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Impact of water stress-induced embolism on bud survival in *Populus nigra* L. sprouts

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Introduction

Bud survival is vital to sustain tree growth across seasons but the lack of water supply may induce weakness that could lead to tree death.

Aims

The aims of this study were to collect information on how the buds are hydraulically supplied from the bearer stem and on the impact of water stress on bud survival.

Material and methods

We submitted young *Populus nigra* potted trees to water stress for several weeks and carried out measurements of bud metabolic activity, transcript expression of aquaporins, xylem water potential of the bearer stem together with local water status within the bud and tissues in the bearer shoot node.



Young potted poplar trees



Time Domain Reflectometer



MRI scanner



Real-time PCR cycler



Pressure chamber

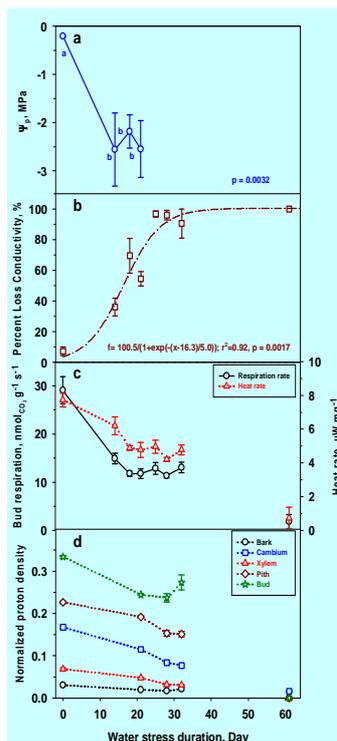


Xylem Embolism Meter

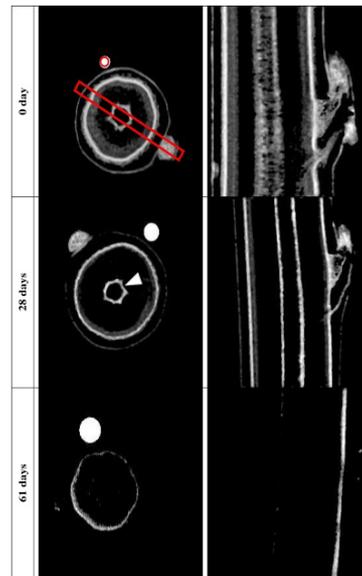


Microcalorimeter

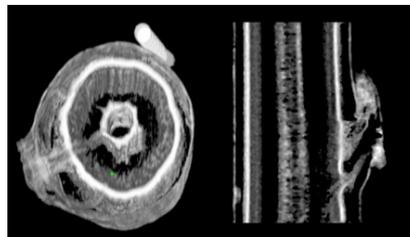
Results and conclusions



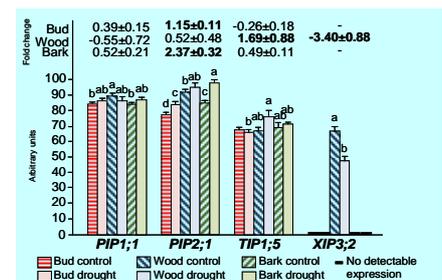
Patterns of predawn leaf water potential (a), percent loss of conductivity of the stem (b), bud heat rate and respiration rate (c) and normalized proton density (d) over the sampling periods of time. Leaf water potential was not available after leaf shedding.



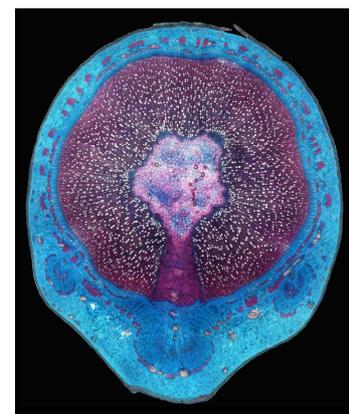
Three-dimensional MRI mapping of the shoot segments containing the bud. Bright discs show the capillary glass filled with doped water that allows the grey level calibration. At the terminal drought stage, the cambium remained hydrated, while the bud was already dry and dead (resolution: 39 μm).



Three-dimensional visualization of the normalized proton density (MRI measurements) in the bud and the stem during a water stress event (4 weeks). The proton density reflects the quantity of water contained in the tissues. These observations enlighten a large hydraulic connection between the bud and the parenchyma tissue that surrounds the pith and the connection of the bud with the cambial area. The cambium was the most highly hydrated tissue (resolution: 39 μm).



Monitoring of mRNA accumulation of PIP, TIP and XIP aquaporin subfamilies in bark, wood and buds. Only *PIP1;1* out of the 32 expressed aquaporin genes did not show significant differential expression (water stressed vs well-watered control) after 28 days of water stress.



Cytological observations (x10) of the stem anatomy. Transverse slice (25 μm thick) shows the large connection between the bud and parenchyma tissue that surrounds the pith.

We found that bud respiration rate was closely correlated to its water content and decreased concomitantly in buds and their surrounding bearer tissues. Modulation of aquaporin expressions (PIP, TIP and XIP subfamilies) seemed to be linked to water movements in living cells. Both buds and trees died simultaneously beyond a threshold water content and respiration rate. Nuclear magnetic resonance (NMR) imaging provided relevant local information about the water reservoirs in the stem, their dynamics and their interconnections (Barigah et al, 2013). This study provides insights into a possible water distribution between connected tissues within water stressed plants, hydraulic trade-offs between the meristematic zone integrity, and the hydration of the bud and its surrounding tissues.

Reference

Barigah TS, M Bonhomme, D Lopez, A Traore, M Douris, J-S Venisse, H Cochard, E Badel, 2013 - Modulation of bud survival in *Populus nigra* sprouts in response to water stress-induced embolism. *Tree Physiology*, 33(3): 261-274.