The Viticulture & Enology Lab

The Role of Vèraison in Berry Drought Tolerance

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This is the third in a series of articles that illustrate the wide range of strategic and basic viticultural research efforts by UC Davis faculty. Dr. Mark Matthews, together with Larry Williams one of two plant physiologists in our Department, is addressing both fundamental plant biology and applied viticulture in his research program. His major goal is the improved use of limited resources, especially water, in grape production. His concept is to identify the physiological mechanisms by which grapes respond to those limitations, e.g. water or nutrient deficiencies. He and his students take their practical observations directly from the vineyard into the lab and vice versa. Dr. Matthews' fundamental work on berry drought tolerance and its implication on wine quality clearly demonstrate that viticultural and enological research are not separable. At the moment, Mark is designing grapevine irrigation studies that will be on their way once the new Harry E. Jacob Research Facility at the Department's Oakville Experimental Vineyard has been completed with the help of our wine & grape community. Dr. Matthews presented this work, which was supported by the University of California, at my annual research symposium Recent Advances in Viticulture and Enology (RAVE 1995) held this Spring at UC Davis.
—Dr. Christian Butzke, Extension Enologist

Berry size is a quality factor of fresh, raisin, and wine grapes. And certainly this is one parameter that is to some extent under grower control. Fruit size generally exhibits an inverse relationship with crop load, which is controlled most often by pruning. Recently, UC Cooperative Extension Specialist Nick Dokoozlian from the Department of Viticulture & Enology found that berry size also responds to grower manipulations of crop load through thinning, but much more so through berry or flower thinning than cluster thinning. Another relatively easy way to alter fruit size is via irrigation since growth is the most sensitive of plant processes to water deficits.

Perhaps more important than size in winegrapes is fruit composition, the concentrations of the many solutes that contribute to winemaking, wine stability, and wine sensory attributes. Although only a few of the many important solutes have been measured, water deficits at different times of the season alter fruit composition in complex ways and result in significant differences in wine color, taste, and aroma.

Since the berry undergoes daily periods of shrinking and swelling, changes in berry size via hydration/dehydration or inhibited growth may alter fruit composition by simple dilution or concentration of flavor components. However, little is known about the factors that determine berry shrinking and swelling and their responses to water deficits.

Mark Greenspan*, a graduate student working with me, conducted experiments to determine the daily water budget of the berry and the extent to which berry contraction contributes to altered fruit size. Our work has shown that berry shrinkage contributes little to changes in fruit size or composition after vèraison. By continually monitoring the diameter of individual berries using devices called displacement transducers throughout the season in vines exposed to different irrigation regimes, he was able to determine how changes in fruit development and in vine water status affected the amount of shrinking and swelling. He made several significant observations. First, he found that for well-watered Cabernet Sauvignon vines near Lodi, fruit growth occurs primarily at night, when the nighttime expansion in volume exceeds the daytime contraction. One surprising discovery was that daytime contraction was about 80% less after vèraison than before vèraison. And, the transition from losses of greater than 5% of berry diameter to about 1% occurred rapidly, over a couple of days just prior to berry coloring.

These diurnal fluctuations arise from changes in water flows into and out of the fruit. Water uptake from the shoot presumably occurs through the low resistance pathways of the phloem and xylem conduits in the pedicel and rachis that attach the berry to the shoot. Outflow can occur via transpiration (water lost by evaporation from the berry to the atmosphere) and in some cases through the xylem back to the parent vine. Another surprising observation was that berry transpiration was primarily responsible for berry water loss both before and after vèraison. There is little movement of water from berries back into the vine, especially after vèraison. Thus, the berries are not a significant source of water for a transpiring canopy.

The third important observation was that daytime contraction was very sensitive to vine water status before vèraison, but was remarkably insensitive after vèraison. When water deficits were imposed by withholding irrigation before vèraison, daily contraction increased to up to 15% of berry diameter and berries became visibly shrunken (although they would generally recover overnight). Similar experiments conducted after vèraison produced no significant change in the small daily contractions. In essence, the berries became drought tolerant after the onset of ripening. This means it is difficult to cause berries to shrink after vèraison. More importantly, since there is little daily contraction, the changes in fruit composition caused by late season water deficits must arise from alterations in the fruit ripening process itself and not simply as a consequence of berry shrinkage. The reduced sensitivity of berry hydration to plant water status that occurred after vèraison may partially explain the common observation of a greater role of pre-vèraison water deficits in determining fruit size and composition than post-vèraison water deficits.

* Mark Greenspan was a M.S. student in Horticulture with Dr. Matthews when he did this work. He is now a Ph.D. student in Biological & Agricultural Engineering with him and is working on automated evaluations of vineyard water use and water status.

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