Root2Res
Root phenotyping and genetic improvement for rotational crops resilient to environmental change

Practice Abstract

Models of the rhizosphere

Problem

Breeding crops that are resilient to abiotic stresses is challenging because of the complexity of root traits. Mathematical models could be used to address this issue.

Solution

Using genotypic and environmental data, models can be developed that not only show the growth of the root systems but also the modification of the soil environment resulting from biological activity.

Benefits

These models can predict the ability of some genotypes to withstand an abiotic stress more accurately, for example, the capacity of root systems to retain water in the soil during dry periods.

Applicability box

Theme: Resistance to abiotic stress

Keywords: Mathematical modelling, exudation, microbiome, soil, water uptake, rhizosphere

Context: Predict performance of crop ideotypes

Application time: All year

Required time: 1-year software development for introduction in crop model platform (e.g. aquacrop, Apsim)

Period of impact: 5 years

Equipment: Computer

Best in: All cropping systems where data is available to calibrate a model

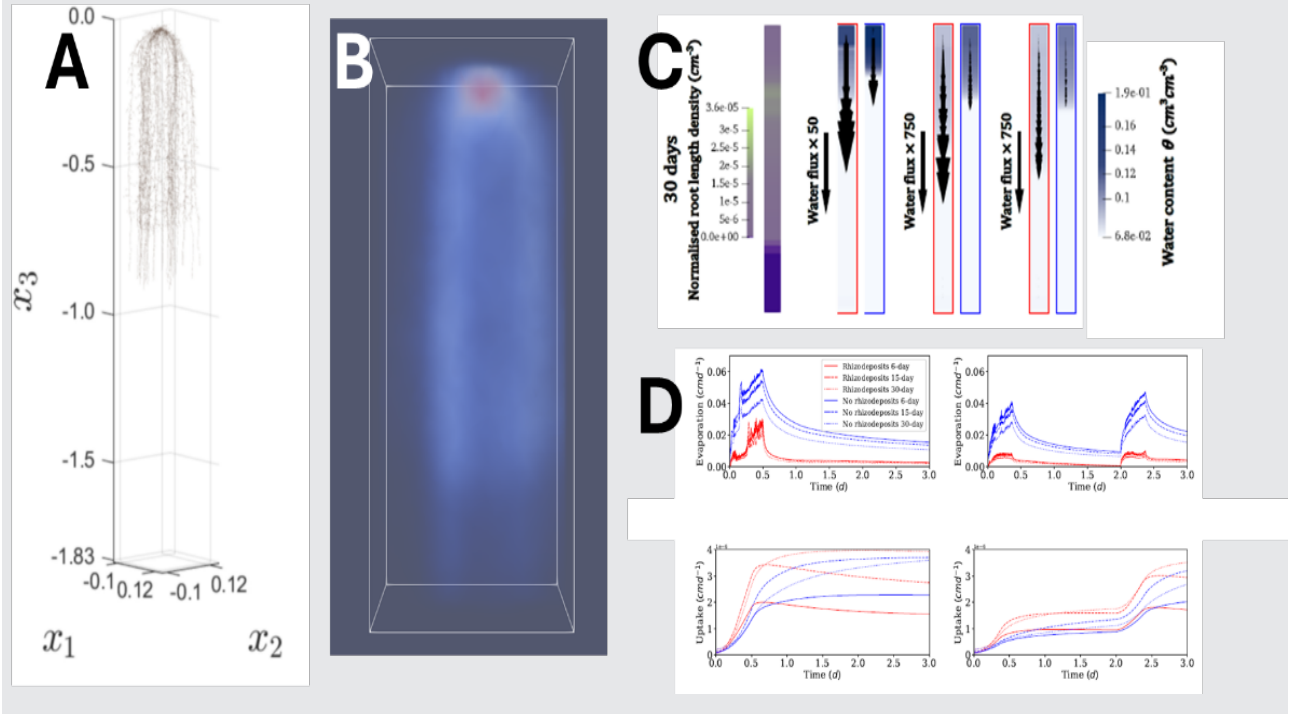

Figure 1: Use of rhizo-sphere models. (A) Root system architecture derived from CRootBox software. (B) prediction of root exudate distri-bution. (D) Simulation of the dynamics of wa-ter in soil. (D) Scenarios testing the effect of exudates on water uptake.

Practical recommendations

- Simulate root systems growth using a root system architecture model (Figure 1A).
- Use experimental data to predict rhizodeposits distribution around plant roots (Figure 1B).
- Determine changes in soil properties such as water retention, hydraulic conductivity or microbial activity.
- Use root uptake and transport equations to determine resource acquisition by the plant (Figure 1C.)
- Use simulations to analyse different scenarios of how crop ideotypes (root architecture, exudation types) affect the performance of a crop under different soil and climatic conditions (Figure 1D).
- The application of the models requires modifications to the crop simulation platforms used by professionals to adjust crop management (e.g. irrigation, fertiliser application, etc.).
- The main difficulty is obtaining data on the crop genotypes to calibrate the models to reliably predict the performance of different rooting traits.

Further information

- Mair, Andrew, Emma Gomez, ,Mariya Ptashnyk and Lionel Dupuy. “Modelling the influ-ence of rhizodeposits on root water upt ke”. BioRXiv
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- Mair, Andrew, Lionel X. Dupuy, and Mariya Ptashnyk. "Model predicts the impact of root system architecture on soil water infiltration." BioRxiv (2021): 2021-07.

About this practice abstract and Root2Resilience

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Root2Resilience: The project is running from September 2022 to August 2027. The overall goal of Root2Resilience – Root phenotyping and genetic improvement for rotational crops resilient to environmental change – is to develop root phenotyping, genetic and modelling tools and use them to define and test innovative genotype ideotypes able to enhance the tolerance to abiotic stress and carbon sequestration in soils

Project website: root2res.eu

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