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Multi-isotope labelling (13C, 18O, 2H) for studying organic matter cycling within plant-soil systems

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Carbon cycling has become of major interest for the understanding and mitigation of global climatic change. Terrestrial ecosystems have a large carbon sequestration potential, but many processes and fluxes of organic matter (OM) cycling within the plant-soil system are not yet well understood [1]. The dynamics of OM cycling within the plant soil-system are determined by environmental parameters, as well as chemical quality of OM input. A well-known technique to study OM dynamics is to label OM inputs with stable isotopes (e.g 13C). Changes in OM quality in the plant and in the soil can be assessed by compound specific isotopic analysis [2]. These techniques give a precise insight of the OM composition, but are laborious and expensive. Here we suggest a new multi-isotope labelling technique using stable 13C in combination with stable 18O and 2H isotopes, which provides information on OM quality by simple bulk material analysis. The method is based on the creation of an isotopic van Krevelen diagram, which is used to describe different compound groups by plotting the atomic ratios of O/C vs. H/C [3].

We could show that new assimilates can be labelled with 13C, 18O and 2H by adding the stable isotopes (continuously) in the gaseous phase (CO_2 and water vapour) to the plants atmosphere. The label has been traced within the bulk material of different compartments of the plant-soil system (e.g. leaves, stems, roots, bulk soil). Our first results showed that after 2, 8 and 14 days of labelling the 18O/13C(new) ratio was notably different in leaf, stem and root tissue (0.0024, 0.0011 and 0.0007, respectively), suggesting a change in OM quality towards more C-rich compounds. d2H analysis will follow and an isotopic van Krevelen diagram will be produced (18O/13C(new) vs. 2H/13C(new)) to describe the changes in OM quality.

The new multi-isotope labelling approach represent a powerful tool to address open questions in plant and soil research such as the allocation of organic molecules within the plant-soil system under changing environmental conditions or the influence of plant roots on soil organic matter stabilization and destabilization processes.

References

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