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How thirsty roots go in search of water

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Credit: University of Nottingham

Scientists from the University of Nottingham, England and Tohoku University, Japan have helped to solve a mystery that has fascinated scientists since Charles Darwin - how plant roots sense water and change direction to find it. In a world where water for agriculture is becoming a global challenge this could lead to improved crop varieties which are better at foraging for water.

Their research - 'Root hydrotropism is controlled via a cortex-specific growth mechanism' - sheds new light on which part of the root perceives a water signal, and which tissues then change their growth to make the root change direction. Their findings have been published in *Nature Plants*.

Lead researcher, Dr Daniela Dietrich from the School of Biosciences at Nottingham, said: "Even when most of the root tip was removed by laser or scalpel, roots of the model plant Arabidopsis thaliana still responded to a water gradient in the medium they were growing on. This showed that hydrotropism - the way in which plant roots respond to moisture content of soil - depends on perception and response in the elongation zone, a rapidly growing area of the root just behind the tip."

So, how do plants search for water?

Hydrotropism is less well understood than responses to other environmental cues such as gravity, light or touch.

A group of cells at the tip of the root, known as the columella, are used to sense gravity, and the researchers wanted to know whether the same cells were involved in sensing water. Using laser ablation, which can destroy cells with pinpoint accuracy, they showed that columella cells are not necessary for hydrotropism.

They also wanted to understand if hydrotropism requires the response of a specific root tissue. The plant hormone Abscisic Acid (ABA) is key to the molecular signalling pathway for hydrotropism, as is a gene called MIZ1. By taking mutants in which key components of this signalling cascade for hydrotropism were missing, and then inducing the expression of those same key components in specific tissue layers only, the researchers were able to demonstrate that the cortex, the tissue layer directly below the epidermis, is where root growth changes in response to water perception.

Dr Daniela Dietrich, the study's lead researcher at the University of Nottingham, said: "We were surprised to see that in both cases, expression in the cortex was able to rescue the hydrotropism response. For the gravitropic response, which involves auxin, the epidermis is important, so it is quite interesting to see that these two environmental responses are controlled by different plant hormones, acting on different root tissues."

The researchers also used mathematical modelling to see whether growth changes in the cortex tissue layer alone are enough to change the direction of the root. When an existing model was adapted so that only cortex cells on one side of the root started to elongate earlier, the changes in root tip direction predicted by the model were reflected in the plant experiments.

More information: Daniela Dietrich et al. Root hydrotropism is controlled via a cortex-specific growth mechanism, *Nature Plants* (2017). DOI: 10.1038/nplants.2017.57

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