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Input related microbial carbon dynamic of soil organic matter in particle size fractions

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This paper investigated the flow of carbon into different groups of soil microorganisms isolated from different particle size fractions. Two agricultural sites of contrasting organic matter input were compared. Both soils had been submitted to vegetation change from C3 (Rye/Wheat) to C4 (Maize) plants, 25 and 45 years ago. Soil carbon was separated into one fast-degrading particulate organic matter fraction (POM) and one slow-degrading organo-mineral fraction (OMF). The structure of the soil microbial community were investigated using phospholipid fatty acids (PLFA), and turnover of single PLFAs was calculated from the changes in their 13C content. Soil enzyme activities involved in the degradation of carbohydrates was determined using fluorogenic MUF (methyl-umbelliferryl phosphate) substrates.

We found that fresh organic matter input drives soil organic matter dynamic. Higher annual input of fresh organic matter resulted in a higher amount of fungal biomass in the POM-fraction and shorter mean residence times. Fungal activity therefore seems essential for the decomposition and incorporation of organic matter input into the soil. As a consequence, limited litter input changed especially the fungal community favouring arbuscular mycorrhizal fungi. Altogether, supply and availability of fresh plant carbon changed the distribution of microbial biomass, the microbial community structure and enzyme activities and resulted in different priming of soil organic matter.

Most interestingly we found that only at low input the OMF fraction had significantly higher calculated MRT for Gram-positive and Gram-negative bacteria suggesting high recycling of soil carbon or the use of other carbon sources. But on average all microbial groups had nearly similar carbon uptake rates in all fractions and both soils, which contrasted the turnover times of bulk carbon. Hereby the microbial carbon turnover was always faster than the soil organic carbon turnover and higher carbon input reduced the carbon storage efficiency from 51 % in the low input to 20 %. These findings suggest that microbial community preferentially assimilated fresh carbon sources but also used recycled existing soil carbon. However, the priming rate was drastically reduced under carbon limitation. In consequence at high carbon availability more carbon was respired to activate the existing soil carbon (priming) whereas at low carbon availability new soil carbon was formed at higher efficiencies.