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Fate of 13C and 15N labeled root litter in different soil depths studied by physical fractionation

Muhammad Sanaullah, Abad Chabbi, Gerard Bardoux, Daniel Billou, and Cornelia Rumpel
BIOEMCO, Thiverval-Grignon, France (sanaullah_1076@yahoo.com)

Root material contributes greatly to soil carbon especially in lower parts of the soil profile. Here, the addition of labile root material to mineral soil may lead to loss of native soil organic matter (SOM) through the priming effect. The objective of this study was to elucidate the fate of root material incorporated into mineral soil and to quantify its effect on native soil carbon in different soil depths, during a three year field experiment. Our conceptual approach included the exposure of litter bags with 13C and 15N labeled wheat root material mixed to loamy agricultural soil at three different soil depths (30, 60 and 90 cm). Physical fractionation of the mineral soil was carried out in order to isolate SOM fractions with different turnover times.

Our results showed that the root litter addition significantly influenced the size of microbial biomass in all three soil horizons. Higher microbial biomass was recorded in the soil surface and was most probably responsible for the higher decomposition of the root litter compared to the subsoil horizons. Maximum root carbon loss was reached after 6 months in the topsoil and after 12 to 20 months at lower depth. In subsoil horizons more than 40% of root carbon remained in soil during the 3 year experiment. Most of the root-derived C and N remained in the three soil depth either occluded in soil aggregates (oPOM) or as organo-mineral complexes. At depth, higher proportions of root carbon were present as oPOM, whereas at the soil surface more root C was associated with the fraction <50 μm. Addition of fresh root litter caused decomposition of native soil C in subsoil horizons and as a result 5-30 % of total native C were decomposed, after 3 years of incubation.

We conclude that long-term field experiments in combination with stable isotope labeling of plant material are a useful tool to study soil organic matter dynamics in situ. Using this technique we were able to show the importance of aggregation for organic matter protection in subsoil horizons. Moreover, we quantified the priming effect of carbon present in organo-mineral interactions of subsoil horizons.