How plant hormones control root growth

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Plant roots can grow without limit. To do so, they need to balance the production of new cells via cell division and elongation. Plant hormones known as brassinosteroids play a key role in this balancing act. New work by the team of Dr. Jenny Russinova (VIB-UGent Center for Plant Systems Biology) unravels how brassinosteroid production is localized in plant roots for optimal growth patterns. Their study is published in the

journal *Nature Plants*.

Plant hormones

Plant roots explore soil in a never-ending search for water and nutrients. Unlike leaves and other plant organs, roots are capable of unlimited growth which allows them to expand and cover vast regions of the plant's underground environment.

At the very tip of the root, a group of dividing cells constantly provides fresh cells, which pushes the root tip forward in the process and enables root growth. Several molecular players that control the balance between cell division and elongation have been identified, including small peptides, reactive oxygen species, and plant hormones—auxin and cytokinin.

Another group of plant hormones, brassinosteroids, plays an important role in balancing cell division and elongation rates during root growth. The signaling cascade which is initiated by this hormone is particularly active in the root elongation zone, but how brassinosteroid signaling is triggered specifically in this region remained unknown.

Dr. Jenny Russinova (VIB-UGent): "Because brassinosteroid hormones play a role in plant stress tolerance, the tools generated in this work will permit monitoring brassinosteroid hormone distribution in response to different biotic and abiotic stresses. Thus, our observation will have a large impact on our understanding of plant performance under climate change scenarios."

Dr. Nemanja Vukašinović and Yaowei Wang, under the supervision of Dr. Jenny Russinova, from the VIB-UGent Center for Plant Systems Biology discovered that the level of brassinosteroid signaling in different root zones of the model plant Arabidopsis thaliana is controlled by

locally restricted synthesis of the hormone itself.

Localized hormone production

By using conventional confocal microscopy, as well as a custom-made spinning disk microscope for vertical plant growth in the Fendrych lab in Prague (Czech Republic), Nemanja Vukašinović, Yaowei Wang, and colleagues were able to demonstrate how plants, by controlling expression levels of brassinosteroid biosynthetic enzymes, can restrict the domain of hormone production.

Dr. Nemanja Vukasinovic (VIB-UGent Center for Plant Systems Biology): "Our research revolved around the fact that brassinosteroids are hydrophobic compounds and as such are unlikely to be highly mobile within the plant tissues. We reasoned that it would make sense to study localization patterns of brassinosteroid biosynthetic enzymes to examine how the hormone is distributed. It turned out that this was a good idea since those patterns revealed increased enzyme expression levels in the elongation zone. That was the main discovery around which we built all other experiments."

Finally, by directly measuring hormone levels in collaboration with the Strnad lab in Olomouc (Czech Republic), the researchers confirmed that brassinosteroid levels are kept at low levels in proliferating cells at the tip, while higher hormone concentrations are produced in the root elongation zone.

More information: Local brassinosteroid biosynthesis enables optimal root growth. *Nature Plants*. DOI: 10.1038/s41477-021-00917-x

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