Geophysical Research Abstracts
Vol. 20, EGU2018-12105, 2018
EGU General Assembly 2018
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Effect of changing plant C:N ratio on plant–microbial–soil relations and resulting priming effect

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The availability of nitrogen (N), the nutrient most commonly limiting plant production, affects plant photosynthetic activity, biomass production and allocation and C:N ratios of plant biomass. We hypothesize that changes in C:N stoichiometry of plant tissues should be related with the flux and C:N stoichiometry of rhizodeposition (namely root exudation), with an impact on the composition of the rhizosphere microbial community and its performance in soil organic matter cycling (priming effect).
We planted individuals of two non–mycorrhizal graminoids, Glyceria maxima and Carex acuta in pots with the field soil. We repeatedly treated the part of the plants by foliar fertilization with 15N–urea in concentrations of 0, 0.3 and 1% (every 14 days). Keeping this design, we indirectly influenced microbial processes only through the root–derived inputs to the soil. All the plants were continually labeled using CO_2 with d13C of -60 ‰ in purpose to quantify the root–derived C input into the soil and to separate the root– from soil–derived C in the soil CO_2 efflux. These characteristics were complemented by others like plant biomass and its C:N, exudation flux and quality, rhizosphere microbial community structure, soil enzymatic activities, gross N transformation rates, all measured after 10 weeks of continual labeling.
The foliar 15N–urea fertilization did not markedly change either shoot or root plant biomass. Although the fertilized plants had markedly higher 15N abundance in shoots and roots, only the C/N ratio of shoots but not of roots decreased in both species. The composition of root exudates released by studied plants was species–specific and plants specifically responded to fertilization. While nonfertilized Glyceria released large amount of exudates in control conditions and its exudation decreased in response to foliar N fertilization, the much lower exudation of Carex tended to increase after fertilization. Both fertilized species also significantly changed composition of their exudates. We further found increasing amounts of 15N in the soil under fertilized plants. Bacterial and fungal communities formed in the presence of plants were highly species–specific, while the fertilization impact on the community composition was weak and visible only in case of bacterial communities associated with plants fertilized with 1% urea (despite the significant effect of foliar N fertilization on exudate flux and comnposition). Independent of fertilization, the plant presence was connected with an increase in oxidases but not hydrolases enzymatic activities and a slight positive priming effect in comparison to the unplanted soil. Plant fertilization further decreased gross ammonification rates, while increased activities of some hydrolytic enzymes. Therefore, the priming effect tended to increase from 2–3 % under nonfertilized plants to 8–14 % under fertilized plants.
Our results show marked species–specific but weaker fertilization effect on exudation flux, its quality and soil microbial community composition. Oppositely, soil processes were less species–specific but more responded to indirect fertilization effects.

Acknowledgements
Financial support was provided by the Grant Agency of the Czech Republic (16-21743S) and by SoWa Research Infrastructure funded by the Ministry of Education, Youth and Sports of the Czech Republic (LM2015075).