Geophysical Research Abstracts
Vol. 20, EGU2018-14011, 2018
EGU General Assembly 2018

Xylem hydraulic recovery: does the amount of parenchyma matter?

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Under extreme conditions of soil drought, trees can face the risk of mortality due to hydraulic failure caused by xylem embolism. Even when xylem embolism is non-lethal, the capacity of trees to survive after drought relief can be expected to depend on strategies to recover xylem hydraulic efficiency, possibly based on Non-Structural Carbohydrate (*NSC*) pools stored in the wood.

We performed experiments on 11 species growing in the Mediterranean region characterised by different: a) xylem embolism vulnerability, as estimated by species-specific $P50$ values (= xylem tension inducing a Percentage Loss of hydraulic Conductance, *PLC* = 50%, ranging between – 0.9 and – 4.6 MPa), and b) total wood parenchyma fraction (PA_{TOT}, ranging between 11 and 37 %). In order to avoid possible excision artefacts during hydraulic measurements, branches at least 2 times longer than the species-specific maximum vessel length (VL_{max}) were collected and bench dehydrated. Before hydraulic measurements, the basal end of the branches was put into a water-filled tray and several cuts from the base were done under water until obtaining subsamples shorter than the VL_{max}. This experimental procedure allowed us to avoid spurious embolism in terminal shoot during dehydration, as well as to reconnect xylem to water and relax xylem tension before hydraulic measurements. A subset of these relaxed samples was measured immediately to estimate the initial *PLC* (*PLCi*, i.e. ∼50%), and another subset was maintained with the basal end in water for 1h before re-measuring *PLC* (PLC_{1h}). Measurements were performed in both intact and girdled samples, and a xylem recovery index was calculated ($RI = PLCi - PLC_{1h}$) to test the potential embolism repair.

We also obtained radial and transverse micro sections and analysed some xylem anatomical characteristics of the branches, i.e. the % axial parenchyma (PA_A), the % radial parenchyma (PA_R), and the total amount of vessels (*CNo*) per transverse section. Then we estimated the % total parenchyma volume ($PA_{TOT} = PA_A + PA_R$) and the volume of parenchyma per single vessel [PA_{TOT}/ CNo].

Branches of 8 out of 11 species had the ability to decrease *PLC* within 1h, while girdled branches did not recover. We found a significant positive correlation between *RI* and both the PA_R and [PA_{TOT}/ CNo].

Our results suggest that the amount of living cells in the wood plays an important role in the process of post-drought xylem recovery, where species with larger reserves of *NSC*s in the more abundant parenchyma are able to recover plant hydraulic functioning following drought stress.