3-D time-lapse imaging captures twisted plant root mechanics for first time (w/ Video)

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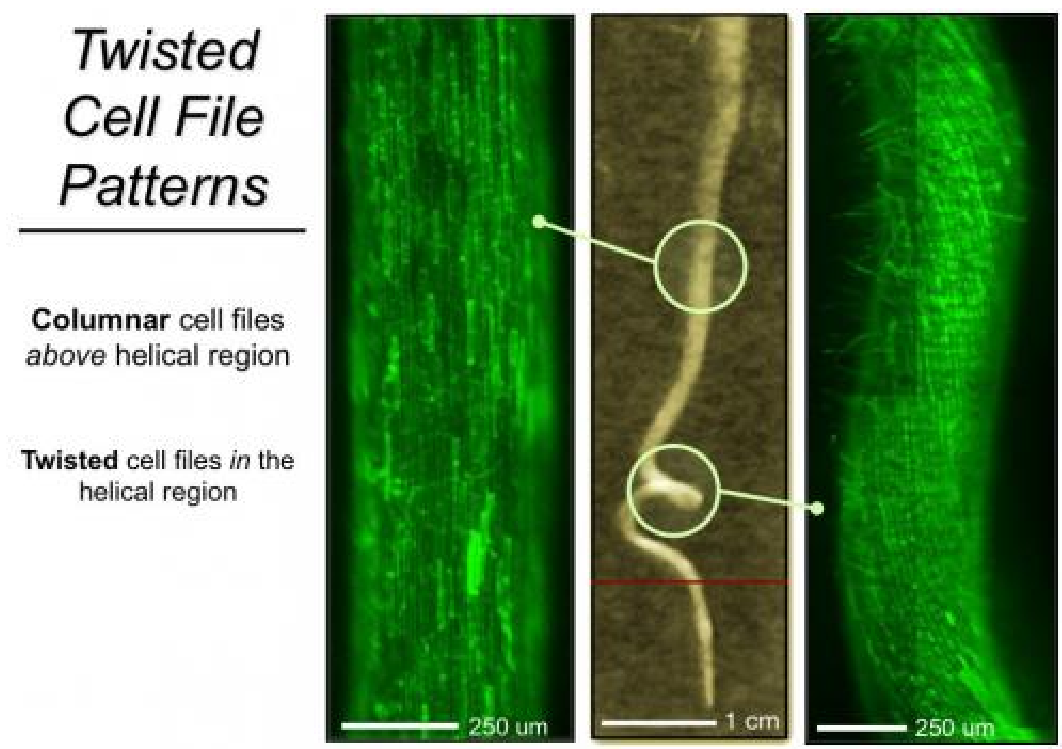

Credit: Vasyl Kacapyr

Using an advanced 3-D time-lapse imaging system, a group of physicists and plant biologists from Cornell University and the Boyce Thompson Institute for Plant Research have discovered how certain plant roots exhibit powerful mechanical abilities while navigating their environment.

The research, published in this week's online Early Edition of Proceedings of the National Academy of Sciences, could eventually assist in breeding crop plants optimized for growth in areas where climate change or over farming has led to difficult soil conditions.

The researchers grew *Medicago truncatula* plants in a transparent gel consisting of two layers – a soft, top layer and a stiff, lower layer. The roots grew straight down until reaching the lower layer, where they began to twist and buckle into spring-like shapes, much like a string begins to curl if it's continuously twisted in one direction.

Combining 3-D movies with measurements and mathematical modeling, the research sheds new light on root growth revealing the role mechanics plays in determining the root shapes. Ultimately, this led to a previously unknown connection between root geometry, growth, and force generation.

"When the roots hit the stiff barrier, growth causes them to buckle like a wire or rod that's been compressed. But by twisting, the buckled roots become helical, allowing the root to push off more gel and get more force at the tip," said Jesse Silverberg, a Cornell graduate student in the Department of Physics and lead researcher for the study.

"Suppose the plant is growing along and finds itself stuck at a layer of clay or tough clump of soil. The root needs an extra force to push through these barriers, and the mathematical model tells us how large of a helix the root needs to grow to do just that. Roughly, the stiffer the barrier, the larger the helix," said Silverberg.

The researchers also used the 3-D technology to discover that 74 percent of the plant roots twisted in a counter-clockwise manner. Silverberg says further research may reveal similar behavior in other plant species.

More information: 3D imaging and mechanical modeling of helical buckling in Medicago truncatula plant roots, *PNAS*, 2012. www.pnas.org/cgi/doi/10.1073/pnas.1209287109

Provided by Cornell University