Geophysical Research Abstracts
Vol. 16, EGU2014-14996, 2014
EGU General Assembly 2014

Soil quality in a cropland soil treated with wood ash containing charcoal

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The strategy of the European Union "Europe 2020" states that by 2020, 20% of final energy consumption must come from renewables. In this scenario, there is an increasing use of biomass utilization for energy production. Indeed, it is expected that the production of wood-ash will increase in coming years. Wood ash, a mixture of ash and charcoal, generated as a by-product of biomass combustion in power plants, can be applied to soil to improve the soil quality and crop production. Since the residue contains significant content of charcoal, the application of mixed wood ash may also improve the SOM content and soil quality in the long term, in soils degraded as a consequence of intensive management. The objective of this study was asses the changes in SOM quality and soil properties in a degraded soils treated with wood ash containing charcoal.

The study was carried out in a field devoted to cereal crops during the last decades. The soil was acidic (pH 4.5) with a low SOC content (3 %) and fine texture. The experiment was based on a randomised block design with four replicates. Each block included the following four treatments: Control, 16 Mg fly wood ash ha-1, 16 Mg mixed wood ash ha-1 (16 Mg) and 32 Mg mixed wood ash ha-1 (32 Mg). The application was carried out once. The ash used in the study was obtained from a thermal power plant and was mainly derived from the combustion of Pinus radiata bark and branches. The wood ash is highly alkaline (pH= 10), contains 10 % of highly condensed black carbon (atomic H/C ratio < 0.5 and T50 en DSC= 500 ºC).
The evolution of SOM properties were monitored over three years by solid state 13C CPMAS NMR and Differential Scanning Calorimetry (DSC). These techniques were applied in bulk samples and aggregates of different sizes. The changes in microbial activity were studied by analysis of microbial biomass C and basal respiration. The soil bacterial community was studied by the Biolog method. Several physical properties, such soil aggregate distribution, hydraulic conductivity and available water contente were also determined.

Three years after applications the SOM content increased lightly in the treatment receiving more than 16 Mg ha-1 of wood ash. SOM in the treated soils displayed a higher degree of aromaticity than in the untreated soils, indicating a gain in more stable SOM compounds probably as a consequence of the charcoal application. However, both methods also revealed increases in labile C compounds, probably due to the carbohydrates added through root system. Microbial biomass-C and soil respiration increased significantly. The treatments also led to increases in the functional diversity indices. The amended soils showed greater utilization of substrates and the ability of soil bacteria to utilize different C resources was also greatly altered.
The application of mixed wood ash did not lead to any difference in MWD, which was around 6 mm in all cases. The application of 16 Mg fly wood ash ha-1 increased significantly the hydraulic conductivity (4.07 cmh-1) when compared with in control plots (1.3 cmh-1) and mixed ash plots (1.52 and 2.45 cmh-1, 16 Mg and 32 Mg respectively). However, air-filled porosity was not higher in 16 Mg fly ash plots. AWC was not improved by wood ash application.