Water Transport in Grape Berry and Pre-Harvest Berry Dehydration

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Abstract

Pre-harvest berry dehydration is reported for different grape varieties in many countries and may be exacerbated by global warming. In Australia a net water loss of up to 30% from berries of the most commonly grown red grape variety *Vitis vinifera* L. cv. Shiraz at the end of ripening is a serious problem causing significant yield losses and higher sugar concentration. The current hypothesis is that this water loss occurs due to a diminishing water inflow into berries at the end of ripening while transpiration prevails. Water backflow from berries to the parent vine via the xylem may contribute to this loss. The approach in this study was to compare hydraulic properties and quantify water uptake and water loss in different varieties to identify the contributing factor(s) in berry water relations that may cause net water loss. Different patterns of hydraulic resistance for water inflow were detected in the rachis, pedicels, and berries in bunches of Chardonnay, Grenache, and Shiraz during berry development. An increase in whole bunch hydraulic conductance was correlated to berry growth in Grenache, but not in Chardonnay and Shiraz. At the end of ripening, berry hydraulic resistance decreased in Shiraz whilst it increased in Chardonnay. This may prevent water backflow from Chardonnay berries to the parent vine, but this difference appeared to occur after weight loss began in Shiraz, and in Grenache, which did not display weight loss, there was a low berry hydraulic resistance. A lower hydraulic resistance in bunches of Grenache corresponds to this variety having more isohydric regulation of plant water potential reported in the literature. Using an *in vitro* transpiration assay on excised berries where both water loss and water uptake were measured, berries of all varieties showed net water uptake in early stages of development switching to a net water loss after veraison. A twofold higher net water loss from mature berries of Shiraz compared to Chardonnay was caused by lower water uptake in Shiraz rather than a higher transpiration rate. I conclude that the difference may be caused by a lower water potential difference as driving force for water uptake into Shiraz berries, since an equal or higher hydraulic resistivity was measured in Chardonnay berries. Finally, a computer model was developed to simulate transpiration and water uptake in the field under changing evaporative conditions during the 2011-12 season. This model demonstrated that water uptake via the xylem and phloem was able to balance peaks in transpiration due to high VPD events just after veraison, but was not able to compensate these peaks at the end of ripening. Compared to Grenache and Chardonnay there was greater sensitivity of Shiraz berries to high VPD at the end of ripening due to insufficient compensation of transpirational water loss by xylem water uptake which may explain this variety's propensity to display significant weight loss.

Declaration

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Contents

List of Figures

List of Tables