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Helical Root Buckling: A Transient Mechanism for Stiff Interface Penetration JESSE SILVERBERG, Department of Physics, Cornell University, ROSLYN NOAR, UNCSU, Dept of Plant Pathology, MICHAEL PACKER, Department of Physics, Cornell University, MARIA HARRISON, Boyce Thompson Institute, Cornell University, ITAI COHEN, CHRIS HENLEY, Department of Physics, Cornell University, SHARON GERBODE, School of Engineering and Applied Sciences, Harvard University — Tilling in agriculture is commonly used to loosen the topmost layer of soil and promote healthy plant growth. As roots navigate this mechanically heterogeneous environment, they encounter interfaces between the compliant soil and the underlying compacted soil. Inspired by this problem, we used 3D time-lapse imaging of Medicago Truncatula plants to study root growth in two-layered transparent hydrogels. The layers are mechanically distinct; the top layer is more compliant than the bottom. We observe that the roots form a transient helical structure as they attempt to penetrate the bi-layer interface. Interpreting this phenotype as a form of buckling due to root elongation, we measured the helix size as a function of the surrounding gel modulus. Our measurements show that by twisting the root tip during growth, the helical structure recruits the surrounding medium for an enhanced penetration force allowing the plants access to the lower layer of gel.

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