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Priming of soil organic matter decomposition by glucose additions in boreal forest soils with different C:N ratios

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The last decade it has been increasingly acknowledged that carbon (C) contained in root exudates can accelerate decomposition of soil organic matter (SOM), a phenomenon known as rhizosphere priming effects (RPE). However, the controlling factors and role of different soil microorganisms in RPE is not yet well understood. There are some indications that the response of the microbial decomposer community to labile C input in the rhizosphere depends on microbial demand for nutrients needed for microbial growth and maintenance, e.g. C and nitrogen (N). Since microbial biomass have specific C:N ratios, an increase in microbial C assimilation in response to root exudation of labile C is contingent on the N availability. Therefore, in soils with low N availability, increased decomposition of SOM in response to input of root exudates might be an N-mining response of the microbial community, where plant derived compounds enhances the microbial production of N targeting extracellular enzymes.

To test this hypothesis we assessed priming in boreal forest soils with different C:N ratios. The soils received daily additions of 13C-labelled glucose during one week. Respiration of glucose and respiration of SOM was distinguished by continuously measuring the respiration of SOM and glucose using a Picarro analyzer. We further aimed to test if priming is accompanied by an increase in the activity of C targeting extracellular enzymes in C-poor soils, and with an increase in the activity of N targeting extracellular enzymes in N-poor soils. Our final aim was to test the hypothesis that an unbalanced C to N supply increases the abundance of microbes decomposing complex SOM, while a balanced C to N supply increases the abundance of "cheaters" who preferentially grow on monomers and other labile compounds.

Our results demonstrate that glucose additions induced priming (12-52% increase in SOM respiration) in all soil types, but there was no linear relationship between priming and soil C:N ratio. We also found significant differences in the activities of all enzymes among different sites, but glucose addition did not influence the enzyme activities. Total oxidative enzyme activities, as well as the ratio between the activities of C and N acquiring enzymes were lower in soil with higher C:N ratios, but these findings could not be quantitatively linked to the observed priming rates. In general, the abundance of microbes growing on substrates of different decomposability was not correlated with soil C:N ratios and we could not find evidence to support the hypothesis that an unbalanced C to N supply increases the abundance of microbes decomposing complex SOM.

Taken together, the findings above suggest that there is no consistent linear relationship between soil C:N ratio and the extent of priming. We did however observe a negative relationship between priming and the microbial C:N ratio. Therefore, priming seemed to be more dependent on the C:N ratio of the microbial community than on the C:N ratio of SOM.