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The long-term effect of biochar on composition of soil organic matter

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Biochar has been described as relatively stable form of C with long mean residence time due to its predominantly aromatic structure. Addition of biochar can sequester C in the soil, albeit the effect of biochar on native soil organic C decomposition, whether it stimulates or reduces the decomposition of native soil organic matter, requires further understanding. The aim of this research was to study the long-term impact of biochar (BC) on the composition of soil organic matter (SOM) in Fragi-Stagnic Albeluvisol. The work was compiled on the basis of field experiment, set up on a production field in 2011. The experiment was drawn up of two treatments and four replicates, where on half of the replicates slow-pyrolysis hardwood BC (51.8% C, 0.43% N) produced at 500-600 °C was applied 50 Mg ha^{-1}. The soil samples were collected from 0-10 cm soil layer in autumn 2020. The air-dried samples were sieved through a 2-mm sieve and divided into two fractions: the particulate organic matter (POM) fraction (soil particles larger than 0.063 mm) and the mineral-associated organic matter (MAOM) (<0.063 mm) by density fractionation method. The soil organic carbon (SOC) and total nitrogen (Ntot) concentrations of bulk soil and fractions were measured. The chemical composition of SOM was studied using ^{13}C nuclear magnetic resonance (NMR) spectroscopy. Bulk soil samples and fractions were pretreated with 10% HF solution before NMR spectroscopy analysis. Two indices were calculated: the ratio of alkyl C/O-alkyl C, which describes the degree of SOM decomposition and soil hydrophobicity (HI): (aromatic-C+alkyl-C)/O/N-Alkyl-C.

The addition of BC to the soil increased the SOC concentration but did not influence the Ntot concentration and the soil C/N ratio increased from 11.6 to 16.7. The distribution of POM and MAOM was not affected by the BC and POM proportion accounted for an average of 57–58%. The SOC concentrations of POM and MAOM fractions were higher in the BC variant. The BC increased the proportion of aromatic-C in the SOM, as the proportion of aromatic-C in initial BC was high (almost 92%). Initially the BC is inherently highly hydrophobic and increased the HI of bulk soil, POM, and MAOM fractions. The HI increased in line: MAOM<bulk<POM (1.51<1.67<1.97). An increase in HI inhibits the decomposition of SOM and it was also confirmed by a decreased ratio of alkyl-C/O-alkyl-C after the BC addition. The decomposition degree was lowest in POM fraction where SOC concentration was more than doubled due to BC. The suppressed decomposition was caused by the limitation of soil Ntot concentration and increased C/N ratio.

In conclusion, the effect of BC on the composition of SOM was still evident after 10 years of

increasing SOC concentration and soil hydrophobicity and decreasing SOM decomposition degree promoting C sequestration to the soil.

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