

Circular economy applied to nature-based solutions for biomass carbon capture and storage in sustainable agriculture, effects of an innovative compost on soil organisms and plants.

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Background The current population growth is continuously and exponentially leading to higher demands and exploitation of natural resources, especially concerning the agronomic field [1]. This over consumption and intensive agriculture lead to many environmental issues such as deforestation, soil erosion and many more, all leading to destruction of wildlife and biodiversity [2]. For this reason, new approaches for sustainable and green agriculture are being developed in the last years, such as the utilization of composts as fertilizer for agronomic practices, allowing to turn waste into natural resources [3]. In particular, various studies have shown the effectiveness of compost combined with biochar. The biochar is a product derived from pyrolysis of biomass that has been proven to increase crop yield and soil water availability when introduced in the soil as amending, while also improving macro-nutrient cycling, preserving the quality of the product, and enhancing soil fertility and microbial activity [4,5]. One of the soil components most sensitive to changes is the soil fauna which is highly adapted to the edaphic environment and plays a fundamental role in different soil dynamics, such as nutrient cycling, organic matter decomposition and many more. Because of soil fauna's sensitivity to soil changes, it can be a reliable bioindicator for evaluating the impact of different agronomic practices [5,6]; unfortunately, there are very few studies about the impact of biochar combined composts on soil fauna communities and dynamics.

Objectives and Activities **The current PhD project will focus on testing innovative composts for green agricultural development and their effects on the soil microarthropods community and crop development. A metabarcoding approach based on environmental DNA will be employed to characterize the biodiversity and community structure of soil microarthropods under different compost treatments.** Both field and laboratory activities were planned to meet the objectives stated above. Field activities will assess the effects of biochar composts on soil microarthropods communities and crop growth. Experiments will be conducted in Emilia-Romagna (PETERMAR: Parco Eco Tecnologico per il Recupero di Materia ed energia dai Rifiuti, Carpi) in collaboration with the BeeLab of UniMore, using plots treated with compost with and without biochar, plus one untreated control parcel. Replicated plots will ensure statistical reliability. Soil samples will be collected (with a standard protocol) in spring and autumn and analysed through eDNA metabarcoding to evaluate short-term and seasonal effects on soil microarthropods communities, and crop measures will be done to evaluate the effectiveness of different treatments. To evaluate long term effects of biochar, the metabarcoding analyses will be carried out also on two other fields in Tuscany, in collaboration with other researchers, where biochar was applied respectively in 2019 and 2022. For all fields, metabarcoding approach will be accompanied by microscopy identification of soil microarthropod species, to characterise the communities that comprise them using standard methods as well. Moreover, for all fields chemical and environmental parameters will be measured, and a CO₂ stockage quantification will be evaluated to observe differences in treatments.

A laboratory test will be performed using a species of Collembola (*Folsomia candida* Willem, 1902), which will be reared in laboratory on soils with and without biochar and biochar enriched composts. Differences regarding the effects on the species reared between soils treated with biochar-enriched compost and those without will be examined also in these experimental settings. In particular, the life cycle of the target species will be monitored, focusing on fecundity and survival of the specimens. As stated for all other soils, the soil used will be monitored for its chemical and environmental factors, and replicas will be carried out to ensure a significative statistical outcome for our results.

The analyses that will be produced during the proposed project will help to finally shed some light on the agronomic efficacy of this compost, and especially whether its effects are sustainable for the life and dynamics of small arthropods communities.

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