Leaf conduits grow wider than thicker and are potentially vulnerable to implosion

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Abstract

Xylem conduits have lignified walls to resist crushing pressures. The thicker the double-wall (T) relative to its maximum diameter (D), the greater the collapse/implosion resistance. Having xylem that is more resistant than necessary incurs high costs and reduced flow, while having xylem not resistant enough may lead to catastrophic collapse under drought. Despite the importance of xylem implosion safety in determining plant drought resistance, it is still unclear how leaves scale Tx D to trade-off among implosion safety, flow efficiency, mechanical support, and construction cost. We measured T and D in over 7,000 leaf xylem conduits of 122 ferns and angiosperms species to investigate how the Tx D scaling varies across species, clades, habitats, growth forms, and vein orders. Overall, leaf xylem conduits grow wider than thicker, potentially resulting in high flow efficiency and lower cost, but at the expense of high vulnerability to implosion. Conduits seem particularly vulnerable to implosion in monocots, aquatic species and in species from hydric habitats, as well as in major veins. The absence of strong trade-offs within the leaf functional traits examined suggests that implosion safety at the whole-leaf level cannot be easily predicted by the sum of the individual conduits' resistance to collapse.

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