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Title: "Physiological changes in plant hydraulics induced by partial root removal of irrigated grapevine (*Vitis vinifera* cv. Syrah)"

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In an effort to learn more about the role of roots in the rehydration of grapevine tissues after heavy transpiration, the authors conducted trials with different types of root prunings to study their impact on the plant's water status, its photosynthesis rates, and its overall canopy structure.

- First, some background on this little-understood subject. When the plant is experiencing high transpiration demands due, for example, to strong winds or high temperatures, limitations in its ability to move water from the soil to the leaf, as well as an increased water vapor loss at the leaf surface level, can cause the plant to suffer water stress. If conditions are severe, breakage of the water column inside the xylem, called cavitation embolisms, may result. This is partially avoided thanks to the ability of the plant to regulate transpiration by closing its stomates, thus sustaining its leaf water potential. Recovery, or "refilling" of the xylem after these periods is thought to happen during the night, when transpiration demands are low. Water is then redistributed to rehydrate the tissues, and allow the stomata to reopen, and photosynthesis to resume the next morning, a process known as **hydraulic redistribution**. Depending on the plant, different organs are involved to different degrees in storing water and then re-distributing it to other tissues. In this study, the authors hypothesize that the roots of the grapevine play an important role in hydraulic redistribution.

- The authors decided to determine whether the hydration status of the root –wet or dry- had any influence on the root's hydraulic conductivity, that is, its ability to transport water. To test this, they compared the removal of two main roots lying directly under the drip zone (root pruned irrigated), with the removal of two main roots lying diametrically opposed, on the dry, un-irrigated side (root pruned dry). They also excavated and buried back vines whose roots were left intact (control). Since vines had anywhere from 6-8 framework roots, these roots treatments involved 25-35% of all cross-sectional root area emerging from the trunk.

- The experiment took place in 2004 and 2005 in Davis, California, on 5-year-old Syrah grafted to 101-14 Mgt. The soil was a very deep (>3 m) sandy, clay loam. The treatments were imposed at the end of May (3 wks after bloom). The vines received drip-irrigation one week before the pruning, and then every 2 wks after the end of June (100 l/vine).

- After imposing the root prunings, the authors monitored a number of variables, including: leaf water potential (using a pressure chamber), stomatal conductance, photosynthetic rate, transpiration rate (using a gas-exchange devise), hydraulic conductivity (calculating the relationship between soil water potential and leaf water potential), and total and lateral leaf areas (calculated destructively from lateral vein lengths in 2004).

- **Effect on water status**. Root-pruned vines always showed lower leaf water potentials, indicating more severe water stress, that the control vines. All three measures -pre-dawn leaf water potential, mid-day leaf water potential, and stem water potential- were similarly impacted. They also noted some leaf wilting in the root-pruned vines. The removal of roots from the irrigated area imposed more water stress than when the roots were removed from a dry area. The authors interpret this as evidence that the dry roots have less ability to rehydrate the plant (less hydraulic conductivity) than the roots from the drip zone. A way to help us understand this is to think that, if the plant suffers more when the "wet roots" are pruned, then wet roots must be playing a more important role in rehydration than "dry roots". In 2005, the year following the prunings, there were no differences in leaf water potential among treatments, suggesting that the root-pruned vines had recovered.

- **Effect on stomatal conductance.** Researchers use stomatal conductance (volumes of gas exchanged per unit of pore surface and per unit of time) to calculate rates of transpiration and rates of photosynthesis. A low conductance means the stomata are partially closed, which in turn means low transpiration and photosynthesis rates. Root pruning caused a 40% decrease in stomatal conductance compared to the control. This decrease was greater for the root-pruned irrigated vines (lower maximal stomatal conductance) than for the root-pruned dry vines. Transpiration and photosynthesis were, accordingly, also reduced in the root-pruned vines, and more so in the root-pruned irrigated vines. The authors noticed these reductions were greatest when the evaporative demand was at its highest (25 days after the roots had been cut).

- **Effect on water conductivity.** The lowest values of stomatal conductance recorded for the root-pruned vines were also associated with the lowest values of hydraulic conductivity. A low value means the vine is experiencing a lot of resistance to move water from the roots to the leaves. These values tended to be lower for the root-pruned irrigated vines than for the root-pruned dry vines, particularly at the beginning of the season.

- **Effect on leaf area.** Severing the roots resulted in substantially lower final leaf area per vine in 2004. This was due to a slowing down of leaf expansion rate. The canopy leaf area reduction was, once again, more severe in the root-pruned irrigated vines (up to 34% less canopy than the control) than in the root-pruned dry vines. The percent of lateral leaves was also affected, and was lowest for the root-pruned irrigated vines. This canopy adjustment might indicate an effort by the plant to reduce its transpiring leaf surface in response to the loss of root surface. These differences in leaf area were no longer apparent in 2005.

What are the implications for the grower? Even though the stress observed in the root-pruned vines was not of a magnitude considered harmful for the vine, the roots from the wet soil area seem to play a more important role in sustaining the water status of the plant that the roots from the dry portion of soil. This means that the roots in non-irrigated portions of soil may have greater anatomical resistance to water flow, or different diameter or distribution, than those in irrigated portions, something the authors are currently studying. The findings may allow us to design more efficient irrigation systems, or better placement of drippers in our current systems.

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