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Effects of plant diversity on microbial nitrogen and phosphorus dynamics in soil

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There is a general consensus that plant diversity affects many ecosystem functions. One example of such an effect is the enhanced aboveground and belowground plant biomass production with increasing species richness, with implications for carbon and nutrient distribution in soil. The Jena Experiment (http://www.the-jena-experiment.de/), a grassland biodiversity experiment established in 2002 in Germany, comprises different levels of plant species richness and different numbers of plant functional groups. It provides the opportunity to examine how changes in biodiversity impact on microbially-mediated nutrient cycling processes. We here report on plant diversity and plant functional composition effects on growth and nitrogen and phosphorus transformation rates, including nitrogen use efficiency, of microbial communities.

Microbial growth rates and microbial biomass were positively affected by increasing plant species richness. Amino acid and ammonium concentrations in soil were also positively affected by plant species richness, while phosphate concentrations in contrast were negatively affected. The cycling of organic N in soils (estimated as gross protein depolymerization rates) increased about threefold with plant diversity, while gross N and P mineralization were not significantly affected by either species or functional richness. Microbial nitrogen use efficiency did not respond to different levels of plant diversity but was very high (0.96 and 0.98) across all levels of plant species richness, demonstrating a low N availability for microbes. Taken together this indicates that soil microbial communities were able to meet the well-documented increase in plant N content with species richness, and also the higher N demand of the microbial community by increasing the recycling of organic N such as proteins. In fact, the microbial community even overcompensated the increased plant and microbial N demand, as evidenced by increased levels of free amino acids and ammonium in the soil solution at higher species richness. A possible explanation for increased organic nitrogen transformation rates is the increased microbial biomass, which has previously been related to higher quantity and variety of plant derived compounds that are available to the microbial communities at higher plant diversity. Given that this explanation is right, it is interesting to note that the additional (plant-derived) microbial biomass at higher species richness, did not translate in higher soil P mineralization rates or phosphate availability.