

Hydraulic connections: Modeling shoots hydraulic architecture of grapevine to apprehend leaf-scale gas exchanges and WUE in complex canopies

R. Albasha¹ and E. Lebon¹

¹INRA, Laboratoire d'Ecophysiologie des Plantes sous Stress Environnementaux, Montpellier, France

Although grapevine (*Vitis vinifera*) is reputed for its high adaptability to low water availability conditions, global warming and the resulting aleatory water deficit events has raised concerns in developing new training systems adapted to the changing climate context (Medrano *et al.*, 2012). Such training systems are thus called to optimize water use while preserving the production quantity and quality.

In this study, the Functional-Structural Plant Models (FSPM) approach was used to estimate the grapevine gas exchange dynamics resulting from different training systems under water deficit conditions. The cornerstone of this work is the simulation of the stomatal conductance g_s at the leaf scale as a function of both the local micro-climate conditions and the plant/soil water status.

g_s is simulated as a function of the net assimilation rate (A_n), vapor pressure deficit (VPD) and inter-cellular CO_2 concentration (C_i) as described by Leuning (1990). The soil/plant water status effect on g_s is accounted for by relating g_s to the leaf water potential Ψ_L according to the empirical approach (Damour *et al.*, 2010). Ψ_L is related to the collar water potential Ψ_C (which represents the averaged soil water potential in the root zone) using three methods of different degrees of complexity: (1) Ψ_L is considered uniform among all the leaves and is equal to Ψ_C (assuming thus that the stem conductance is negligible); (2) Ψ_L is function of Ψ_C and varies locally with the transpiration flux density (E) but no hydraulic connection is considered between the leaves; (3) Ψ_L is function of Ψ_C and E with leaves being hydraulically connected using a complete description of the shoot hydraulic structure of the plant.

The results of this study aims at providing answers to leaf-scale physiological responses of grapevine under water deficit conditions for different canopy structures. The resulting model could be used to assist training systems design to optimize water use efficiency.

Key words: *Vitis vinifera*, hydraulic architecture, stomatal conductance, water deficit, training systems.

Acknowledgments

This work was carried out as part of the EU project INNOVINE (FP7-KBBE-2012-2016, grant no. 311775)

References

- Damour, G., Simonneau, T. Cochard, H., Urban, L., 2010. An overview of models of stomatal conductance at the leaf level. *Plant Cell Environ.*, 33, 1419 – 1438.
- Leuning, R., 1995. A critical-appraisal of a combined stomatal-photosynthesis model for C3 plants. *Plant Cell Environ.*, 18, 339 – 355.
- Medrano, H., Pou, A., Tomás, M., Martorell, S., Gulias, J., Flexas, J., Escalona, J. M., 2012. Average daily light interception determines leaf water use efficiency among different canopy locations in grapevine. *Agricultural water management*, 114, 4 – 10.