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Rhizosphere carbon priming: a plant mechanisms to enhance soil nitrogen accessibility?

Maire Holz[1] and Johanna Pausch[2]
[1]Center for Agriculultural Landscape Research (ZALF) e.V., Müncheberg, Germany (maire.holz@zalf.de)
[2]Agroecology, BayCEER, University of Bayreuth, Germany

Soil C priming is a short-term change in the turnover of soil organic matter caused by the addition of easily available organic C to the soil. The increase in SOM decomposition during priming is likely to affect not only C- but also gross N mineralization from SOM because large amounts of soil N is stored in SOM that is decomposed during priming. In order to assess whether soil C priming results in an increase in gross and mineralization and finally in enhanced plant N availability and uptake, we searched the literature for studies relating soil C priming to soil N cycling. In order to assess the effect of soil priming on soil N cycling we included studies quantifying soil C priming (PE) and gross N mineralization (GNM) in plant systems and in incubation setups. Secondly, we searched for studies measuring GNM in dependence to addition of C to the system. The third data set comprised studies, quantifying PE and the % of soil N derived N uptake as well as total N uptake of plants. Finally we included studies that quantified soil priming and enzyme activities in the respective soil samples. In order to be able to compare PE to GNM, % of soil N derived N uptake and soil enzyme activities respectively, we calculated the excess of GNM, % of soil N derived N uptake and soil enzyme activities by subtracting the parameter values of the control from the treatment values. We found a significant positive relation between soil C priming and GNM for studies with plants (R^2=0.21) indicating that soil priming caused by root exudation increased soil N mineralization. In agreement with this, activities of enzymes related to the N cycle were positively related to priming (p=0.09), though, due to the small number of studies, the enzyme results must be interpreted with caution. In contrast to plant studies, the relation between soil C priming and GNM was significantly negative for incubation studies (R^2=0.06). These contrasting results for plant and incubation studies indicate that incubation studies might not adequately reflect processes occurring in the rhizosphere. It is possible that plants attract particularly N mineralizing microbes for example by exudation of signaling compounds, a process that would not be reflected in incubation studies. We also found a significant positive relation between soil C priming and the % of soil N derived N uptake by plants (R^2=0.56) and total plant N uptake (R^2=0.21) indicating that at least part of the N mineralized during priming was available to, and taken up by the plants. In conclusion, the results of our meta-analysis indicate that rhizosphere C priming positively feeds back to plant N nutrition by causing increased N mineralization in the rhizosphere that facilitates plant N uptake.