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Soil organic matter stabilization in top and subsoil

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As soils have a recognized capacity of carbon storage, the understanding of the mechanisms responsible for soil organic matter (SOM) stabilization are of extreme importance. Yet, our knowledge about the factors and processes controlling the amounts of stabilized versus mineralized SOM is still remarkably limited. We examined the decomposition of different plant inputs in a top- (0 – 0.2 m) and subsoil (0.8 – 0.9 m) of an Andosol. We performed an incubation experiment during 60 days using as amendments 13C isotope labelled plant leaves (Salix spp.) and dissolved organic carbon (DOC) extracted after incubation of leaves (pelleted – 1 mm or liquid - < 0.7 μm). Soil respiration was measured with a δ13C CO_2 Isotope Analyzer. After the incubation period, the soils were fractionated by density using a sodium polytungstate solution of 1.8 g cm-3 into two fractions: heavy (> 1.8 g cm-3) and light (< 1.8 g cm-3). The added 13C amount was then measured by Isotope-ratio mass spectrometry (IRMS). This experiment allowed us to observe distinctive SOM stabilization and mineralization patterns in both soil layers depending on the added material. The DOC, whether pelleted or liquid, was significantly more respired than the leaves in both soil layers. In the subsoil but not the topsoil, we observed a significant difference between the respiration of the different DOC forms (pelleted and liquid). Since both DOC forms vary by location (distributed vs point source) and size (pelleted vs liquid), the mineralization results point at several explanations: (i) smaller particles are more efficiently stabilized in subsoil layers by mineral interactions than larger structures due to their greater surface area, (ii) more dilute material is more efficiently adsorbed as concentrated organic matter exceeds sorption capacity (saturation concept), or (iii) more concentrated organic matter is more easily mineralized than more dilute because microorganisms are able to specialize to metabolize the substrate. As the leaves and pelleted DOC were both point sources of SOM, the differences in their mineralization rates indicates a significant influence of material solubility. We also observed distinct patterns of SOM stabilization in top- and subsoil. In the subsoil, a greater proportion of the added DOC (pelleted and liquid) than the leaves was found in the heavy fraction, which is commonly interpreted as stabilized C on clay surfaces and less accessible to microorganisms. This may indicate that mineral association explained differences in CO_2 evolution. In the topsoil, added C remained in light fractions typically interpreted as largely unassociated with minerals. However, presence in such light fraction in the topsoil must still have reduced mineralization. Higher proportions of added leaves and pelleted DOC remained in the topsoil mineral fraction than of the liquid DOC, which indicates that point sources of C provided higher stabilization into soil minerals. These differences clearly illustrate distinct mechanisms for SOM protection depending on the evaluated soil layer and amendment added. We demonstrated that SOM stabilization in top and subsoil is significantly affected by the spatial distribution and the solubility of the amendment.