Dynamic analysis of root architecture in sugar beet (*Beta vulgaris*) using an aeroponics phenotyping platform

Desmet, F.[1], Legrand, G.[2], Wauters, A.[2], Draye, X.[1]
[1] Université catholique de Louvain (UCL), Earth & Life Institute-Agronomy (ELIA), Place Croix du Sud, 2 - L7.05.01 – B 1348 Louvain-La-Neuve
[2] IRBAB-KBIVB, Molenstraat. 45 – B 3300 Tienen-Tirlemont, Belgium

Introduction

The morphology and development of the root system influence the field performance of crop plants. However, the difficulty to capture root information restricts our understanding of root shape and function. Aeroponics and rhizotrons infrastructures allow the quantification of morphological and functional root traits in non-invasive and dynamic ways. Recently, the value of aeroponics has been proven to characterize elongation rates, emergence kinetics and root branching of thousands of cereal plants.

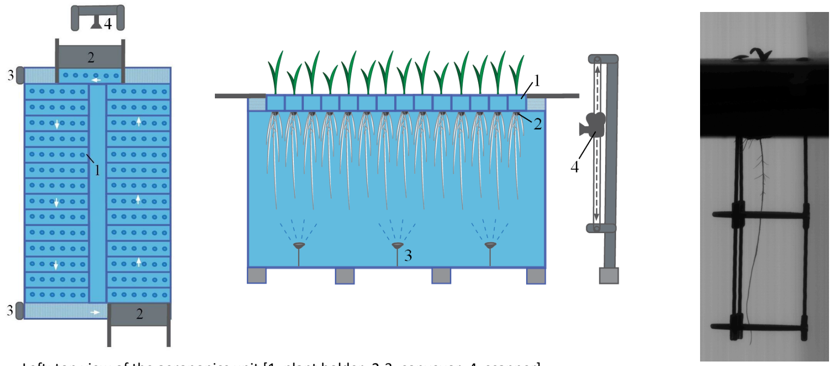
Objective

The objective of our study is to adapt the aeroponics and rhizotrons systems to sugar beet (*Beta vulgaris*) and to validate these techniques with the comparison of nematode tolerant and sensitive varieties. Indeed, it has been proposed that root growth dynamics may be a component of nematode resistance.

Aeroponics

The UCL aeroponics platform is a fully automated infrastructure that allows the monitoring of growth dynamics of 1,000 whole plants with a time resolution of 2 hours and a spatial resolution of 700 DPI. The dedicated software "Aeroscan" allows the reconstruction of root growth trajectories and the estimation of emergence dynamics and individual root growth rate.

- **+** : High throughput, high resolution method
- **-** : Highly artificial environment

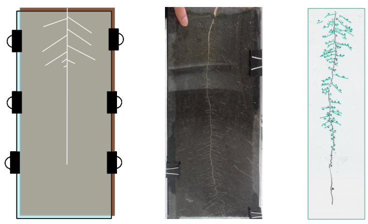


Left: top view of the aeroponics unit [1. plant holder; 2-3. conveyor; 4. scanner]
Center: side view of the aeroponics unit [1. plant holder; 2. rockwool plug; 3. nozzle; 4. scanner]
Right: illustration of a 7-day old sugar beet seedling.

Rhizotrons

A rhizotron consists of a thin soil container, assembled with a plywood plate on the back side and a plexiglas on the front side. Roots are visible at the soil-plexiglas interface and their trajectories are copied manually using acetate sheets that can be scanned into digital images. Software such as "SmartRoot" enable the extraction of meaningful quantitative information.

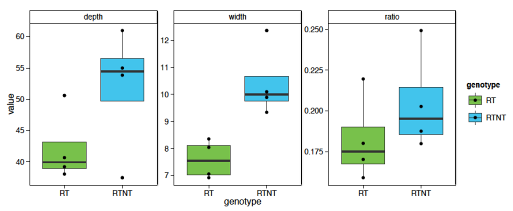
- **+** : Growth conditions close to field conditions
- **-** : Low throughput method



Left: rhizotron schema (80 x 20 x 0.3 cm)
Center: picture of a 3-week old sugar beet root system
Right: manual tracing on acetate sheet, ready for digitizing

Results

The quantification of root system shape from rhizotron images indicates that the root system of the nematode tolerant variety displays a higher growth rate than that of the nematode sensitive variety. This growth difference results in extended depth and width, but has no effect on non-dimensional shape indicators.



Conclusions and perspectives

These preliminary results suggest that nematode sensitive and tolerant varieties differ in their speed of soil exploration from early growth stages. The resulting effect on soil exploration during the crop cycle will be modelled using 3D growth models and analyzed with records of nematode abundance along the soil profile.

Because these effects are manifested early, the aeroponics facility will be further evaluated given its potential for breeding purpose.

References - Ligeza A. and al. 2011 , Aeroponics as a tool for high throughput phenotyping « plant phenotyping workshop » Juelich Germany

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