Behavior of mycorrhizal communities in agroforestry: Case of the walnut plantations associated with maize and faba bean

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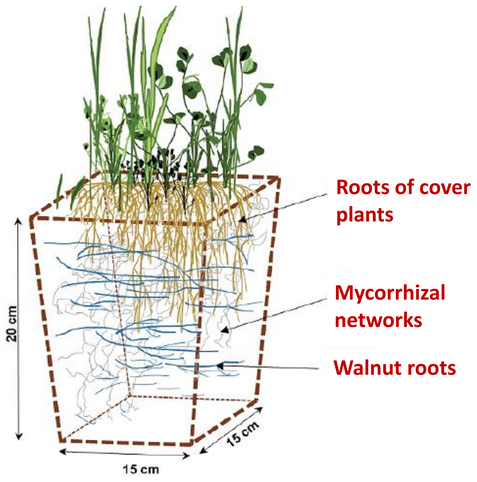
Walnut and maize in an Agroforestry plot

Context : Agroforestry systems play a very important role in reducing wind speed, improving soil structure, increasing biodiversity and carbon sequestration [1]. One of the beneficial microbiota that has a symbiotic association with most of the plants is arbuscular mycorrhizal fungi (AMF) [2]. The diversity of AMF can be a critical factor in enhancing both the productivity and the diversity of plants in agroecosystems. However, very few studies have been carried out on the impact of mycorrhization on walnut trees with associated crops (e.g maize, wheat). The integration of a vegetal cover in intercrop in walnut plantations is an innovative practice, still little developed. Although cover crops are widely used in conservation agriculture or organic farming, there is little knowledge on the impact of cover crops on native mycorrhizal fungi. The aim of our study was to evaluate arbuscular mycorrhizal fungal community associated to walnut roots under agroforestry and agricultural systems.

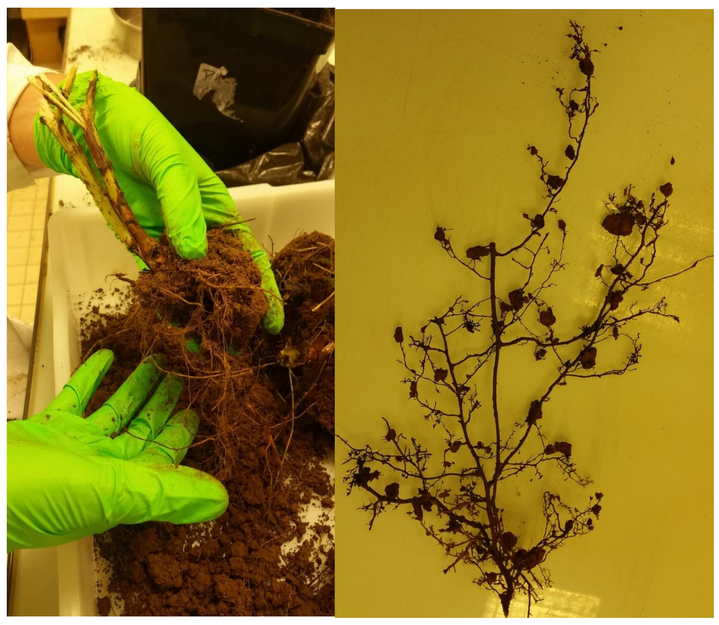
Walnut plantations with faba bean in an organic farming plot

Sampling and analyses of soil physicochemical and biological parameters



In June 2017 and 2018, root and rhizosphere soil samples and technical itineraries were collected from the agroforestry plots in Dordogne and the experimental station of Creysse (South-western France). Five modalities (Walnut in Conventional with and without vegetal cover, Walnut in Organic farming with and without vegetal cover, Walnut and maize in Agroforestry) and soil physico-chemical (Organic C, OM, N total, mineral N, pH, trace elements) and biological (DNA bacterial and fungal, mycorrhizal colonization, glomalin, ergosterol, enzyme activity) analyses were studied.

