Mechanical disparities in plant tissues for controlled morphogenesis

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Abstract

Over the last years the effects of mechanics on plant growth have received increasing interest in combination with advancements in imaging techniques. Turgor pressure is known to deform in the rigid walls of plant cells, resulting in the appearance of mechanical stresses within them. Such stresses cause plastic deformations to the cell wall over time and therefore growth. However the precise link between the mechanical properties and shape of plant tissues and their growth remains to be elucidated.
Here we observe the 3D growth of the anther of *A. Thaliana*. We notice a significant growth differential between the epidermis and the inner layers as the lobes emerge from the homogeneous tissue. To explain this differential we reproduce the pressurization of an ideal plant tissue with finite element modeling. This allows us to relate the growth gradient to cell size, cell wall thickness and stiffness as well as pressure differentials within the tissue.
Multiple experiments display no gradient of cell size, pressure nor cell wall thickness at the initiation of the lobes. Osmotic shock experiments on live anthers allow us to plasmolyze their cells, thus removing the turgor pressure. We then reverse-engineer the cell wall stiffness at the cellular scale by modifying it iteratively and simulating the pressurization of the anthers back to their original state. A significant stiffness gradient appears between the epidermis and the inner tissue of a given anther lobe. This work provides insight on how plants control the direction and magnitude of their growth. Thorough measurements of cell size, pressure and cell wall properties seem required to further understand the morphogenesis of plant organs.

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