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Ethylene assists auxin in the regulation of root cap renewal in *Arabidopsis thaliana* L.

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Motivation and Aim: In plants, a root cap (RC) is an extraordinary organ, which continuously grows while maintaining a constant size. The tissue size homeostasis is due to a synchronization of columella stem cell proliferation and cell detachment at the periphery of RC, and it is essential for the root functioning. Auxin gradient in the RC is a key regulator, which couples the two processes. It is assumed that cell division occurs at an auxin maximum, and detachment – at a minimum [1]. However, the mechanisms of how auxin coordinates the two processes are unknown. Here we accomplish *in vivo* and *in silico* analysis of root cap self-renewal in *Arabidopsis thaliana* to get a new insight into the underlying mechanisms.

Methods and Algorithms: For *in silico* analysis, we developed a hybrid 1D model of auxin-regulated cell dynamics in columella, which implements "division at a maximum – detachment at a minimum" concept [2]. Confocal and light microscopy techniques were used to estimate RC cell dynamics *in vivo*.

Results: To formally describe RC cell dynamics observed both *in planta* and in a computer simulation, we used easily detectable structural parameters: the number of attached/detached/total RC cell layers. Comparing the results of *in vivo* experiments and mathematical modeling, we found that the model properly describes RC cell dynamics only under normal conditions but not under auxin excess, implying that "division at a maximum – detachment at a minimum" concept needs a refinement. A plant hormone ethylene is an essential regulator of root development, wherein the two hormones are known to reciprocally regulate each other's activity [3]. Using 1-aminocyclopropane-1-carboxylic acid (ACC) treatment and a mutant assay, we demonstrated that alterations of both ethylene production and signaling affect root cap dynamics *in planta*. Next, utilizing mathematical modeling, we predicted that simultaneous fine-tuning of auxin effect on cell growth and division could provide for ethylene-related RC phenotypes. Finally, the combined results of *in vivo* and *in silico* analyses of auxin response in mutants deficient in ethylene signaling supported the role of ethylene in auxin-mediated regulation of RC cell dynamics.

Conclusion: Taken together, our results demonstrate that ethylene assists auxin in the regulation of root cap renewal in *Arabidopsis thaliana*.

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