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Water-stable 0-20 μm microaggregates of cultivated topsoils as relevant indicators of soil functioning ?

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Growing concern about sustainable soil management in agroecosystems, has given new impetus to research on soil quality indicators used to monitor the ability of ecosystems to either resist or degrade or recover from disturbances, i.e. land use change, climate warning, pollution, tillage... Integrating soil aggregation characteristics, and their dynamics, into agrosystem studies is very useful to understand how cultivated soils function and how their soil organic matter pools could be preserved or improved.

The aim of the researches reported here was to test the hypothesis that the characterization of water-stable organo-mineral 2-20µm microaggregates - in terms of size, composition, typology and stability - would be relevant dynamic soil quality indicators of the impact of cropping practices.

For this, two agrosystems were studied: (1) a temperate maize-cropped silt loam soil amended with sewage sludge and (2) a vertisol of south-eastern Martinique presenting a high sensitivity for erosion and used for intensive vegetable cropping. A quantitative and qualitative study of organo-mineral associations, combining granulometric soil fractionations and morphological/analytical characterizations at ultrastructural (TEM/EDX) scale was conducted.

0-20µm water-stable organo-mineral aggregates were involved in the structural stability of the maize-cropped soil and their organic matter was still recognizable, mainly of plant origin, but also of bacterial origin. Some impacts of the application of sewage sludge were the emergence of microaggregates containing residues of sludge flocs, which can be considered as specific indicators of sludge, and the transfer of Cu from sludge to endogenous soil organic matter within microaggregates.

In the agricultural vertisol different types of water-stable 2-20µm microaggregates, were defined, based on the nature and the biodegradation state of the organic matter included in them. Their relative distributions varied as a function of land use (e.g. sugarcane/fallow) and were linked to the measured erosion of these soils. Indeed, the proportion of bacterial aggregates and aggregates with plant fragments was shown to be positively linked to C content and percentage of >500µm water-stable macroaggregates, contrary to microaggregates containing highly degraded organic matter.

Such results showed that microaggregates may reveal structural changes depending on land use. The development of methods, such as a relevant image analysis to recognize and account for the different types of aggregates, is expected in order to integrate 0-20µm microaggregates and their characteristics into soil organic matter dynamics modelling.