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Black Nitrogen as a source for the built-up of microbial biomass in soils

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In areas with frequent wildfires, soil organic nitrogen (SON) is sequestered in pyrogenic organic matter (PyOM) due to heat-induced transformation of proteinaceous compounds into N-heterocycles, i.e. pyrrole, imidazole and indole compounds. These newly formed structures, known as Black Nitrogen (BN), have been assumed to be hardly degradable by microorganisms, thus being efficiently sequestered from the N cycle. On the other hand, a previous study showed that nitrogen of BN can be used by plants for the built-up of their biomass (de la Rosa and Knicker 2011). Thus, BN may play an important role as an N source during the recovery of the forest after a fire event.

In order to obtain a more profound understanding of the role of BN within the N cycle in soils, we studied the bioavailability and incorporation of N derived from PyOM into microbial amino acids. For that, pots with soil from a burnt and an unburnt Cambisol located under a Mediterranean forest were covered with different amendments. The toppings were mixtures of unlabeled KNO_3 with 15N labeled grass or 15N-labeled PyOM from burned grass and $K15NO_3$ mixed with unlabeled grass material or PyOM. The pots were kept in the greenhouse under controlled conditions for 16 months and were sampled after 0.5, 1, 5, 8 and 16 months. From all samples the amino acids were extracted after hydrolysis (6 M HCl, 22 h, 110 ºC) and quantified via gas chromatography mass spectrometry (GC/MS). The fate of 15N was followed by isotopic ratio mass spectrometry (IRMS).

The results show that the contribution of extractable amino acids to total soil organic matter was always higher in the unburnt than in the burnt soil. However, with ongoing incubation their amount decreased. Already after 0.5 months, some PyOM-derived 15N was incorporated into the extractable amino acids and the amount increased with experiment time. Since this can only occur after prior microbial degradation of PyOM our results clearly support a lower biochemical recalcitrance of N-rich charred residues than formerly assumed. Our experiment demonstrated further that aside from being incorporated into plants (de la Rosa and Knicker 2011) the release PyOM-N can also be used for the built-up of new microbial biomass.

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