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Hydraulics of transgenic grapevines overexpressing a PIP2 aquaporin

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Abstract:

We constitutively overexpressed *VvPIP2;4N* in *Vitis vinifera* L. 'Brachetto' and in the resulting transgenic plants we analysed i) the expression of endogenous and transgenic *VvPIP2;4N* and of four other aquaporins, ii) whole-plant, root, and leaf ecophysiological parameters, and iii) leaf abscisic acid content. Expression of transgenic *VvPIP2;4N* inhibited neither the expression of the endogenous gene nor that of other PIP aquaporins in both root and leaf. Under well-watered conditions, transgenic plants showed higher stomatal conductance, gas exchange, and shoot growth. The expression level of *VvPIP2;4N* (endogenous + transgene) was inversely correlated to root hydraulic resistance. The leaf component of total plant hydraulic resistance was low and unaffected by overexpression of *VvPIP2;4N*. Upon water stress, the overexpression of *VvPIP2;4N* induced a surge in leaf abscisic acid content, and a decrease in stomatal conductance and leaf gas exchange. Our results show that aquaporin-mediated modifications of root hydraulics play a substantial role in the regulation of water flow in well-watered grapevine plants, while they have a minor role upon drought, probably because other signals, such as ABA, take over control of water flow.

On detached leaves, hydraulic capacitance (Ch) and resistance (Rh) were assessed following recovery dynamics after leaf dehydration. The dehydration was imposed by submitting the leaves at 0.5 to 1 MPa overpressure through a Scholander bomb. The recovery after dehydration was checked in dark, in light non-transpirative condition, and in light-transpirative condition. In leaves processed in dark conditions, Rh decreased and Ch increased compared to wild type plants, suggesting that in transgenic leaves, trans-cellular pathways activated during dehydration superimposed on apoplastic ones, saving water inside cells, as in/out cell-to-apoplasm water movements were aquaporin-controlled. Upon light, either when leaves transpired or not (either by depressing vapor pressure deficit or by feeding leaves with abscisic acid, causing stomatal closure) the described effects disappeared. We conclude that light activates leaf aquaporins masking the transgene effect on controlling leaf Ch and Rh, and confirming that the *in-vivo* leaf hydraulics is not affected by transgenic aquaporin *VvPIP2;4N* overexpression.