Influence of the root-soil mechanical interaction on the variability of root architecture

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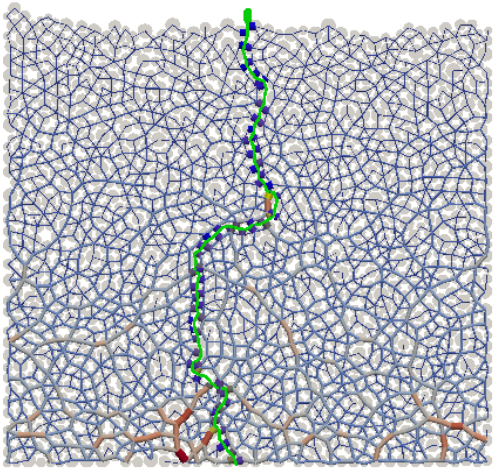
ABSTRACT

The phenotypic variability of root architecture is only partially explained by the genotype and the environment [1]. It has been advanced that much of this variability is related to the developmental instability of meristems, a consequence of stochasticity at the cellular level. In this work, we investigate the effect of soil disorder at the particle scale on root variability by means of a numerical model based on Discrete Element Method (DEM) [2]. The architecture of the root system growing in a granular medium is influenced by the mechanical feedback between the roots and the surrounding grains. The simulations allow us to characterize the reorganization of the grains under the action of a growing root system, and the effect of resulting forces acting on the root development (elongation rate, branching...). These interactions will be quantified using methods and tools provided by the physics of granular media.

The root system is modelled using chains of connected spheroline elements. At beginning, a first element is fixed at the top surface of the granular packing. Starting from the bottom end of this element, a new element is introduced and a growth rate is applied until a characteristic length is reached. A new element is then added and the process is iteratively repeated. We performed a parametric study in which we vary the different parameters that control the root growth (elongation rate, elastic modulus, bending moment between root elements...) and different parameters pertaining to the granular soil. Finally, simulation results will be compared with experimental data provided by a genotypic platform (CIRAD Rhizoscope) allowing roots growing in ballotini [3].



DEM simulation of root growth

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