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Effects of litter manipulation on soil biochemical processes: A global meta-analysis

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Global changes can alter the quantity and quality of above- and below-ground inputs, which will affect soil carbon (C) dynamics and nutrient cycles. The effects of detritus from above- and below-ground are not entirely uniform. Although numerous experiments have been conducted, the general patterns of how litter manipulation affect soil biochemical processes and whether such effects varied among changes in above- and below-ground inputs remain unclear.

Here, we conducted a meta-analysis of 2181 observations from 216 published studies to examine the responses of belowground processes to manipulated above- and below-ground litter alterations. Our results showed that, across all studies, litter manipulation generally had significant effects on soil moisture, but had minor effects on soil temperature and pH. Litter addition generally stimulated C and nutrient cycle, and microbial variables, whereas removal of litter, root and both of them generally suppressed or did not change these processes. Specifically, litter addition significantly increased soil respiration (R_s) and soil organic carbon (SOC) content in the mineral soil by 24.5% and 6.2%, respectively. Litter removal, root removal, and no inputs (removal of both litter and root) reduced R_s by 23.6%, 38.1%, and 50.2%, respectively. Litter removal and no inputs on average decreased SOC content in the mineral soil by 19% and 22.8%, respectively, but such negative effect did not occur under root removal. This suggests that aboveground litter may be more valid in soil C stabilization than roots within a relatively short period. In addition, manipulation level also regulated the responses of SOC, R_s and MBC to litter alterations. The direction of litter manipulation effects on multiple variables are basically similar among ecosystem types.

Overall, our findings provide a reference for assessing the impact of primary productivity growth on C and nutrient cycling in terrestrial ecosystems under global changes, and highlight that the effects of aboveground litters and roots should be separately incorporated into soil C models.