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Biochemical stability of organic matter in soils amended with organic slow N-release fertilizer derived from charred plant residues and ammonoxidized lignin

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As an important plant nutrient, N that has been removed from the soil by plant growth is replaced mainly by the use of synthetic fertilizers. Although this practice has dramatically increased food production, the unintended costs to the environment and human health due to surplus and inefficient application have also been substantial. Major losses of N to the environment can be minimized if „sustainable[U+201F] agricultural practices are combined with reasonable fertilization. The latter can be achieved by applying slow N-release fertilizers. Here, the N is incorporated into an organic matrix, which after its amendment to soils, slowly decompose, allowing the liberation of the nutrient. Deriving from organic waste, such an amendment helps to efficiently recycle resources and increases the C sequestration potential of soils. However, in order to turn this approach into a successful strategy, the material has to be bioavailable but still sufficiently recalcitrant to ensure slow and controlled N-release. In the present study, we tested potential slow N-release fertilizers recycled from organic waste for their biochemical stability in soils. They comprised N-rich charred grass residues and N-lignin derived from waste of the pulp and paper industry and enriched in N by ammonoxidation. The substrates were mixed with soil of an Histic Humaquept and subsequently subjected to microbial degradation at 28°C in a Respicond IV Apparatus for 10 weeks. Additionally, soil material without organic amendment and soils mixed with lignin or charcoal both with and without KNO_3 were included into the experiment. During the degradation experiment the CO_2 production was determined on an hourly base. The degradation rate constants and the mean residence times were calculated using a double exponential decay model (pools with fast and slow turnover). Alterations of the chemical composition of the organic matter during degradation were studied by solid-state 13C NMR spectroscopy. First results indicated that without N addition, lignin only slightly altered the degradation rate of the slow turning soil organic matter pool (mean residence time of the slow pool: 10 years). Additional fertilization with KNO_3, increased the respective mean residence time, possibly because the presence of easily available N decreased the activity of the lignolytic enzymes. A comparable behavior was observed for the experiment with the barbeque charcoal. However, application of N-lignin resulted in faster degradation, possibly because the restricted N-availability augmented the decomposition of the lignin backbone. The N-rich charred grass residues/soil mixture, on the other hand, showed mean residence times being in the range observed for the soil without amendment and fertilization, indicating comparable degradation rates of soil organic matter and grass char. The present results confirm the close relationship between N availability and C degradation of soil organic matter. Producing slow N-release fertilizers, one has to bear in mind that not only the C/N ratio but also the quality of the organic carbon and nitrogen determines the degradation rate of the substrate and thus the availability of the applied N.