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# A phenotyping procedure for imaging root hairs on whole root system reveals responses to nutrient availability and to inoculation with PGPR-like bacteria

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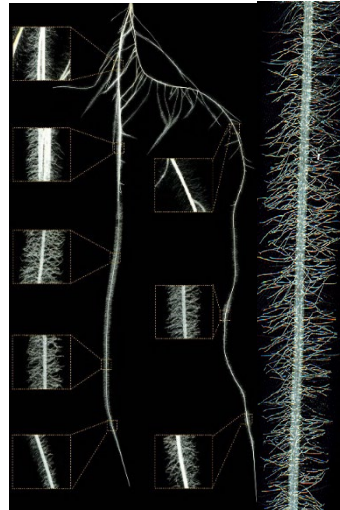
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## Introduction

Breeding new cultivars allowing to reduce the ecological costs of conventional agriculture, including fertilization and irrigation, is a major objective of the research in plant sciences [1]. Root hairs at the root-soil interface provide a major contribution to nutrient and water uptake [2]. Different methodologies for root architecture phenotyping have been described in the literature and implemented on different platforms at the international level [3]. However, these methodologies generally do not take into account the development of root hair zones at the root surface, in particular because of the small size of root hairs, which makes them difficult to distinguish

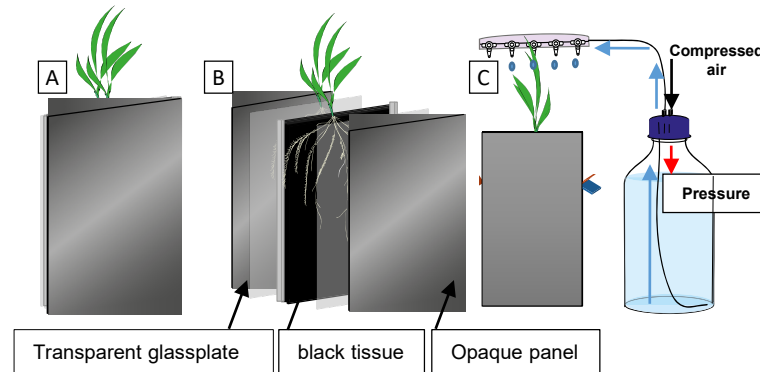
### Our objectives are :

- To develop a methodology for phenotyping root development and elongation of root hairs.
- To investigate the effect of abiotic (water and nutrient availability) and biotic (inoculation with bacterial strains) treatments on wheat (cv. Oued Zenati) root hair development .



## The methodologies developed

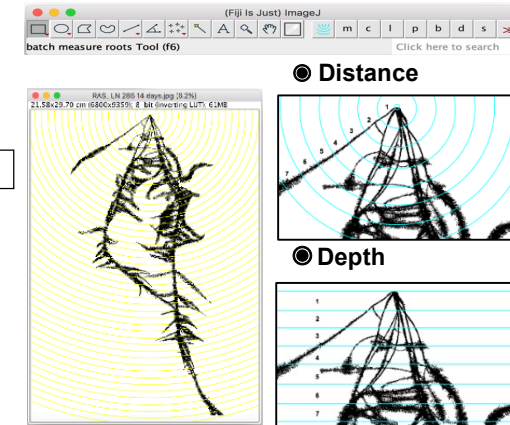
### A- Root hair phenotyping system ( Rhizobox-like system)



- A: Front view of rhizobox
- B: Vertical distribution of rhizobox components
- C: The rhizobox system and the irrigation system

The rhizobox is scanned periodically with high resolution scanner

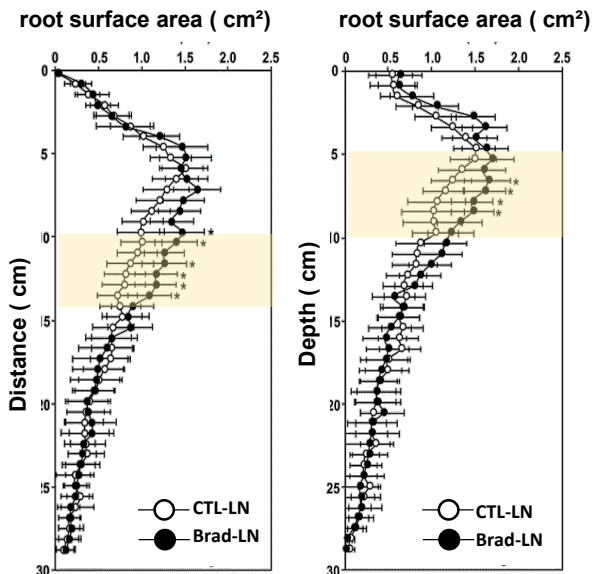
### B- A developed program to analyse root surface area



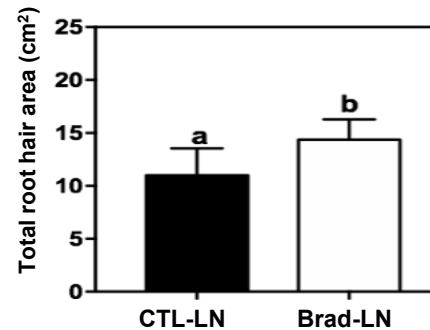
Analyze Complex Root Tool (ACRT) program<sup>4</sup>

## Wheat root and root hair response to low N with or without inoculation with PGPR-like bacteria

### C- Root area analysed per distance and depth using ACRT program



### D- Root and root hair surface area analysed using winRHIZO™ software



## Results

Inoculation with PGPR bacteria resulted an increase in total root hair surface area

## Conclusion and perspectives

The developed methodology allows for instance to reveal root hair developmental responses to low N inoculated *versus* low N non inoculated conditions. The results obtained indicate that *Bradyrhizobium japonicum* ORS285 strain can interact with the wheat cultivar (Oued Zenati) by increasing the root hair surface area.

Such analyses pave the way to screenings of collections of microorganisms (PGPR) in different abiotic conditions (nutrient availability) and to comparisons between wheat genotypes recapitulating wheat domestication in term of root and root hair responses to abiotic stress and efficient interaction with PGPR bacteria.

### References :

- [1] J.P. Lynch (2007) Roots of the Second Green Revolution. Aust. J. Bot. 55: 493–512
- [2] T. Rongsawat *et al.* (2020) Looking for root hairs to overcome poor soils. Trends Plant Sci. 26: 83-94
- [3] J.A. Atkinson *et al.* (2019) Uncovering the hidden half of plants using new advances in root phenotyping. Curr Opin Biotechnol. 55: 1-8
- [4] V.Baecker, [https://github.com/MontpellierRessourcesImagerie/imagej\\_macros\\_and\\_scripts/wiki/Analyze\\_Complex\\_Roots\\_Tool](https://github.com/MontpellierRessourcesImagerie/imagej_macros_and_scripts/wiki/Analyze_Complex_Roots_Tool)