

Rosom - Influence of mechanical root-soil interactions on the variability of root architecture

OBJECTIFS

The main objective of this project was to understand and quantify the mechanical feedback between growing roots and a deformable granular substrate through a transformative interdisciplinary approach based on physics of granular materials. The methodology was built on 1- experiments of root growth in glass beads (ballotini) of different sizes carried out in the Rhizoscope platform available in CIRAD, Montpellier; 2- Discrete Element Modelling (DEM) that will consider growing wire inclusions in a granular structure.

RESULTATS

Experimental data:

Four different plant species, i.e. rice, pea, eucalyptus and date palm tree, were grown in hydroponic conditions within glass beads of different sizes (1mm and 5mm in diameter). Growth was followed recording pictures at different times for about 1 month. Variability of root shapes was then analysed with regards to the granular medium structure (see Fig. 1).

Development of a root analysis software :

Covering polygons were used to evaluate form features or to classify the growth strategy of root systems. The root system density was quantified through the analysis of hole distribution provided by the decomposition of background regions in circular elements (see Fig. 2).

Development of a DEM of root growth:

The model was developed in 2D using the Molecular Dynamics method. It allowed grain-grain and grain-root tip forces to be quantified during root growth. Force spectra and root flexuosity were analysed with regards to root mechanical properties and granular structure. They exhibited general trends that provided analytical mechanoperception equations. Estimating these forces gives useful information to quantify the biomechanical response of roots. Figure 2 : a- root analysing tool GT-Roots allows estimating space occupation; b- simulated force chains representing the intensity of mechanical contacts; c- example of force spectra calculated at root tip during growth.

PERSPECTIVES

The following steps of this project will be to 1- design an experience that will be closer to the developed 2D model for validation; 2- add branching processes in the growth model; 3- compare experimental and simulated root tortuosities; 4- analyse Rhizoscope data with regards to the force signal estimated with the model.

Responsable :

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