Knowing how cells grow and divide can lead to more robust and productive plants

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A large portion of a plant is hidden below the ground. This buried root system is essential for the plant: it provides stability, water, and food. In contrast to mammals, where the body plan is final at birth, the formation

of new root branches ensures that the root system keeps growing throughout a plant's life. The labs of Prof. Ive De Smet and Prof. Tom Beeckman (VIB-UGent Center for Plant Systems Biology), together with researchers from the University of Nottingham (UK), Heidelberg University (Germany) and the University of Copenhagen (Denmark) identified a novel component that controls the development of root branches supporting plants. Their findings will be published this week in the journal *Proceedings of the National Academy of Sciences* of the United States of America.

Prof. Ive De Smet and his team investigate how plants deal with changing environments, specifically with temperature extremes and drought stress. Prof. Tom Beeckman and his team explore how (lateral) roots evolved and develop. In plants, new organs are formed all the time. To do this, there must be a tight regulation of when and where a new organ is formed, and of how the cells that will make up this organ need to grow and divide.

To investigate organ formation in plants, the researchers used root branching as a model system. This process occurs continuously along the growing root, endlessly increasing the root system, and requires an extremely fine-tuned coordination of asymmetric cell divisions in cells that can give rise to new roots, together with the synchronization of processes in surrounding tissues. This ensures that the roots grow in the best possible way to take advantage of the nutrients and water in the soil.

Dr. Ramakrishna (University of Nottingham), who is the first author of the study, explains how the team discovered a new component through which plants control this: "To identify novel factors involved in governing root branching, we explored which genes are expressed during the early stages of the process. This led to the identification of a cell wall modifying enzyme – a molecule that regulates chemical reactions – that controls the cell divisions leading to the growth of a new root. Mutations

in the gene that codes for this enzyme led to swelling of root cells that give rise to a new lateral root and resulted in subsequent defects in the first asymmetric cell divisions during the formation of root branches."

These results show that a very tight regulation of cell size impacts the position of cell divisions, and thus the location and growth of new root branches. The identification of a cell wall enzyme acting in the extracellular space mediating plant stem cell divisions suggests we need to take into account a much broader range of proteins in our future search to disentangle the process of root branching.

Prof. Tom Beeckman (VIB-UGent) adds: "Identifying this enzyme is only a first step. The next challenge is to unravel how these cell wall modifications control cell size and how this is coordinated with other molecular processes during root branching."

Prof. Ive De Smet (VIB-UGent) continues: "Ultimately, we strive to understand how plants respond to their ever-changing environment. Improving root architecture can contribute to stabilization of plant yield under adverse environmental conditions."

This study, and the new research avenues it opens up, could lead to innovative techniques to improve root architecture in favor of higher crop yields and plants more resistant to drought and nutrient stress.

More information: Priya Ramakrishna et al. EXPANSIN A1-mediated radial swelling of pericycle cells positions anticlinal cell divisions during lateral root initiation, *Proceedings of the National Academy of Sciences* (2019). DOI: 10.1073/pnas.1820882116

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