Title

Assessing in situ cereal root biomass and traits in response to intercropping with legume.

Background

In a severe context of climate change and resource depletion (Reijnders 2014), improving yield stability for food security while reducing environmental impact are requested for sustainability. More specifically, there is a need to increase crops P uptake efficiency without further increasing P inputs, i.e. a better exploitation of soil resources in agroecosystems (Hinsinger et al. 2011). Breeding aims at improving a plant species by selecting specific traits and has been used to attempt to increase P uptake efficiency (Sanginga et al. 2000; Balyan et al. 2016; van de Wiel et al. 2016), with failures when applied to the reality of the field (Rose et al. 2013). Indeed, the expression of desired phenotypes of such selected genotypes can be hindered by P limitation (van der Bom et al. 2023). In other words, specialized genotypes for resource acquisition can be inefficient under complex environments (van der Bom et al. 2020). Promoting better utilization of the resources can be achieved with intercropping different genotypes (Hinsinger et al. 2011; Aziz et al. 2015). However, we lack information on how contrasting genotypes would respond to intercropping; root plasticity could impact root system architecture with avoidance strategies to strengthen root spatial complementarity or by contrast could rather enhance root intermingling aiming at increasing interspecific facilitation.

Project

The objective is to compare the *in situ* response in root biomass and traits of 2 barley cultivars selected for their contrasting root system (e.g., deep and shallow) to intercropping with faba bean.

To do so, we will conduct a field experiment in legume-deep rooted barley and legume-shallow rooted barley intercropping and their monostands. We will relate aerial yield and P uptake to horizontal and vertical variations of root distribution and traits up to 1m depth.

Tasks

The student will take part to this project, including field experiment, sampling campaigns, sample processing and data analysis.

We are looking for a student in a closely related field to plant and soil science, agronomy or biology and have interest in crop ecology and soil science. The successful candidate is highly motivated, shows autonomy, fluent in English.

Our research group

The student will be anchored in the Belowground Crop Ecology group, in the Crop Science section, within the Department of Plant and Environmental Sciences, Faculty of SCIENCE, University of Copenhagen. We are located at the KU Taastrup campus (2630, Denmark). Our research group focuses on interactions belowground between roots and the surrounding environment, contributing to the development of resilient cropping system with efficient resource use.

The internship can start in March 2024 for a duration of 6 months or less (flexible).

Please send your cover letter and CV to Lorène Siegwart - ls@plen.ku.dk before 30/11/2023.

References

Aziz M, Mahmood A, Asif M, Ali A (2015) Wheat-based intercropping A review. J Anim Plant Sci 25:896–907

Balyan HS, Gahlaut V, Kumar A, Jaiswal V, Dhariwal R, Tyagi S, Agarwal P, Kumari S, Gupta PK (2016) Nitrogen and Phosphorus Use Efficiencies in Wheat: Physiology, Phenotyping, Genetics, and Breeding. In: Plant Breeding Reviews, Volume 40. John Wiley & Sons, Ltd, pp 167–234

Hinsinger P, Betencourt E, Bernard L, Brauman A, Plassard C, Shen J, Tang X, Zhang F (2011) P for Two, Sharing a Scarce Resource: Soil Phosphorus Acquisition in the Rhizosphere of Intercropped Species. Plant Physiol 156:1078–1086. https://doi.org/10.1104/pp.111.175331

Reijnders L (2014) Phosphorus resources, their depletion and conservation, a review. Resour Conserv Recycl 93:32–49. https://doi.org/10.1016/j.resconrec.2014.09.006

Rose TJ, Impa SM, Rose MT, Pariasca-Tanaka J, Mori A, Heuer S, Johnson-Beebout SE, Wissuwa M (2013) Enhancing phosphorus and zinc acquisition efficiency in rice: a critical review of root traits and their potential utility in rice breeding. Ann Bot 112:331–345. https://doi.org/10.1093/aob/mcs217

Sanginga N, Lyasse O, Singh BB (2000) Phosphorus use efficiency and nitrogen balance of cowpea breeding lines in a low P soil of the derived savanna zone in West Africa. Plant Soil 220:119–128. https://doi.org/10.1023/A:1004785720047

van de Wiel CCM, van der Linden CG, Scholten OE (2016) Improving phosphorus use efficiency in agriculture: opportunities for breeding. Euphytica 207:1–22. https://doi.org/10.1007/s10681-015-1572-3

van der Bom FJT, Williams A, Bell MJ (2020) Root architecture for improved resource capture: trade-offs in complex environments. J Exp Bot 71:5752–5763. https://doi.org/10.1093/jxb/eraa324

van der Bom FJT, Williams A, Raymond NS, Alahmad S, Hickey LT, Singh V, Bell MJ (2023) Root angle, phosphorus, and water: Interactions and effects on durum wheat genotype performance in drought-prone environments. Plant Soil. https://doi.org/10.1007/s11104-023-05966-z