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# Rhizosphere effect in forest ecosystems: controls of plant competition, root traits and mycorrhizal association

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Rhizosphere has been increasingly recognized as a hotspot of microbial activity and biogeochemical cycling. However, the factors controlling rhizosphere effects, particularly in forest ecosystems, are poorly understood. We have used a number of complementary methods to investigate the rhizosphere effects on soil carbon and nutrient cycling in forest ecosystems. Here we report how plant competition, root traits, and mycorrhizal association control the magnitude of rhizosphere effects.

In the first study, by growing tree seedlings in a C4 soil, we showed that three tree species (larch, ash and Chinese fir) all showed significant positive effects on soil carbon decomposition and gross nitrogen mineralization. However, such rhizosphere effects were reduced by intraspecific competition, particularly in ash and Chinese fir, likely due to the competition of available nitrogen and limitation of microbial activity in the double seedling treatment compared to the single seedling treatment.

In the second study, using the same method (C3 tree seedlings grown in C4 soils), we found that when a single tree species (Chinese fir) was grown in three different C4 soils, the positive rhizosphere effects on soil carbon and nitrogen mineralization can be predicted with the traits (biomass, length, surface area or nitrogen content) of absorptive fine roots (1st and 2rd order), but not with the traits of transport coarse roots (3rd and higher order). However, when three different species (larch, ash and Chinese fir) were grown in a common C4 soil, there was no relationship between rhizosphere effects and traits of absorptive roots or transport roots.

In the third study, based on the adhering soil method to sample paired rhizosphere and bulk soils from mature field-grown trees, we investigated the rhizosphere effects of 12 coexisting tree species associated with arbuscular mycorrhizal (AM) or ectomycorrhizal (ECM) fungi in a temperate secondary forest in Northeast China. We found that although soil characteristics, microbial biomass and enzyme activity, and carbon and nitrogen mineralization rates differed significantly between rhizosphere and bulk soil, the rhizosphere effects did not vary remarkably between the two mycorrhizal types (AM vs. ECM), despite large variations in some variables among species within each group and overall. These results suggest that mycorrhizal association alone is a poor predictor of the rhizosphere effects of the 12 co-existing tree species. Future work need to combine phylogenic history and functional traits of plant species with the type and traits of mycorrhizal associations to better understand how plant-microbe interactions influence biogeochemical cycling in the rhizosphere.