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Carbon dynamics in different soil types amended with pig slurry, pig manure and its biochar

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Determining the structure and components of soil and soil organic matter is very important in terms of sustainable agriculture and forestry and greenhouse gases emissions. Organic management can increase labile C and N in the short-term, and total soil C and N in the long-term, but less is known about how management practices may affect soil organic C (SOC)quality and stability. Methods to improve the management of livestock slurries to reduce the environmental impact and carbon losses are gaining importance. There is a need to find the best wastes treatment which enhances soil fertility but also carbon sequestration, to mitigate the effects of global warming.
The objective of this study was to assess the short-term changes in SOC pools, using raw pig slurry, the solid phase of pig slurry, and its biochar as amendment in different soil types (Regosol, Luvisol and Kastanozem). The three different amendments were applied at 5 g C kg-1 soil. An unamended soil for each type was used as control. Soils were incubated in triplicate for 60 days at 25ºC and at 55% of their water holding capacity. Samples were sampled to monitor the evolution of soil organic and inorganic carbon, recalcitrant carbon, soluble carbon, carbon mineralization, SOC thermal distribution (thermogravimetric analysis - differential scanning calorimetry - quadrupole mass spectrometry), and characterization of functional groups (Fourier transform infrared spectroscopy (FTIR)). Results showed that soils amended with raw pig slurry and the solid phase of the slurry showed higher values of soluble carbon, and higher carbon mineralization rates compared to biochar application, which showed values similar to controls. SOC increased at the end of incubation with biochar and the solid phase of the slurry applications in Kastanozem and Regosol.
Thermogravimetric results showed an increased weight loss of the Regosol compared to Luvisol and Kastanozem, owing to the higher content of soil carbonates. Luvisol and Chernozem had higher volatile compounds than Regosol, with no significant differences among treatments. Changes in total weight loss of soil among treatments were small, although endothermic and exothermic calorimetric peaks were different depending on the treatment, mainly in Regosol and Luvisol, being higher in biochar amended samples. The proportion of C containing gas species below 550 ºC was higher in Luvisol and Kastanozem with no differences among treatments.
As a general pattern, FTIR absorbance intensity followed the pattern Kastanozem > Luvisol > Regosol due to the different amount of organic matter. Areas of bands representing chemically terminal alkenes moieties at 3286 cm-1 and 3340 cm-1 in Luvisol and Kastanozem. Chemically refractory aromatic moieties at 1580 cm-1 and 1594 cm-1 in Luvisol and Chernozem, and at 729 cm-1 and 754 cm-1 in the three types of soils. Areas of bands representing chemically terminal alkane moieties at 1359 cm-1 and 1380 cm-1, alkenyl moieties at 962 cm-1 and 975 cm-1, and alkynes at 636 cm-1 and 663 cm-1 in all types of soils. The soil samples measured before incubation presented higher absorbance intensity than at the end of incubation, indicating mineralization of organic matter with incubation. No significant alterations in the functional groups were observed with the application of the amendments in any soil. This study suggested that the application of 5 g C kg-1 soil was not sufficient to modify organic functional groups at short term.
Thus, different soil types behave differently in terms of amendments applications, being the Regosol more prone to alter SOC content and stability after applications. The application of biochar promoted higher SOC concentrations and stability at the end of the incubation.

Keywords: Pig slurry, Pig Manure, Biochar, thermogravimetric analysis, FTIR, soil respiration, soil mineralization.