Incorporation of ^{13}C labelled root-shoot residues in soil in the presence of *Lumbricus terrestris*: An isotopic and microbial approach

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Résumé:

Litter from plant biomass deposited on soil surface can either be mineralized or transferred into the soil as organic compounds, depending on numerous biotic factors. Many studies have focused on the origin of organic matter, with a particular attention to the fate of root and shoot litter. It is generally admitted that roots decompose at a slower rate than shoots, resulting in a higher carbon sequestration in soil for compounds originating from roots. Earthworms play a central role in litter decomposition and carbon cycling, ingesting both organic and mineral compounds which are mixed, complexed and dejected in the form of casts. Their action is generally associated with a modification of the microbial community and activity in soil. The simultaneous impact of earthworms and root-shoot on soil carbon cycling is still poorly understood.

This study aimed at defining the rate of incorporation of root and shoot litter with or without earthworms. A mesocosm experiment was set up to follow the incorporation of ^{13}C labelled Ryegrass root and shoot litter in the soil, in the presence of earthworms (*Lumbricus terrestris*). Soil samples were collected at 0-20 and 40-60 cm, as well as surface casts, at the beginning and after 1, 2, 4, 8, 24 and 54 weeks of experiment. Organic carbon content and $\delta^{13}C$ values were determined for all the samples with Elemental Analysis – Isotope Ratio Mass Spectrometry. The metabolic diversity of the microbial community was characterized using the Biolog® EcoPlate™. The DNA was extracted using the PowerSoil® DNA extraction Kit (Mobio) in the soil and cast samples, after one year of experiment and quantified with the Quant-iTTM dsDNA High-Sensitivity Kit to estimate microbial abundance.

Roots and shoots were continuously incorporated in the 0-20 cm soil layer during the year of experiment, the carbon from labelled litter (C_{lab}) reaching 11.4 % after 54 weeks. On the contrary, no significant incorporation was observed in the 40-60 cm layer. An earthworm effect on litter incorporation was observed in casts from the very first weeks of experiment (C_{lab} from 34.8 to 51.4 % after 2 weeks) and in soil after 24 weeks. Earthworms accelerated root and shoot decomposition in soil. Roots decomposed at a slower rate compared to shoots. However, after one year, earthworms erased the difference between residue types in casts and to a lesser extent in soil, revealing their capacity to decompose both roots and shoots. After one year, the metabolic activity of cultivable bacteria, expressed in average well color development, was higher in the casts containing roots or shoots (1.7 Optical Density - OD) and the mesocosms containing roots (1.5 OD), compared to soil controls (0.9 OD). Microbial DNA quantities were around two fold higher in the soil containing earthworms and in casts compared to other mesocosms.