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Dynamics of organic matter and microbial populations in amended soil: a multidisciplinary approach

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The application of organic amendments to soils, such as pig slurry, sewage sludge and compost is considered a tool for improving soil fertility and enhancing C stock. The addition of these different organic materials allows a good supply of nutrients for plants but also contributes to C sequestration, affects the microbial activity and the transformation of soil organic matter (SOM). Moreover, the addition of organic amendment has gained importance as a source of greenhouse gas (GHG) emissions and then as a cause of the “Global Warming”. Therefore, it is important to investigate the factors controlling the SOM mineralization in order to improve soil C sequestration and decreasing at the same time the GHG emissions. The quality of organic matter added to the soil will play an important role in these dynamics, affecting the microbial activity and the changes in microbial community structure.

A laboratory, multidisciplinary experiment was carried out to test the effect of the amendment by anaerobic digested livestock-derived organic materials on labile organic matter evolution and on dynamics of microbial population, this latter both in terms of consistence of microbial biomass, as well as in terms of microbial biodiversity. Different approaches were used to study the microbial community structure: chemical (CO_2 fluxes, WEOC, C-biomass, PLFA), microbiological (microbial enumeration) and molecular (DNA extraction and Roche 454, Next Generation Sequencing, NGS).

The application of fresh digestate, derived from the anaerobic treatment of animal wastes, affected the short-term dynamics of microbial community, as reflected by the increase of CO_2 emissions immediately after the amendment compared to the control soil. This is probably due to the addition of easily available C added with the digestate, demonstrating that this organic material was only partially stabilized by the anaerobic process. In fact, the digestate contained a high amounts of available C, which led to increase WEOC concentration in digestate treated soil compared to the control soil. The depletion of C, likely due to the microbial activity, was confirmed by the gradual decrease of WEOC concentration in soils amended with digestate. The SUVA254 measurement showed an influence of digestate on the quality of soil WEOM, with higher values in the control rather than in the digestate amended soil, indicating a great amount of aromatic compounds in native SOM.

The results of the PLFAs showed that the addition of digestate did not lead overall changes in the microbial community structure compared to the control, except for a shallow decrease of fungi. This probably suggests that the slow rate of mineralization of the organic matter added with digestate does not induce to a rapid shift of microbial community structure. The NGS showed the most important bacterial phyla and fungi species that were involved in the SOM turnover. Furthermore, this approach might be useful to trace the residence time of microbial pathogens supplied with digestates.