Background

Plant productivity is tightly linked to plant water loss, and it is increasingly threatened by escalating drought. Crop physiologists and breeders are urgently seeking plant water use strategies and traits that can improve crop yield under drought. Certain plant traits and water use strategies can enhance crop performance under drought [1]. For example, smaller root xylem vessels (hollow tubes that conduct water from the roots to the shoot) have been shown to reduce vegetative biomass loss under water stress in maize [2] and provide a yield advantage of 3-11% in wheat [3]. This is hypothesized to be due to enhanced soil water conservation caused by a reduction in the root's ability to channel water to the shoot (lower hydraulic conductance). However, this hypothesis is largely speculative, as the actual effect of reduced xylem area on plant water use during drought is rarely empirically assessed. Recent studies suggest a larger xylem area could also increase pearl millet yield under drought [4]. Thus, the mechanistic link between traits like xylem area and yield under water stress remains elusive, which is one of the gaps we aim to address.

Objectives

Your first task will be to experimentally quantify which role xylem morphology plays in the water use regulation during increasing VPD (atmospheric drought) and during decreasing soil moisture (soil drought) in pearl millet. This will happen over the course of 2-3 weeks (from 07.09. on) at IRD Montpellier in collaboration with the group of Dr. Alexandre Grondin. The stay in Montpellier will be fully funded.

Your second task will be to use the data generated to parameterize a soil-plant hydraulic model to predict water use under varying drought regimes [5]. This will happen at the Root-Soil Interaction group at TUM under the supervision of Dr. Tina Koehler.

Requirements

We are looking for a highly motivated master's student who meets the following criteria:

- Strong interest in plant water relations, root physiology, and drought adaptation
- Willingness and ability to work independently during a 2–3-week experimental campaign in Montpellier from 07.09.-19.09/ 26.09.2025 (end date to be decided)
- Enrolled in a master's program relevant to the topic
- Basic understanding of soil-plant hydraulics/ crop physiology/ root physiology
- Good communication skills and proficiency in English
- Experience in data analysis using R, Python, or MATLAB
- Ideally, prior laboratory or greenhouse experience in plant physiology or plant hydraulic measurements
- Familiarity with basic modeling concepts in soil-plant systems is a plus
- Strong organizational skills, ability to plan and execute experiments
- Motivation to engage in interdisciplinary work (combining empirical data collection with modeling)
- Team player with a collaborative attitude in an international research setting

If you are interested, please send your **CV and a 1-page motivation letter** until **08.08.2025** to: tina.koehler@tum.de

References

1 Vadez, et al. Carminati (2024). Nature Reviews Earth & Environment. 10.1038/s43017-023-00514-w.

2 Klein, et al. Lynch (2020). Plant physiology. 10.1104/pp.20.00211.

3 Richards, et al. Passioura (1989). Australian Journal of Agricultural Research. 10.1071/AR9890943.

4 Affortit, et al. Grondin (2024). 10.1101/2024.11.09.622826.

5 Koehler, et al. Carminati (2023). Journal of experimental botany. 10.1093/jxb/erad221.