Geophysical Research Abstracts
Vol. 21, EGU2019-6112, 2019
EGU General Assembly 2019

Leaves speak volumes: sun and shade leaves differences and similarities in volumetric diffusional traits using non-invasive microCT imaging and gas exchange measurements.

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The diffusion of gases within leaves is inherently a 3D process, and leaf construction is considered to be optimized for diffusion under the specific growth environment under which the leaf developed. Yet there is limited empirical data linking actual leaf gas exchange to 3D and volumetric anatomical traits. Here, we provide one of the first characterizations of leaf anatomy using non-invasive high-resolution computed tomography (microCT) linked to gas-exchange measurements, allowing for the comparison of leaf-area-based to volumetric-based traits using a combined drought and shading experiment in *Vitis vinifera* cv. Cabernet Sauvignon, using shading as a way to modify leaf anatomy. Shading decreased leaf thickness and the surface of mesophyll cells exposed to the intercellular airspace (A_{mes}) per leaf area (A_{mes}/A_{leaf}, commonly known as S_m), but had no effect on Ames per total mesophyll volume (A_{mes}/V_{mes}), indicating that leaves tend to preserve the total amount of diffusive surface in a leaf. Light saturated photosynthesis on a leaf volume basis ($A_{sat,vol}$) was not different between sun and shade leaves, and no relationship was observed between photosynthesis (per leaf area, $A_{sat,area}$, and $A_{sat,vol}$) and A_{mes}/V_{mes}, reemphasizing that diffusive surface is a conserved trait during leaf construction and allows for leaves to optimize CO_2 assimilation under the condition they developed in. Characterization of the resistance of the leaves' airspace to gas diffusion will be presented to differentiate sun and shade construction strategies.