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Rhizosphere effect of woody plants: A meta-analysis

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Interactions among plants, soil and microbiota play an important role in maintaining the function of terrestrial ecosystems, which often occur in rhizosphere. The rhizosphere effect is defined as the difference in soil properties and biogeochemical processes between rhizosphere and root-free bulk soil. Despite its importance in controlling soil biogeochemical cycling, quantitative assessments of the rhizosphere effects of woody plants are still rare. In this study, we synthesized the rhizosphere effects of woody plants on soil physicochemical properties, microbial biomass and community structure, enzyme activities, and carbon (C) and nitrogen (N) mineralization rates. We also explored the controls of rhizosphere effects by functional traits (eg. leaf life form, mycorrhizal type), environmental and experimental variables (eg. soil sampling method).

Our results showed that the rhizosphere effects on most soil physicochemical variables were positive (except pH). For example, the rhizosphere stimulated C mineralization rate by 56.7%, gross N mineralization rate by 57.9%, and net N mineralization by 60.9% on average compared to the root-free bulk soil. Moreover, for enzyme activities and C mineralization rate, the rhizosphere effects were generally higher in shrubs than in trees. For C mineralization rate, the rhizosphere effects of evergreen species were stronger than those of deciduous species. However, the rhizosphere effects did not vary significantly between species associated two mycorrhizal types (arbuscular mycorrhizal, AM vs. ectomycorrhizal ECM), with few exceptions for NO_3^-, NH_4^+, bacteria and fungi biomass. Overall, this meta-analysis comprehensively assessed the rhizosphere effects of woody plants (187 species and 29 variables) on global scale and strengthened our understanding of the effect of living roots on soil C and nutrient cycling in the rhizosphere.