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Rhizosphere priming effects of mature trees: are they determined by mycorrhizal association?

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The rhizosphere has been increasingly recognized as a hotspot of biogeochemical cycling in forest ecosystems. However, such rhizosphere priming effects (RPE) on soil carbon and nitrogen cycling for mature field-grown trees, particularly trees associated with contrasting mycorrhizal associations, remain largely unknown. Here we report the RPE of five tree species associated with arbuscular mycorrhizal (AM) or ectomycorrhizal (ECM) fungi in a subtropical forest ecosystem on Mt. Wuyi in south China.

We selected three AM trees (Cryptomeria fortune, Schima superba and Liquidambar acalycina) and two ECM trees (Castanopsis eyrie and Carpinus viminea) that were about 50 years old and co-occurring in a subtropical evergreen broad-leaved forest. Intact living roots (remaining attached to mature trees) with fifth and higher orders of each species were dug up, washed and then buried into root chambers filled with C4 soils (planted with maize for 30 years) for up to 720 days. We periodically collected soil respiration of each chamber by a closed-circulation CO_2 trapping system, separated soil-derived CO_2 from root-derived CO_2 using a natural abundance 13C method, and then determined the RPE as the difference in soil-derived CO_2 between rooted and rootless chambers.

We found that the magnitude and direction of RPEs varied widely, ranging from -3% to +297%. RPEs were significantly influenced by tree species ($P = 0.009$), with the highest values for Carpinus viminea and the lowest values for Schima superba. Moreover, RPEs showed clear seasonal variations ($P < 0.001$), and became increasingly stronger toward the end of the experiment (with increasing incubation time in the chamber). On average, the RPEs of ECM trees tended to be higher than that of AM trees ($P = 0.089$). We are currently measuring gross and net nitrogen mineralization rates, microbial biomass, enzyme activity and community composition, soil characteristics, and root traits to further investigate the mechanisms of RPEs.

Collectively, these findings indicate that live roots of mature trees and their mycorrhizal associations could enhance soil carbon decomposition, and ECM tree species may have stronger RPEs than AM tree species in subtropical evergreen broad-leaved forest.