Mechanical stress-induced reorganization of the root stem cell niche of Arabidopsis seedlings cultured *in vitro*

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The mechanical stress is one of the critical signals affecting the root functioning at different levels from individual cells to the whole root system. Many fundamental processes, such as turgor regulation, cell expansion, lateral root organogenesis and tropic responses are controlled and modulated via mechanical forces-mediated signaling pathways (Monshausen and Haswell, 2013). Experiments with mechanical stress locally applied to maize root apices (Potocka et al., 2011) proved a strong impact of a mechanical factor on the cellular organization of the root apical meristem (RAM). In the experiment, root apices were forced to grow through a narrowing that triggered ectopic cell divisions in the quiescent centre (QC) and caused a transformation of the meristem from closed to open. However, due to relatively large QC in this species and to the lack of the cell type-specific marker lines, precise tracking of cell fates within the root meristem is rather difficult.

The objective of the current study was to analyse an impact of continuously applied mechanical stimulus on the root meristem of the model plant *Arabidopsis thaliana*. The highly organized RAM of Arabidopsis contains the stem cell niche, comprising four rarely dividing quiescent centre cells surrounded by mitotically active initial cells for the different tissues (Dolan et al., 1993). To mimic the natural soil conditions in experimental assay and to cause mechanical perturbation during root growth, seedlings of wild type and chosen transgenic lines were cultured *in vitro* in tubes filled with granulated agar medium. Confocal microscopic examination of roots stained with propidium iodide showed changes in the organization of the RAM. The most significant findings were: an increased mitotic activity of the quiescent centre cells, atypical divisions of the initials and irregular arrangement of cells in the root cap columella. In our study, the differentiation status of distal stem cells (columella initials) was monitored with the J2341 enhancer trap line and Lugol staining method. Moreover, an analysis of DR5rev::GFP and DR5::GUS reporters revealed changes in auxin distribution in root tips of mechanically stimulated seedlings. An attempt was also made to find out if the cell wall chemical components might be involved in the mechanosensing processes and the maintenance of the root stem cell niche.

The obtained results allow drawing the following conclusions: the external mechanical stress disturbs the precisely specified cell division pattern of the RAM and alters auxin distribution in the region. The results are analysed and discussed in reference to the ability of stem cell niche to adapt to stressful environmental conditions, in this case to the mechanical impedance of the medium.

References

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