RecycleP

Understanding the recycling of organic phosphorus in Mediterranean agro-forestry ABSYSs

ABSTRACT

Phosphorus (P) is an essential element for living organisms and often limits terrestrial ecosystem productivity. For this reason, P fertiliser are largely used to improve crop productivity. However, the use of P fertilizeris not withoutserious environmental threats, including eutrophication ofsurface waters. A promising way of reducing external P inputs to agroecosystems is to increase the recycling rate of organic phosphorus (Po), which constitutes alargepool inmostsoils.

The introduction of trees into agroecosystems (agroforestry) affects nutrients cycles and availability, for example by modifying the amount and quality of litter inputs. Most studies focussing on nitrogen or carbon under such systems, very few studies have assessed the role of trees in P availability for crops so far (D'Hervilly et al 2021) and no one in Po recycling. In this project, we envisage to study how trees affects the recycling of Po, with particular focus on P immobilized in microbes (microbial biomass P, MBP), which is the most labile and dynamic Po pool. Our overall objective is to characterize quantitatively soil phosphorus pools and Po cycling in a Mediterranean agroforestry system compared to a sole crop control and taking into field heterogeneity.

Our main hypothesis is that the introduction of trees and associated perennial herbaceous species on the tree-row will modify the distribution of P pools and increase the turnover of Po, particularly of the MBP via higher inputs of plant-derived labile carbon and this will translate in higher P availability.

To test the hypothesis, we will rely on both controlled-experiment conditions and field observations, in which we will include the surface and the deeper soil horizons. We will apply the oxygen isotopes in phosphates (18O-P) as a tracer for biological P transformation with natural abundance (in situ) and labelling approaches (in controlled-conditions). For field measurements, we will rely on an established, equipped and well characterized experimental site: the site DIAMs (Dispositif Instrumenté Agroforestier Méditerranéen), located close to Montpellier.

The outcomes of this research will improve the understanding on how the trees affect biological P transformations and P availability. Including subsoil observations, we expect to better understand the contribution ofsubsoil to plant nutrition.

Trees might be one of the keys to "unlock" the Po pool. Unravelling the mechanisms behind will ultimately help develop more sustainable cropping systems with reduced external inputs.

Keywords : Mineralization, Microbial P, P availability, Carbon use efficiency, Multi-isotopes labelling

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GOAL

The overall objective of this project is to characterize quantitatively soil phosphorus pools and organic P cycling in a Mediterranean agroforestry system compared to a sole crop control and taking into account carbon availability and field heterogeneity.
Our main hypothesis is that the introduction of trees and associated perennial herbaceous species on the tree-row will modify the distribution of P pools and increase the turnover of Po, particularly of the MBP via higher inputs of plant-derived labile carbon and this will translate in higher P availability. We additionally hypothesize that this effect will vary with soil depth under the influence of tree and perennial herbaceous species roots. Indeed, the introduction of trees creates a spatial heterogeneity in soil properties and functions at the plot scale along the tree rows- crop transect (Guillot et al., 2019; Guillot et al. 2021) and within the tree row (D'Hervilly et al., 2020). However, trees-induced heterogeneity has not been studied so far along the soil profile.