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PREFACE

Mechanical Forces in Plant Growth and Development

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Various external and internal factors can affect plant growth and development, and mechanical force is one of most essential factors among them. Both the mechanical forces within plant tissues, that is, tensile stress and external mechanical forces, that is, mechanical pressure are considered to influence plant growth and development in various aspects (Bull–Hereñu et al. 2022). Previous classical studies based on the observations of morphogenesis in various plants, particularly of the floral development, have suggested that mechanical forces among floral organs could be an important driving force in changing the floral morphology (reviewed by Ronse De Craene 2018). Classical experimental approaches has also been conducted to examine the effects of applied mechanical pressure on plant organs by fitting molds or the change of internal tensile stress patterns through wounding the plant tissue (e.g. Hernández and Green 1993).

Recent technical and theoretical advances have enabled a more comprehensive analysis of how the mechanical forces affect plant growth and development. Hamant et al. (2008) demonstrated that mechanical forces influence the orientation of microtubules in plant cells, in turn the distribution of tensile stress, by combining live imaging with a confocal microscope and using the finite-element method to model the shoot apical meristem (floral meristem). In this study, they used the laser cell ablation to alter internal stress patterns in the meristem. Louveaux et al. (2016a) adopted the same approach and used a stochastic model explaining the selection of a division plane to demonstrate that mechanical forces also affect the cell division. Beauzamy et al. (2015); Louveaux et al. (2016b) induced mechanical forces on the floral meristem of *Arabidopsis thaliana* using the nano-indentation method and characterized the floral meristem behavior. Milani et al. (2011) established the method to directly measure the tensile stress pattern of epidermal cells in shoot apical meristem, which can be utilized to examine the effects of mechanical forces exerted on the shoot apical meristem.

Given these backgrounds, this special issue of JPR entitled "Mechanical forces in plant growth and development" to revisit the significance of mechanical forces in plant morphogenesis and promote future research. At first, this issue reviews previous studies and introduces recent studies examining the effects of mechanical forces on floral morphology. Ronse De Craene (2024) summarized the floral development in various species, highlighting the importance of mechanical forces in its evolution of angiosperms. Examples illustrating how the interaction between mechanical pressure and heterochrony is responsible for shifts in organ position and the establishment of a novel floral Bauplan are presented and discussed. Thaowetsuwan et al. (2024) elucidated the diversity of floral morphology in the genus *Croton* (Euphorbiaceae) based on the detailed observations and suggested the potential influence of mechanical forces on this diversity. Jerominek and Claßen-Bockhoff (2024) focused on the explosive movement of style in flowers of Marantaceae and investigated its mechanisms driven by internal tensile stress. Iwamoto et al. (2024) developed a novel experimental system to analyze the organ-level effects of mechanical forces on floral development. Using this novel experimental system, they successfully altered the floral development in *A. thaliana* by applying artificial mechanical forces onto floral primordia. While these studies enhance our understanding of the relationship between the mechanical forces and floral morphology, two papers focused on the molecular basis of how mechanical forces influence plant growth and development. Asaoka et al. (2024) conducted three-point bending tests on the inflorescence stem of various *A. thaliana* mutants and revealed the correlation among mechanical properties of whole stem, stem morphology and inner tissue arrangement. Kubota et al. (2024) reviewed the land plant-specific mechanosensitive channels in *A. thaliana*, *mid1*-complementing activity

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1 (MCA1) and its paralog MCA2 including recent findings on them. They discussed the physiological roles of these mechanosensitive channels based on their spatio-temporal expression patterns.

We believe that incorporating recent advanced approaches in plant molecular physiology into the classical analysis of plant morphology represents an interdisciplinary approach in further research aimed at understanding plant growth, development, and evolution.

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