-cropped', 'over-cropped' and 'balanced', based on historical yield and pruning weight data. Concentrations of β-damascenone and isobutylmethoxypyrazine in berry samples were converted to odour activity values (OAV) as indicators of 'dark fruit' and 'green fruit' aromas, respectively. Balanced vines (mean Y/P = 8:1) reached the target sensory threshold (a minimum ratio of dark fruit OAV to green fruit OAV of 300) at lower °Brix than under-cropped vines (mean Y/P = 3:1)—mean Brix was approximately 3.5 degrees lower for balanced vines (Figure 1). Over-cropped vines (mean Y/P = 14:1) reached similar °Brix levels as the other treatments, but failed to reach the minimum OAV ratio for acceptable sensory attributes. Soluble solids accumulation increased as Y/P decreased, but balanced vines accumulated β-damascenone more rapidly relative to change in Brix than the other treatments (data not shown).

The second study was conducted in a commercial vineyard in Paso Robles over three seasons[5]. Four cropping levels were achieved by bunch thinning approximately mid-way between fruitset and veraison. Also, there were five target Brix levels for each cropping level. Wines were made in 500kg lots each season and evaluated by a combination of expert and consumer sensory panels and descriptive analysis. In the second season, the highest yielding treatment (14t/ha; Y/P = 4.0:1) reached maximal consumer likeability score at 24°Brix, whereas the lowest yielding (6.3t/ha; Y/P = 1.4:1) did not do so until 27°Brix. In the three-year summary of descriptive analysis, the wines from high yield (balanced) vines correlated most strongly with desirable berry, body and colour depth, whereas wines from lowest yielding (under-cropped) vines correlated most strongly with undesirable vegetative character and astringency.

These studies indicate that under-cropped vines, often the result of excessive bunch thinning, produced fruit that accumulated positive aroma compounds at a slower rate and green aromas at greater rate than balanced vines. In unbalanced (under-cropped) vines, sugar ripening is too rapid relative to flavour ripening (and perhaps also development of phenolics/mouthfeel).

In theory, it should be possible to delay sugar accumulation relative to other compositional changes during ripening, so as to achieve better synchronisation of sugar and flavour/phenolic ripening and wines of lower alcohol concentration without any untoward effects on flavour and structure. This may be done by reduction of leaf area, reduction of photosynthetic rate or increased irrigation just before harvest.

LEAF AREA REDUCTION BY DEFOLIATION OR SHOOT TRIMMING

A reduction of leaf area after fruitset can be achieved by defoliation or by shoot trimming (reduction of leaf number per shoot). Although research on this topic to date is limited, some studies have reported

