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The role of maize root exudates to availability of N source in different forms in top- and subsoils

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Nitrogen (N) availability is a main constraint to plant productivity, especially when vegetation relies largely on subsoils, which contain considerable N resources but in low availability. Rhizodeposition can promote N cycling by stimulating microbial growth and activity and thus induces the release of mineral-bound nutrients and accelerates decomposition of soil organic matter (SOM). However, many specific processes how root exudates interact with distinct N forms altering their subsoil mobilization still remain unclear. We hypothesize that the lower microbial activity but higher sorption capacity of subsoils induces subsoil-specific N dynamics. To disentangle this, we added four N sources (free NH_4^+, sorbed NH_4^+, urea and plant residues with identical total N content) into top-and subsoils. We quantified microbial processes regulating mineral and organic N availability in top-and subsoils by simulating rhizosphere condition via application of collected root exudates in a well-controlled microcosm experiment. Our results showed that neither growth of the total microbial community, nor shift in the community composition occurs based on maize root exudate amendment resembling a daily exudation amount. However, we observed a clear increase in microbial activity and activation of organic nutrient mobilizing mechanisms (e.g. enzyme activation), which was in most cases higher in sub- than in topsoils. This suggests that root exudates may not be of highest relevance for topsoil nutrient mobilization. In contrast, high root exudation is of much higher relevance for crops, which aim to mobilize a significant proportion of their nutrients from subsoils. We could demonstrate that subsoil communities were well capable of using litter-derived N, especially if root exudates accelerate overall activity and N cycling in subsoils. N incorporated from plant litter is successively recycled in microbial bio-and necromass following the initial degradation. Consequently, if breeding for deep-rooting crops with nutrient uptake from subsoils shall be promoted in the future, it is essential to ensure that these crops deep roots have a high root exudation to activate the highly C limited microbial communities of the subsoil.