

**M1 or M2 internship proposal (2023)**

***phenotyping of rhizosphere traits on different wheat genotypes: experiments on early stages***

Key words: phenotyping, biological traits, soft wheat, rhizosphere, mucilage, experiments, water deficit.

|  |  |
| --- | --- |
| **The laboratory** | |
| Unit | **UMR 1114 EMMAH :** Environnement Méditerranéen et Modélisation des Agro-Hydrosystèmes (SWIFT team) : <http://www.umr-emmah.fr/> |
| EMMAH unit and SWIFT team | The **EMMAH** joint research unit is developing research on the interactions between crops and water resources under the influence of climate change, particularly water deficit. In this context, the **SWIFT** team is working on characterizing water transfers in the soil and soil-plant interactions through the rhizosphere, in relation to resistance to water deficit. |
| **The internship** | |
| Context | Droughts are likely to occur with greater frequency in the near future, on a large scale and in a variety of soil and climatic contexts. This requires the development of more water-efficient and drought resistant farming systems, an important basis for the agro-ecological transition. To meet this challenge, **it is necessary to deepen our knowledge of the morphological and functional traits of the plant in its environment**, which would be likely **to improve this resistance to water deficit**, not only at the aerial level but also belowground level (soil).  Thus, among the possibilities of water use efficiency by plants, **we propose to investigate the role of the rhizosphere -the soil zone influenced by the plant- by studying its biophysical functioning** through the production of exopolysaccharides (EPSac) and microbial biomass and activity. Our hypothesis is that these rhizospheric parameters (or traits) directly influence the water retention capacity of this soil volume in the vicinity of the roots and that these plant/soil interactions/feedback could contribute to the plant's resistance to water deficit. We have recently observed correlations between plant response to water stress, biomass and microbial activities and quantities of soil exopolysaccharides under controlled conditions and in pots on wheat. The challenge is to discriminate the effects of these rhizospheric traits on the plant's response to water stress, compared to other plant traits. The hypothesis is that the modification of soil properties by the roots (rhizospheric traits) is an element of resistance to water deficit and that these modifications vary according to species and varieties. |
| Objectives of the internship | The proposed internship will contribute to a larger project through the **characterisation of rhizosphere traits of different wheat varieties at early stages**.  The objective of this internship is therefore to measure rhizospheric traits (**mucilage production by the roots, soil EPSac concentration, soil microbial activities**) of the plant for different wheat genotypes at early stages of plant development.  Two types of **experiments in growth chamber** are planned for this internship. Experiments at the **germination stage** to characterise root mucilage, and experiments at the **seedling stage** for a first varietal screening (on 10 varieties) and to specify certain rhizospheric processes (on 5 selected varieties). In parallel to this internship, field experiments on phenotyping platforms with different water treatments will be carried out: depending on the organisation of the experiments, the student will participate in these field experiments, but this will not be the main focus of his/her internship.  Planned work:  1-**A first varietal screening** will allow us to choose 5 wheat varieties among the 10 studied in the framework of the project. This choice of 5 varieties will be based, on the one hand, on the water deficit tolerance rating of the 10 varieties as the main criterion, resulting from the knowledge of these varieties, and, on the other hand, on a first simple phenotyping/rhizospheric screening test (relying on the evaluation of the mass of soil adhering to roots) for the 10 varieties under standardised conditions.  2-**A characterisation of rhizospheric traits** of different wheat varieties at early stages will be performed:  - At the germination stage (aero-hydroponic cultivation, Zickenrott et al., 2016) by sampling the exuded root mucilages from the roots. These mucilages will be chemically characterised.  - At the seedling stage, with plants grown on different soils. The rhizosphere will be characterised by rhizospheric soil mass, analysis of EPS extracted from the rhizospheric soil and measurements of microbial activity and biomass in the rhizospheric soil.  These characterisations (germination and seedling stages) of the different wheat varieties through their mucilage and rhizosphere will be compared (within the framework of the overall project) with the behaviour in the field at flowering of the rhizospheric activity of these same varieties, when faced to a water deficit.  In addition to the **implementation and monitoring of experiments** on wheat at the early stages, the analyses carried out by the trainee will be :  -**Chemical analyses**: extraction of EPS (exopolymeric substances) from the soil with ion exchange resin and colorimetric quantification of exopolysaccharides (EPSac) in glucose equivalent; qualitative analysis of the extracted EPS by measuring the mid infrared spectrum (MIR), which gives a "fingerprint" of their chemical composition (Bérard et al., 2020).  -**Biological analyses**: biomass and microbial catabolic activities with the MicroRespTM tool (Bérard et al., 2011). |
| Date and duration of the internship | Start date: February 2023  Duration: 4-6 months maximum |
| Location | INRAE Avignon. UMR EMMAH – Web : <https://www6.paca.inrae.fr/emmah> |
| Expected activities of the trainee | The trainee will: work with the SWIFT team of the UMR EMMAH, and:  - Carry out laboratory experiments to collect EPSac and rhizosphere measurements of different wheat genotypes at the germination and seedling stages  - Perform EPS extraction from rhizosphere soil samples in the laboratory and their analysis.  - Perform microbial activity measurements on rhizosphere soil samples.  - Analyse and interpret the results.  - Write weekly reports and a report. |
| Practical conditions | * Gratification: see IMPLANTEUS organisation * INRAE contribution to lunch costs (inter-company restaurant nearby) and public transport. * Association of Company Employees (ADAS) for access to sports and cultural activities * The INRAE domain is located 8 km from the city centre of Avignon (bus line, low-cost bicycle rental at INRAE). |
| **General information** | |
| Profile required | * Student M2 or M1 in agronomy or plant ecology or chemistry * Interest in plant experiments and soil functioning * Motivation for experimental and laboratory work (phytotron experiments, analyses) * Interest in team work (other trainees, PhD students, technicians and researchers) * Knowledge and mastery of office automation tools, if possible use of R (or Rstudio) * Organisation, rigour, autonomy * Writing skills. Need to read scientific literature in English |
| Contacts and supervisory staff for the internship | For more information and to apply: send a CV and a letter of motivation to the following e-mail addresses  Claude DOUSSAN : claude.doussan@inrae.fr  Annette BERARD : annette.berard@inrae.fr |

Références bibliographiques :

**Bérard A.,** T. Bouchet, G. Sevenier, A.L. Pablo, R. Gros, 2011. Resilience of soil microbial communities impacted by severe drought and high temperature in the context of Mediterranean heat-waves. *European Journal of Soil Biology*. 47 : 333-342. doi:10.1016/j.ejsobi.2011.08.004.

**Bérard A**, Clavel T, Le Bourvellec C, Davoine A, Le Gall S, **Doussan C**, Bureau S, 2020.Exopolysaccharides in the rhizosphere: A comparative study of extraction methods. Application to their quantification in Mediterranean soils. Soil Biology and Biochemistry. doi: <https://doi.org/10.1016/j.soilbio.2020.107961>

George TS, Brown LK, Ramsay L, White PJ, Newton AC, Bengough AG, Russell J, Thomas WTB, 2014.. Understanding the genetic control and physiological traits associated with rhizosheath production by barley (Hordeum vulgare). New Phytologist 203: 195–205

Zickenrott I-M, Woche S.K., Bachmann J., Ahmed M.A., Vetterlein D., 2016. An efficient method for the collection of root mucilage from different plant species—A case study on the effect of mucilage on soil water repellency. J. Plant Nutr. Soil Sci. 2016, 000, 1–9 DOI: 10.1002/jpln.201500511