Sensor important to understanding root, seedling development

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Marshall Porterfield, at left, and Angus Murphy will be able to better understand how the plant hormone auxin regulates plant root growth and seedling establishment with a biosensor developed at Purdue University. Credit: Purdue Agricultural Communication photo/Tom Campbell

A biosensor utilizing black platinum and carbon nanotubes developed at Purdue University will help give scientists a better understanding of how the plant hormone auxin regulates root growth and seedling establishment.

Marshall Porterfield, an associate professor of agricultural and biological engineering and biomedical engineering, created a new sensor to detect the movement of auxin along a plant's root surface in real time without damaging the plants.

The nanomaterials at the sensor's tip react with auxin and create an electrical signal that can be measured to determine the auxin concentration at a single point. The sensor oscillates, taking concentration readings at different points around a plant root. An algorithm then determines whether auxin is being released or taken in by surrounding cells.

"It is the equilibrium and transport dynamics that are important with auxin," said Porterfield, whose findings were published in the early online version of *The Plant Journal*.

A current focus of auxin research is understanding how this hormone regulates root growth in plants growing on sub-optimal soils. Angus Murphy, a Purdue professor of horticulture and the paper's co-author, said that worldwide pressure on land for food and energy crops drives efforts to better understand how plant roots adapt to marginal soils. Auxin is one of the major hormones involved in that adaptive growth.

"It's the key effector of these processes," Murphy said.

Although sensors using similar nanomaterials have been in use for real-time measurement of auxin levels along a root surface for several years, those earlier sensors required application of external auxin at toxic levels as part of the measurement process. Porterfield and Eric McLamore, a former Purdue postdoctoral researcher, created a new algorithm to decode the information obtained from the sensor. The algorithm processes the sensor information to show whether the hormone is moving into or out of cells. This allows the sensor to be self-referencing, eliminates the need for auxin application, and allows instantaneous and continuous measurements to be made during root growth.

Other current methods based on radioisotope tracers and auxin-responsive fluorescent proteins inserted into the plant can detect changes taking place over hours. Most auxin responses take place on a timescale of minutes.

Murphy said auxin movement is key to how plants adapt to their environments. He said that the effort to develop the sensor with Porterfield originated with the need to improve real-time measurement capability and develop a method that allows comparison with other measurements to better understand how auxin transport and other biological functions are connected.

"Using sensors like this, we can get answers that just aren't possible with existing tools," Murphy said. "Being able to measure the efflux and uptake simultaneously is really essential to a lot of ongoing work."

Murphy and Porterfield were looking for a simple model to use to test the sensor and chose an auxin transport mutant in corn. Wendy Peer, a Purdue assistant professor of horticulture and a paper co-author who studies seedling development and establishment, collaborated with Murphy in a detailed analysis of auxin transport in mutant and control corn roots using traditional methods. The information was then used to validate the sensor's functionality.

Murphy plans to continue testing on other auxin-related mutants. The National Science Foundation and the U. S. Department of Energy funded the research.

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