PHD PROJECT DESCRIPTION
(4000 characters max., including the aims and work plan to de published online)

Project title:
Functional soil and plant microbiomes as biological indicators and tools for adaptation to soil salinization

1.1. Project goals

The doctoral project will be carried out as a microbiological module of the Horizon Europe RIA SaliNova project. The main goal is to determine how soil, rhizosphere and plant-associated microbiomes respond to soil salinization and whether native microbial communities, their functional traits and molecular indicators can be used as biological indicators and microbiome-informed tools for adaptation to saline soils. The PhD candidate will work within the SaliNova demonstration sites, to be selected after the project start.

1.2. Outline

The project will combine field sampling, soil and plant microbiology, molecular microbiome profiling, functional analyses of microbial communities and controlled plant experiments. Soil, rhizosphere and root/endosphere samples will be collected along a salinity gradient. The candidate will analyse microbial diversity, community composition, microbial metabolic activity in soil, functional potential of soil and plant-associated microbiomes, and the occurrence of microbial markers related to salt stress adaptation and plant performance. Culture-independent approaches, including NGS-based microbiome profiling, quantitative molecular assays and community-level physiological analyses, will be used to identify microbial taxa, functions and interaction patterns associated with salinity tolerance. Selected soil or organic-amendment treatments will be tested in plant experiments under salt stress to assess their effects on plant performance, soil properties and native microbiome responses. The final outcome will be a set of microbial indicators, functional microbiome markers and practical recommendations for local management of saline soils.

1.3. Work plan

Year 1: selection of the field site with the SaliNova consortium, mapping of salinity gradients, baseline sampling, EC/pH and soil analyses, optimization of sample processing procedures, first DNA extractions and preliminary molecular characterization of soil, rhizosphere and plant-associated microbiomes.

Year 2: microbiome analysis using NGS, taxonomic and functional profiling of microbial communities, assessment of microbial metabolic activity in soil, community-level physiological profiling, analysis of microbial markers associated with salinity stress and plant performance, and selection of candidate indicators for further validation.

Year 3: field or mesocosm validation of selected soil, organic-amendment or microbiome-supporting treatments, monitoring of native microbiome responses under salinity stress, comparison with selected SaliNova partner sites, e.g. UFI/Italy, VU/Netherlands or TI/Spain, and integration with plant performance, soil chemistry and environmental data.

Year 4: final analyses, identification of robust microbial and functional indicators of soil salinization, preparation of guidelines for SaliNova, publications and doctoral dissertation.

1.4. Literature

1. Hrynkiewicz K. et al. 2019, *Journal of Advanced Research* 19:49–56.
2. Furtado B.U. et al. 2025, *Journal of Plant Growth Regulation*.
3. Thiem D. et al. 2025, *Plant and Soil*.
4. Koczorski P. et al. 2022, *Frontiers in Microbiology* 13:1006722.
5. Michl K. et al. 2025, *ISME Communications* 5:ycae165.
6. Shokri N. et al. 2024, *Reviews of Geophysics* 62:e2023RG000804.
7. Hassani A. et al. 2024, *PNAS* 121:e2317332121.

1.5. Required initial knowledge and skills of the PhD candidate

Advanced knowledge of microbiology, molecular biology and plant/soil biology; readiness for fieldwork and laboratory work with environmental and plant samples; advanced knowledge of DNA-based methods, statistical analysis, bioinformatics and data integration; very good English communication skills; motivation for interdisciplinary and international work.

1.6. Expected development of the PhD candidate's knowledge and skills

The candidate will gain advanced skills in environmental and plant microbiology, NGS-based microbiome analysis, molecular detection of microbial indicators, functional assessment of soil microbial communities, plant stress experiments, analysis of microbiome–soil–plant interactions, data integration and cooperation in a European consortium. The candidate will also develop publication, presentation, project-management and open-science competences.