Morphological characterization of arbuscular mycorrhizal fungi in walnut roots

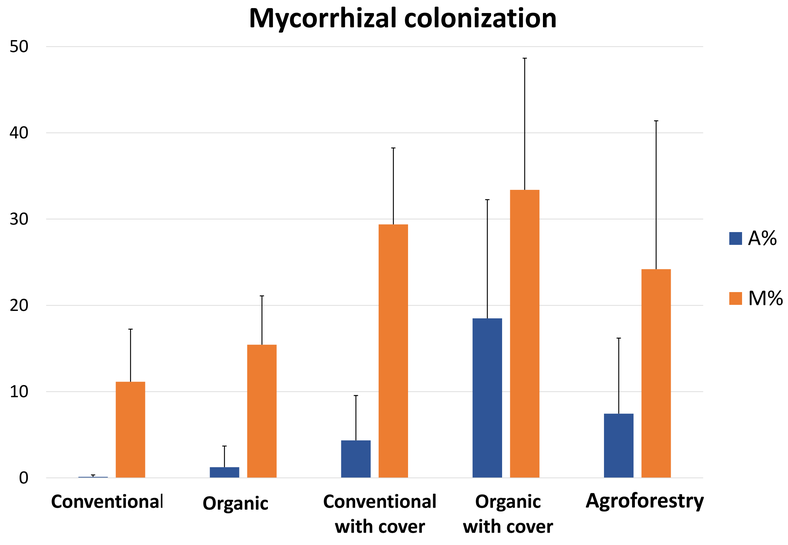


Walnut roots and rhizospheric soil aggregates

Walnut roots stained and mounted on slides

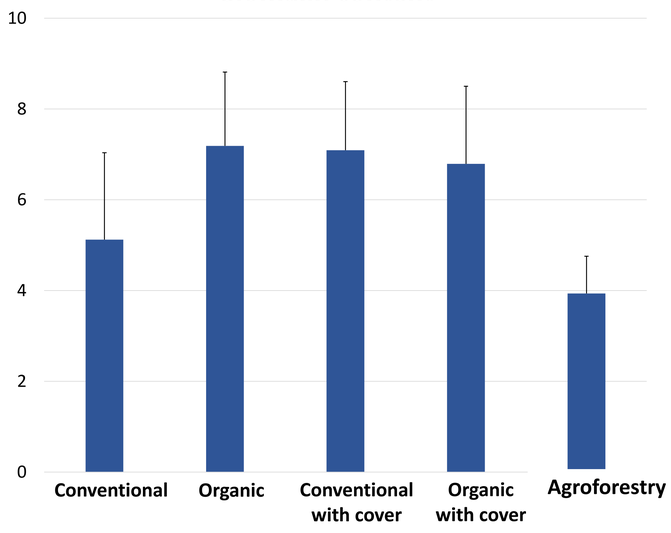
Native AM fungal community colonization in walnut plantations with faba bean

Mycorrhizal colonization

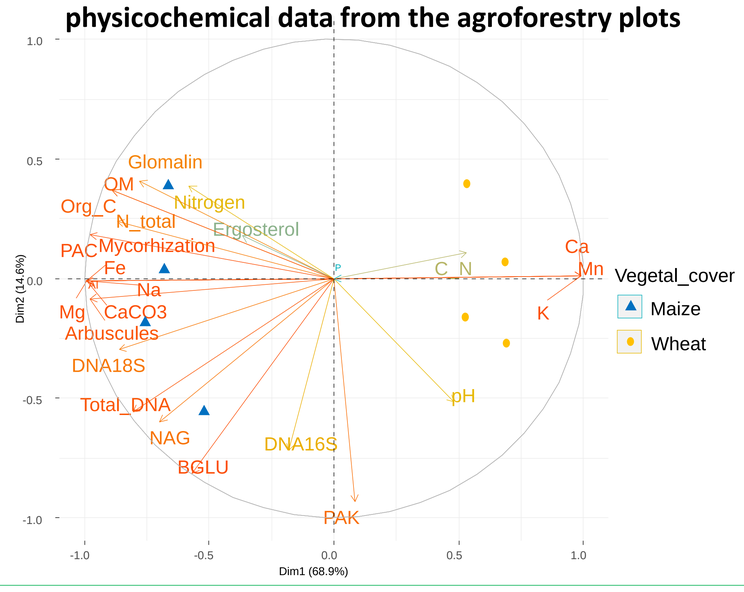


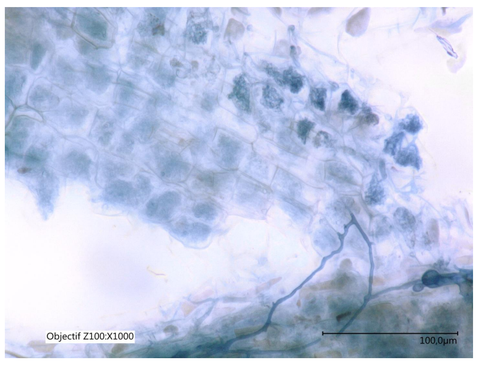
A%: Arbuscular density ; M%: Mycorrhizal intensity

Glomalin content

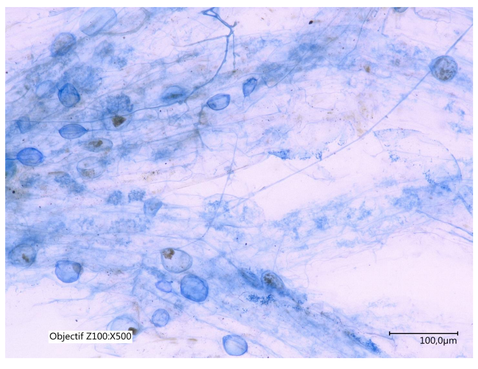


Principal Component Analysis (PCA) of the biological and physicochemical data from the agroforestry plots





Arbuscules and hyphae observed in a walnut root in organic farming



Vesicles and hyphae observed in a faba bean root in organic farming

Our results showed a higher mycorrhizal colonization in walnut trees in organic farming in comparison with those in conventional farming. In fact, the highest percentage of total AMF colonization was recorded for walnut trees in the presence of faba bean (M=33 % ; A=18%). However, mycorrhizal colonization observed in agroforestry plots accounted 24%. We also found significant differences between Conventional with and without cover in glomalin concentration. Multivariate analysis based on PCA revealed that ergosterol content, glomalin concentration and soil organic status were mainly correlated to mycorrhizal colonization and hence relevant to explain walnut trees mycorrhization. The use of faba bean showed the great role played by vegetal cover in the enhancement of mycorrhizal colonization of plants. The establishment of plots of mycorrhizal communities on walnuts with intercrop maize culture would be a very beneficial model to study the transfer of arbuscular mycorrhizal fungi from walnut trees to maize.

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