

How do mycorrhizal strategies shape root trait variation and influence ecosystem processes?



Starting date : January 2026

Localisation : INRAE Villenave d'Ornon – UMR ISPA

Duration : 6 months

Experience : Master 2 internship

Key words : Mycorrhizae, root traits, soil ecophysiology

Context and objectives : In the context of global climate change, understanding the functioning of forest soils is a major challenge for assessing the dynamics of biogeochemical cycles and the productivity of terrestrial ecosystems. Mycorrhizal fungi are central to this functioning, playing a critical role in ecological processes such as nutrient cycling and carbon storage. These symbioses, that occur in about 90% of terrestrial plant species, are mainly divided between ectomycorrhizal (EM) and arbuscular mycorrhizal (AM) fungi, two guilds that exhibit contrasting nutrient acquisition strategies^{1,2}. AM associations are generally linked to an acquisitive strategy, relying on rapid foraging for soluble phosphorus and nitrogen with relatively low carbon investment from the host. This strategy is typically coupled with fast root turnover and a dependence on the uptake of inorganic nutrient forms directly from the soil³. In contrast, EM fungi have evolved a more conservative strategy, using hydrolytic and oxidative enzymes inherited from their saprotrophic ancestors to access organic nitrogen and phosphorus pools. These associations generally require a larger carbon allocation from the host plant, that supports the energetically costly enzymatic machinery involved in nutrient acquisition⁴.

Studying these contrasting mycorrhizal strategies is therefore essential to understand the divergent responses of AM- and EM-associated tree species to contemporary environmental change. In this context, the analysis of tree root trait variation and mycorrhizal types may provide essential insights into how tree species differ in their nutrient acquisition strategies, carbon investment, and interactions with the soil environment⁵.

The central question of this internship is therefore: *How do root traits vary among tree species depending on their associated mycorrhizal type (AM vs. EM), and what are the implications of these differences for soil functioning?*

This internship will primarily focus on a morphological study of root samples collected from six tree species growing in an arboretum of the REINFFORCE network. Root samples will be scanned and analyzed to quantify variation in root morphology and the level of mycorrhizal colonization, complemented by chemical analyses of the root material. This corpus may be expanded with additional tree species growing in the same arboretum to strengthen and test comparisons. The intern will have access to state-of-the-art microscope facilities, scanners and softwares to establish key root traits such as specific root length, root diameter and root branching patterns alongside access to complementary datasets on soil gas exchange and chemical characteristics to help understand variations in the root traits. This internship will enable students to acquire solid skills in laboratory techniques while also gaining valuable field experience.

Localisation : The student will work at the UMR ISPA (Interaction Sol-Plante-Atmosphère) at the INRAE Nouvelle-Aquitaine center in Villenave d'Ornon (France), under the supervision of Eva Demullier (Doctorant) and Lisa Wingate (Research director). The monthly allowance is approximately € 560 / month (regulated trainee rate for 35h / week from January to June 2026). Recommended accommodation: room in a university residence (request to be made to the CROUS) or city accommodation to be sought (Bordeaux Sud, Bègles, Pessac, Talence or Villenave d'Ornon).

Competencies required : This internship is aimed at students motivated by plant and fungal ecology, soil–plant interactions, and the study of root traits. The work will involve significant laboratory activities, including morphological and chemical analyses of roots, as well as assessing mycorrhizal colonization levels. Students will also gain practical field experience collecting soil samples from arboreta.

A solid understanding of statistical analysis using the R environment will be necessary. Good writing and communication skills in English (and French) will be a plus.

Recruitment process : Please send a cover letter and CV to Eva Demullier and Lisa Wingate by **October 31, 2025**.

Lisa WINGATE : lisa.wingate@inrae.fr

Eva Demullier : eva.demullier@inrae.fr

References

- (1) Smith, S. E.; Read, D. J. *Mycorrhizal Symbiosis*, Academic Press.; London, 2008.
- (2) Brundrett, M. C.; Tedersoo, L. Evolutionary History of Mycorrhizal Symbioses and Global Host Plant Diversity. *New Phytologist* **2018**, 220 (4), 1108–1115.
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- (4) Hawkins, H.-J.; Cargill, R. I. M.; Van Nuland, M. E.; Hagen, S. C.; Field, K. J.; Sheldrake, M.; Soudzilovskaia, N. A.; Kiers, E. T. Mycorrhizal Mycelium as a Global Carbon Pool. *Current Biology* **2023**, *33* (11), R560–R573. <https://doi.org/10.1016/j.cub.2023.02.027>.
- (5) Comas, L. H.; Eissenstat, D. M. Patterns in Root Trait Variation among 25 Co-existing North American Forest Species. *New Phytologist* **2009**, *182* (4), 919–928. <https://doi.org/10.1111/j.1469-8137.2009.02799.x>.