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Litter quality and quantity alters the balance of soil organic matter composition and decomposition in forests

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Forests hold vast reserves of terrestrial carbon in the form of soil organic matter. The complex chemistry of soil organic matter and the multitude of interactions with soil biota and minerals, has resulted in uncertainty regarding the long-term fate of soil carbon in forests, especially with global environmental change. Increasing temperatures, atmospheric CO_2 levels, shifts in moisture regimes, coupled with changes in the quality and quantity of litter inputs will alter soil carbon biogeochemical processes but the underlying mechanisms are unclear. Furthermore, there is a limited understanding of how global environmental change may impact the balance of soil organic matter pools and sources (microbial-derived versus plant-derived). To improve the understanding of soil biogeochemical processes, the molecular-level composition of soil organic matter was assessed after twenty years of annual changes in litter inputs in an old-growth conifer forest (H.J. Andrews Forest, Oregon, USA). Soil carbon and nitrogen as well as solid-state ^{13}C nuclear magnetic resonance (NMR) was also measured. Doubling of litter inputs over twenty years did not increase soil carbon. The lack of increase was associated with higher microbial biomass (phospholipid fatty acids) which degraded these additional inputs via soil priming. Double litter additions also increased the relative stage of soil organic matter decomposition (as measured by ^{13}C NMR spectroscopy) in the mineral soil. Double wood also enhanced soil organic matter decomposition but differently than double litter. Double litter, which is predominantly comprised of conifer needles, has a lower carbon to nitrogen ratio and is of a higher quality than wood. A comparison of litter quality to the production of microbial-derived lipids revealed that both litter additions increased the production of these lipids but differently. Double litter (high quality litter) increased the concentration of microbial-derived lipids in the 0-10cm soil layer whereas double wood (low quality litter) increased the concentration of microbial-derived lipids in the O horizon only. These results demonstrate that litter quality as well as quantity can alter the production of microbial-derived lipids and the overall balance of soil organic matter composition and decomposition.