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Biochemistry of plant litter types drives differentiation into particulate and mineral-associated soil organic matter and determines the magnitude of priming effect

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Soil organic matter (SOM) originates predominantly from above and belowground OM inputs derived from plants. Although the formation of SOM is well studied, it still remains unclear how the biochemical composition of litter affects the formation of new SOM as well as the degradation of “native” SOM. In the present study we aimed to disentangle the effect of plant litter composition on C transference from different plant tissues into specific SOM fractions and to determine the magnitude of priming effect on native SOC caused by litter amendments. To this end, we individually incubated ^{13}C enriched Eucalyptus spp. major litter types (bark, leaves, twigs and roots) in soil (0–20 cm) of a sandy-clay loam (Haplic Ferralsol - Brazil). Additionally, a soil sample without plant residue addition was incubated as a control. The samples were incubated at 80% of their water-holding capacity at 25 °C for 200 days. Soil respiration was assessed along the incubation period through headspace gas sampling and $^{13}C/^{12}C–CO_2$ analysis in a cavity ring-down spectrometer. After the incubation, soil subsamples were physically fractionated using a combined density-particle size separation method. The total C and the δ ^{13}C of each soil organic matter fraction were measured and the litter-C contribution for each SOM fraction was assessed using a two-end member isotope mixing model. The molecular composition of the incubated plant material and SOM fractions were determined by solid-state ^{13}C-CPMAS-NMR spectroscopy. Interestingly, we found no significant differences for total SOM contents among the different treatments. Conversely, incubation without litter amendment (control treatment) resulted in lower total SOM contents, indicating mineralization of “native” SOM along the incubation period. The partitioning of litter-derived C into SOM fractions indicated that leaves litter were preferentially transferred to mineral associated organic matter (MAOM), while roots contributed more to particulate organic matter (POM). Cumulative C-CO_2 evolution from the treatments over the incubation period increased in the following order: twigs > leaves > bark > roots > controls. Incubation with twigs, bark and roots significantly increased “native” SOM respiration, while the treatment with leaves addition did not differ from the control. When tracing the source of “native” SOM-derived CO_2, we observed a similar amount of C being respired from MAOM, regardless the treatment, while incubation with twigs, bark and roots resulted in higher respiration of “native” SOM-derived C from POM. Our data demonstrates that the biochemical composition of plant litter

determines the fate of newly formed organic matter (MAOM or POM) and controls the degradation of “native” SOM. Therefore, plant residues enriched in more easily degradable compounds (leaves) are preferentially transferred to MAOM and causes less native SOC priming. On the other hand, plant residues enriched in structural compounds (twigs, bark and roots), are preferentially respired or allocated into the POM, also resulting in higher priming effect intensity.