Poroelastic coupling in artificial branches

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Poroelastic coupling in biomimetic branches :

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Abstract

Plants are constantly subjected to external mechanical loads such as wind, rain or even neighbours. These stimuli are known to affect the growth of the plants, a process called thigmomorphegenesis. Interestingly, plants physiological responses to these external loads is sometimes observed far from the stimulated area, which suggests the transportation of information through the plant. Among the different hypothesis found in the literature to account for this long-distance transport (electrical signal, hormone transport), it has been proposed that local mechanical stimuli (bending) could generate an hydraulic pulse that moves through the xylem. This appealing idea seems to be supported by recent experiments made in the PIAF laboratory on cut branches or whole plants, showing that the rapid bending of a branch is associated to transient overpressure in the xylem.

In this work, we address this question from a physical perspective and investigate the coupling between mechanical bending and hydraulic response in biomimetic branches. The branches consists in transparent elastomeric (PDMS) beams drilled with longitudinal micro-channels and filled with a viscous fluid. We precisely measure the hydraulic response (pressure amplitude, propagation velocity, decay time) as function of the different control parameters of the system (bending amplitude, micro-channel density, macroscopic rigidity, hydraulic conductivity) and compare with typical responses obtained on real plants. This study enable to better understand the physical mechanisms at play in the long-distance transport of information in plants.

Keywords

poroelasticity, growth