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Artificial rhizospheres: Exudate effects on soil organic carbon content, aggregation and microbial community composition in topsoil vs. subsoil

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Rhizodeposition is known to be a major source of organic matter (OM) input to subsoils – a soil region which is generally characterised by very low organic carbon (OC) concentrations, yet stores on average more than half of the total soil OC stocks of the profile. In this study, we used an artificial root system as a model to investigate the effects of soluble root exudates on soil OC dynamics, soil structure formation and microbial community composition in both topsoil and subsoil under controlled laboratory conditions.

Microporous capillaries functioning as artificial roots were installed in simple microcosms filled with topsoil and subsoil samples of a haplic Luvisol from a European beech (Fagus sylvatica L.) forest. The system was fed with two different concentrations of a model root exudate solution (60% acetic acid, 35% glucose, 5% serine) over the course of 30 days. The exudate concentrations represented (1) a low natural exudation rate reported for another German beech forest (Tückmantel et al., 2017) and (2) 30-fold this carbon (C) concentration, a value having been applied in previous comparable artificial root experiments (Keiluweit et al., 2015; Meier et al., 2017). The artificial rhizosphere soil was then analysed for OC and nitrogen (N) and was subjected to an aggregate fractionation, yielding macroaggregates (> 250 μm), as well as different size classes of microaggregates (250-53 μm, 53-20 μm, < 20 μm). Furthermore, amino sugars and phospholipid fatty acids (PLFA) were extracted to investigate the microbial community composition within the artificial rhizosphere soils.

First results show that the effects of soluble root exudates vary, depending on their concentration as well as the soil material (topsoil vs. subsoil) they are applied to. In both soil depths, OC contents tended to decrease in the low exudation treatment, and to increase in the high exudation treatment. A similar trend of opposing effects of exudate concentration was seen for the aggregate size distribution in the topsoil: The low exudation rate led to less macroaggregates and more microaggregates > 20 μm and vice versa for the high exudation treatment. In the subsoil, the high exudate supply had a very strong effect on macroaggregation, which increased by 86%.

Our study demonstrates that the impact of soluble root exudates on soil OC storage and structural development differs substantially between top and subsoil. Furthermore, our results indicate, that these effects can be divergent for different exudate C concentrations that are applied in artificial root experiments or may occur naturally.

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