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KEY REGULATOR OF PLANT ROOT GROWTH IDENTIFIED

New technology for enhancing root hair growth and nutrient uptake

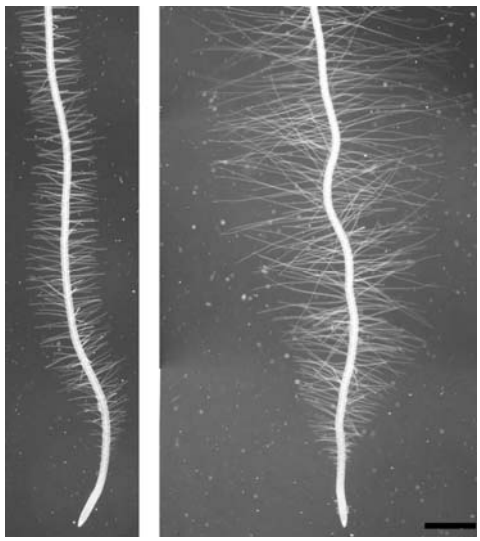
In a paper published on-line this month in *Nature Genetics*, Keke et al demonstrate that a gene called RSL4 is the master regulator of root hair growth. Root hairs are vital for nutrient uptake from the soil and are critical to allow the roots of young seedlings penetrate the soil at germination.

RSL proteins are basic helix loop helix transcription factors that positively regulate the formation of root hairs. RSL proteins are highly conserved across all land plants including all the major crop species.

By imaging GFP-tagged versions of the protein, the group of Professor Liam Dolan at the John Innes Centre (Norwich, UK) discovered that root hair growth occurs when RSL4 is present in the cell and as soon as RSL4 disappears, growth ceases. This suggests that the presence of RSL4 in a cell is sufficient to program the growth of hair cells.

If RSL4 is sufficient for growth the authors assumed that prolonged production of RSL4 in root hairs would increase the size of root hairs.

Indeed, constitutive expression of RSL4 results in constitutive root hair growth. Constitutive expression results in the continuous growth of root hairs.



Constitutive expression of RSL4 results in dramatic increase in root hair length (right) compared to wild type (left)

The hairs that develop on roots of cells that constitutively express RSL4 can be between up to 4 times the length of wild type hairs.

Keke et al then went on to determine the role of RSL4 in the response to nutrient stress. A variety of environmental stresses modulate growth and size of root hairs. For example, low phosphate availability in the soil induces the formation of longer root hairs than on plants grown in the presence of adequate phosphate. This is an adaptive response to stress since the growth of root hairs allows plants to mine a greater volume of soil and increase the chances of acquiring sufficient phosphate for growth.

As expected, low phosphate stress induces RSL4 and mutants that lack RSL4 function cannot respond to phosphate stress indicating that RSL4 programs cell growth during the phosphate stress response.

"We discovered Nature's way of controlling root hair growth. If you want root hair growth to occur you turn on RSL4; when you have had enough growth you turn it off" says Professor Liam Dolan the leader of the team that discovered RSL4.

These data indicate that RSL4 is a master regulator of hair growth – if RSL4 is present then growth occurs and if it is not then root hair growth ceases. This provides the perfect tool to modulate root hairs in crops.

Unpublished data from the Dolan laboratory (now at The University of Oxford) confirms that RSL genes control the development of hairs in a wide range of crops including rice, wheat and brassicas. Modulating the expression of RSL4 will allow the modulation of the growth of root hairs at will.

The expectation is that these plants will have enhanced phosphate and iron uptake under normal conditions and potassium and nitrate uptake under water stressed conditions.

The RSL technology is the subject of pending patent applications filed by PBL, the technology transfer company of the John Innes Centre.

Literature:

Keke Yi, Benoît Menand, Elizabeth Bell and Liam Dolan (2010). A basic helix-loop-helix transcription factor controls cell growth and size in root hairs. *NATURE GENETICS* published online 7 Feb 2010.

Menand, Yi, Jouannic, Hoffman, Ryan, Linstead, Schaefer and Dolan (2007). An Ancient Mechanism Controls the Development of Cells with a Rooting Function in Land Plants. *SCIENCE,* 316 (5830): 1477-1480.

About PBL:

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