Effects of slow and fast pyrolysis biochar on soil C and N turnover dynamics

This study compared the effect of two principal pyrolysis methods on the chemical characteristics of biochar and the impact on C and N dynamics after soil incorporation. Biochar was produced from wheat straw that was thermally decomposed at 525 °C by slow pyrolysis (SP) in a nitrogen flushed oven and by fast pyrolysis (FP) using a Pyrolysis Centrifuge Reactor (PCR). After 65 days of soil incubation, 2.9% and 5.5% of the SP- and FP-biochar C, respectively, was lost as CO2, significantly less than the 53% C-loss observed when un-pyrolyzed feedstock straw was incubated. Whereas the SP-biochar appeared completely pyrolyzed, an un-pyrolyzed carbohydrate fraction (8.8% as determined by acid released C6 and C5 sugars) remained in the FP-biochar. This labile fraction possibly supported the higher CO2 emission and larger microbial biomass (SMB-C) in the FP-biochar soil. Application of fresh FP-biochar to soil immobilized mineral N (43%) during the 65 days of incubation, while application of SP-biochar led to net N mineralization (7%). In addition to the carbohydrate contents, the two pyrolysis methods resulted in different pH (10.1 and 6.8), particle sizes (113 and 23 μm), and BET surface areas (0.6 and 1.6 m2 g−1) of the SP- and FP-biochars, respectively. The study showed that independently of pyrolysis method, soil application of the biochar materials had the potential to sequester C, while the pyrolysis method did have a large influence on the mineralization-immobilization of soil N.

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