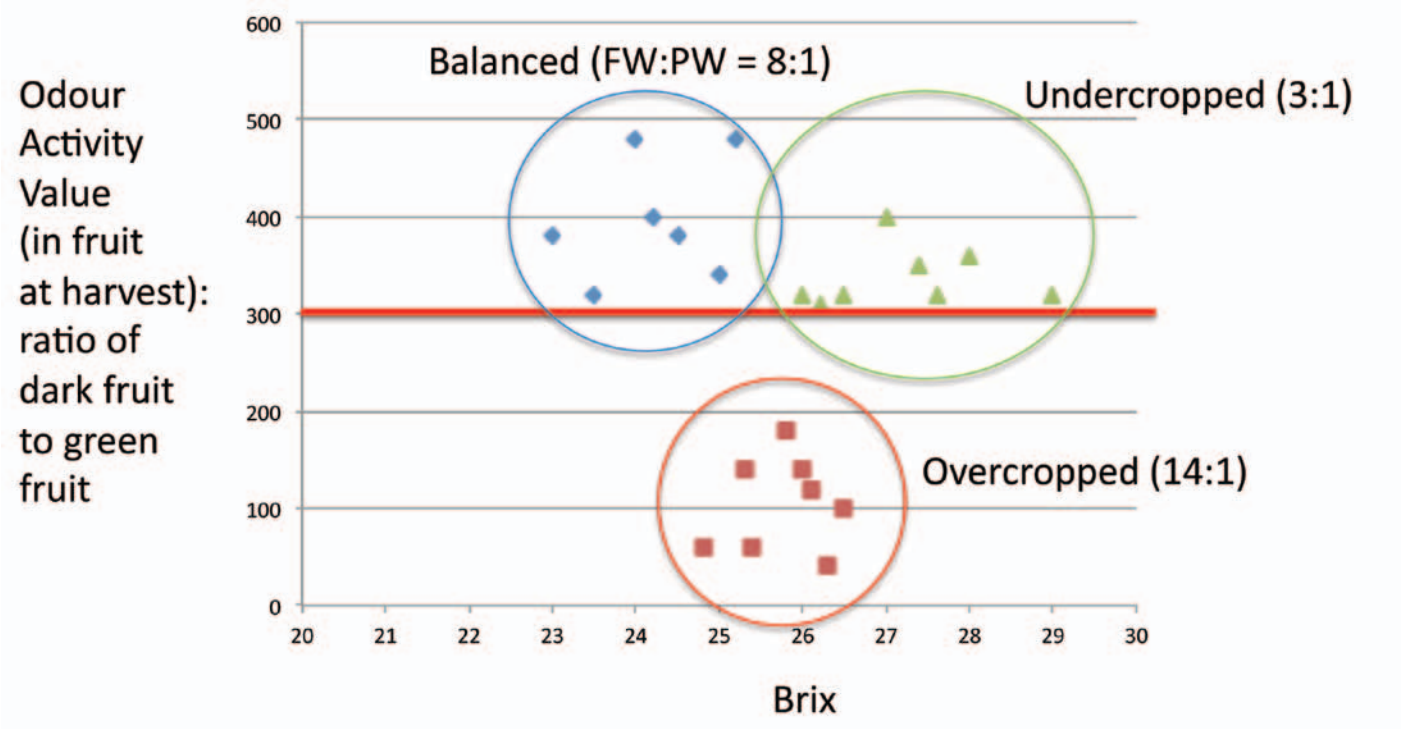

Figure 1. Influence of yield:pruning weight ratio (FW:PW) on Brix and odour activity values of B-dąmascenone ('dark fruit') and isobutylmethoxypyrazine ('green fruit') in Cabernet Sauvignon berries at harvest. Each data point represents a single replicate. Redrawn from Figure 3, Dokoozlian, N.; Ebisuda, N. and Cleary, M. (2011) Some new perspectives on the impact of vine balance on grape and wine flavour. Proc. 17th GIESCO meeting, Asti/Alba Italy. 407-409.

the success of these approaches. For Riesling in the Rheingau, Germany, reducing LA/FW after flowering with either mechanical defoliation or shoot hedging by 28% and 57%, respectively, caused a delay in maturity by 14-20 days without any effect on titratable acidity (TA) or pH[6]. Similarly, Whiting[7,8] achieved a significant delay in sugar accumulation for Shiraz grapes at Bendigo when the leaf area was reduced by more than 50% at any time from the end of rapid shoot growth to veraison — yield was not affected but anthocyanin concentration was reduced. At the same harvest date, treated wine had 2% lower alcohol than the control, but the wine score was also significantly reduced. The author concluded that this technique may be suitable for production of lower alcohol white wines, but not for red. Pre-veraison removal of all lateral shoots from the basal six nodes of Montepulciano vines in Marche, Italy, reduced LA/FW by 27% but had no significant effect on yield, Brix, TA , pH or total anthocyanin concentration relative to untreated vines[9].

There have also been variable responses to shoot trimming. Sangiovese vines in Emilia Romagna, Italy, were subjected to either light trimming (14 nodes retained per shoot) or severe trimming (10 nodes per shoot) at 15°Brix[10]. Over three seasons, a 2°Brix reduction for severely trimmed vines in one season was the best response. Yield reduction ranged from 6-24% less than the control. There was no effect on anthocyanin concentration in two out of three seasons, and slight reduction in the other season. In another study, shoots of Tempranillo and Grenache bush vines in Rioja, Spain, were severely trimmed (cut at node above distal bunch) by hand just after fruitset[11]. Veraison was delayed by 20 days. For Tempranillo, at the same harvest date, fruit on trimmed vines (LA/FW = 0.64) was 3.5°Brix lower than the control (LA/FW =1.88) but there was also a small but significant reduction in yield and total anthocyanin concentration.

