

Under pressure - insights into xylem and its hydraulics

Plant water relations are frequently under pressure. Water transport is passively driven by transpiration, which generates negative pressure (i.e. negative water potential), transduced from leaves to the roots and to the soil via the water columns in the transport system. Negative water potentials also develop when the stomata are closed but soil water supply is limited.

Trees, due to long transport pathways from the soil to the crown, can reach remarkably low water potentials. The stability of water columns under these conditions is only possible due to optimized structures, enabling both, sufficient transport capacities (hydraulic efficiency) and prevention of interruptions in water columns (hydraulic safety). In the xylem, various structural features of the transport conduits, including their connections via bordered pits, contribute to maintaining hydraulic efficiency and safety.

Under climate change, tree water relations are increasingly under pressure, when drought intensities and frequencies as well as temperatures (and thus water vapor deficits) increase. This leads to lower water potentials, which may exceed species-specific thresholds in hydraulic safety and thereby critically reduce hydraulic efficiency.