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Title: **"Berry size and vine water deficits as factors in winegrape composition: Anthocyanins and tannins"**

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This is the sequel to a study on the effects of water deficits on berry size and berry components, by two of the authors. First we learned that sustained water deficits decreased berry size, and then that water deficits increased the amounts of seed and skin in berries of the same size. This second article addresses the next obvious question: How do water deficits affect the amount of tannins and anthocyanins in skins and seeds? The work is carried out in the same vineyard and with the same water treatments. The main results, of important practical consequences, follow here.

- As in a previous work, before trying to learn how treatments affect anything else, the authors classified the berries into 6 categories based on size (<0.50g, 0.51-0.75g, 0.76-1.00g, 1.01-1.25g, 1.26-1.50g, >1.50g). This was done to separate the effects due to water deficit from the effects due to berry size.

- The goal of this article was to study how 3 levels of irrigation (low, normal and high) affect 4 chemical parameters in the berry (soluble solids, seed tannin, skin tannin, and anthocyanins).

- Normal irrigation was 32 liters/vine/week. Low irrigation was 32 liters/vine/week after leaf water potential reached –15 bars. High irrigation was 64 liters/vine/week.

- The authors start out by looking at how water deficit affects soluble solids accumulation – or Brix. They find that "the larger the berry, the more sugar" rule stands true. But it must be emphasized that this is not the same as saying "the larger the berry, the greater the Brix". This is due to the fact that when both the content (sugar) and the size of the container (berry) change at the same time, the container may remain equally full (concentration) or not, depending on the rate of change of each of the relative components. In fact, in this case, berry size increases more than the sugar content, so the overall effect is that sugar concentration, or-degrees Brix, decreases in larger berries.

- In addition to berry size affecting **Brix**, the authors find that water status also has an important effect on sugar concentration. They observe that low-irrigation berries show higher Brix than high-irrigation berries, in all berry size categories. In other words, over-irrigated berries take longer to mature. This has been noted before, but there was always the doubt of whether the increases in Brix were due to the accompanying decrease in berry size. The current study clarifies the matter: the water deficit imposed by the low irrigation caused a Brix increase in the berries, no matter what the berry size.

- Incidentally, the normal irrigation vines deviated from the trend above. In those berries, the Brix ended up even higher than in water deficit berries of equivalent size. This may be due to the fact that, under low irrigation treatment, the stress may have been severe enough to have compromised photosynthesis and sugar translocation for certain berry sizes.

• Tannins and anthocyanins: As if things were not already getting complicated, the authors looked at these components in two different ways: as **total content** (in grams per berry), and as **concentration** (in grams/gram of berry). And here is what they found.

• **Seed tannin content increased as berry size increased** Water status, on the other hand, did not have an effect here. The seed tannin increase was correlated with larger seed mass in the larger berries. When the seed tannin was expressed as a relative concentration (grams per gram of berry), seed tannin concentration was the same regardless of berry size.

• **Skin tannin content increased as berry size increased** Additionally, water deficit berries had the highest content of skin tannins, regardless of berry size. When the skin tannin was expressed as a concentration, the water deficit berries still had the highest skin tannin concentration (the normally irrigated berries had the next highest, and the highly irrigated berries had the lowest). However, this concentration, so responsive to water status, was not significantly affected by berry size.

• And finally, **anthocyanins** behaved similarly to skin tannins. **Anthocyanin content also increased as berry size increased** Water deficit berries also had the highest anthocyanin content, regardless of berry size. When anthocyanin was expressed as a concentration, water deficit caused a highly significant increase in anthocyanin. The normally irrigated berries had the next highest level, and the highly irrigated berries had the lowest. Unlike skin tannin, however, anthocyanin concentration decreased as berry size increased. This was because the anthocyanin rate of increase was less than the corresponding berry size increase.

• If you find it hard to track how numerators, denominators and ratios change at the same time, the conclusions above are summarized in the following table.

	Effect of increased berry size	Effect of water deficit on berry content	Effect of water deficit on berry concentration
Brix	↓	↑	↑
Seed tannin	—	—	—
Skin tannin	↑	↑↑	↑
Anthocyanin	↓	↑↑	↑

• The authors then go on to discuss the possible physiological origin and potential implications of their results. And they give some numerical examples. You can expect to get about a 20% decrease in yield with water deficit due to the resultant smaller berries. But you can also expect to get about 45% more anthocyanins from the skins for the same reason. That's the trade off!

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