In many regions in Australia, defoliation should be trialled with caution because it may cause excessively-delayed ripening at high crop loads or could lead to excessive bunch exposure and, therefore, heat-damaged fruit.

ANTI-TRANSPIRANT FOLIAR SPRAY

One technique that does not require physical reduction of leaf area—and consequent increased bunch exposure—is the use of a foliar spray of a film-forming anti-transpirant. Palliotti and colleagues[12] carried out foliar applications of Vapor Gard® (also known as pinolene) which was shown to cause a temporary limitation of photosynthesis of field-grown grapevines[12]. In an experiment with Sangiovese field vines in the Marche, Italy, Vapor Gard was applied to foliage at the end of veraison, and again two weeks later. Both high and medium crop loads were achieved by bunch thinning at veraison. Photosynthesis was inhibited for about 30 days. There was no effect on canopy density, leaf area per vine, LA/FW or yield components. The anti-transpirant spray significantly reduced soluble solids accumulation: berry Brix at harvest was approximately 2° lower for medium crop load and 3° for high crop load. However, the anti-transpirant treatment also slightly reduced the concentrations of anthocyanins and polyphenols at the same Brix[12].

IRRIGATION STRATEGY

Anecdotally, increased irrigation during the last few weeks before harvest has been claimed by some winemakers to cause a significant delay in ripening with concomitant reduction in wine quality. However, this is not necessarily supported by experimentation. When irrigation applied to Cabernet Sauvignon in a hot region of California was doubled for the period of ripening from 22°Brix to harvest, there was only a slight reduction in wine ethanol concentration in one out of two seasons[5]. Furthermore, similar irrigation practices have shown no significant effect on wine sensory score or wine composition[13, 14].

OTHER FACTORS

In some regions, winemakers are not willing to harvest until the green character in fruit, as determined by berry sensory evaluation, drops to a level that they consider to be appropriate for the intended wine style. High alcohol concentration in the final wine might, therefore, be a consequence of an extended 'hang-time'. Therefore, any viticultural practice that reduces the concentration of methoxypyrazines at veraison will potentially enable fruit to be harvested earlier at lower soluble solids. The degree of bunch exposure pre-veraison can influence the accumulation of methoxypyrazines, but it does not appear to have much effect on degradation after veraison. Leaf removal in the bunch zone prior to veraison will decrease levels at harvest, but leaf removal at veraison or later has little effect[15, 16, 17]. High levels at harvest are associated with any factor that stimulates pre-veraison shoot vigour[18]. There might be a direct effect of shoot vigour on methoxypyrazine concentration that is independent of the degree of bunch exposure, i.e., the higher the vigour, the greater the concentration[19]. Shoot vigour may be reduced by deficit irrigation, various soil management practices or by downward shoot positioning[20].

CONCLUSIONS

Vine balance might be the key to achieving good synchronisation of sugar accumulation and 'flavour' ripening. Accumulation of aroma compounds, berry colour and mouthfeel compounds appears to be uncoupled from sugar accumulation. Optimal flavour in berry and wine might be achieved at lower sugar levels in balanced vines relative to under-cropped vines. Irrigation for the last few weeks prior to harvest does not reduce Brix. Practices that reduce leaf area to fruit weight can slow down sugar accumulation, but there have been variable effects on fruit composition and wine quality. Although there might be negative effects for red wine varieties, there might be potential for whites, and for this reason, research is ongoing. On a recent trip to Geisenheim, Germany, I was shown experiments being conducted on the effect of shoot trimming, defoliation and anti-transpirant spray on Riesling by Vanessa Schoebe, a PhD candidate supervised by Dr Manfred Stoll.

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