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Soil organic matter dynamics and microbial activity in a cropland and soil treated with wood ash containing charcoal

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Wood ash is generated as a by-product of biomass combustion in power plants, and can be applied to soil to improve nutritional status and crop production. The application of mixed wood ash, a mixture of ash and charcoal, may also improve the SOM content and quality. The charcoal contained in mixed wood ash is a pyrogenic organic material, a heterogeneous mixture of thermally altered polymers with aromatic domains. This structure may favour oxidation, facilitating further microbial attack and generation of new SOM compounds. In addition, accelerated C mineralization of this material may also be due to the priming effect of the rhizosphere, which may even enhance the decomposition of more recalcitrant SOM.

The study was carried out in a field devoted to cereal crops during the last few decades. The soil was acidic (pH 4.5) with a low SOC content (3 %). 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, 16 Mg mixed wood ash and 32 Mg mixed wood ash ha-1. The ash used in the study was obtained from a thermal power plant and was mainly derived from the combustion of Pinus radiata bark.

The changes in SOM were monitored over two years by solid state 13C CPMAS NMR and Differential Scanning Calorimetry (DSC). 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.

Both 13 C-CPMAS NMR spectra and DSC curves revealed that the SOM in the treated soils displayed a higher degree of aromaticity than in the untreated soils, indicating a gain in more stable SOM compounds. However, both methods also revealed increases in other labile C compounds. Microbial biomass and soil respiration increased significantly as a result of these effects and possibly also due to a priming effect. The treatments also led to increases in the functional diversity indices. The amended soils showed greater utilization of substrate and a faster response. The ability of soil bacteria to utilize different C resources was also greatly altered. Greater utilization of carbohydrates, carboxylic acids, amino acid and amines was observed.