Laboratoire Étude et COmpréhension
de la bioDIVersité
ECODIV EA 1499 / USC –
Université de Rouen Normandie - INRAe

PhD position – 2025-2028

Role of rhizodeposition in the dynamics of soil organic matter

Context

In the context of growing climate change and food insecurity, increasing the organic matter content of agricultural soils is a significant challenge. This reduces dependence on mineral fertilizers and sequesters carbon (C) in the soil, offsetting greenhouse gas emissions such as CO_2 and mitigating global warming[1]. The key challenge for large-scale crop soils is shifting them from a C destocking status to a C storage status. Two levers can be used to achieve this reversal of carbon sequestration trajectories: (i) increasing direct inputs of fresh organic carbon to the soil and (ii) promoting the stabilization of organic carbon in the soil. The challenge is therefore to develop cropping systems that can combine these approaches while maintaining economically viable production[2].

One way to promote C storage in soils is through rhizodeposition, whereby plants contribute fresh organic matter to the soil via their living roots[3]. Rhizodeposition has been identified as a major source of soil organic matter formation, particularly the fraction stabilized by interaction with reactive minerals in the soil[3]. Selecting field crop varieties based on their ability to supply the soil with fresh C via rhizodeposition represents a promising way to promote organic C storage in agricultural soils. However, rhizodeposition can also promote the mineralization of soil organic carbon by destabilizing organo-mineral associations[4] or stimulating decomposers[5]. The overall effect on the net balance of organic carbon gain/loss in soils remains poorly understood[6].

Objectives

The objective of this PhD thesis is to test the effect of two sorghum varieties, which contrast in terms of their rhizodeposition flux, on soil organic matter in an arenosol. The thesis consists of three complementary studies:

- An ex situ study based on ^{13}C labelling of sorghum plants, carried out at the BIAM laboratory followed by incubations under controlled conditions at the ECODIV laboratory allowing the measurement of the effect of living roots on the mineralization processes of C and nitrogen from soil organic matter via the phenomenon of 'rhizosphere priming effect'[6–8].
- A field study carried out at CEREEP - ECOTRON IDF based on a C3-C4 crop succession[9] coupled with isotopic measurements $^{13}C/^{14}C$[10] to determine the formation of new C from sorghum, the quantity and age of mineralized native C, as well as the net balance of soil C gains/losses over the growing season. The effect of sorghum varieties with contrasting rhizodeposition will be tested in interaction with the addition of reactive minerals that can promote C storage in the soil.
- A prospective study based on the numerical modelling of soil organic carbon dynamics using the AMG model[11,12]. Field study data will be used to predict the soil carbon storage induced by sorghum cultivation over several decades according to different climate trajectories.

Expected candidate skills

The candidate must have a Master's degree and significant experience working in a research laboratory. They must have good theoretical knowledge of one or more of the following specialisms: biogeochemistry, soil science/pedology and functional ecology. They must be proficient in statistical tools in R and have excellent written and oral English skills. Experience in numerical modelling and aptitude for laboratory and fieldwork would also be advantageous.

Practical aspects

Duration: 3 years over the period October 2025/October 2028

Place: ECODIV Lab, Bâtiment Blondel, place Emile Blondel, UFR Sciences et Techniques, Université de Rouen Normandie F-76821 Mont Saint Aignan cedex, France

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Application, before June the 20th : Please send your CV, cover letter and Master's marks (or equivalent), along with the full contact details of two referees, by email to: Ludovic HENNERON (ludovic.henneron1@univ-rouen.fr), Delphine DERRIEN (delphine.derrien@inrae.fr) and Michaël AUBERT (michael.aubert@univ-rouen.fr)

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