Stable isotope labelling techniques as a promising tool in studying the fate of pesticides in soil

Thordis Zegarski1, Anja Miltner1, Karolina M. Nowak2, Matthias Kästner1

1 UFZ - Helmholtz-Centre for Environmental Research, Dept. of Environmental Biotechnology, Permoserstr. 15, 04318 Leipzig, Germany

2 RWTH Aachen University, Institute for Environmental Research, Worringerweg 1, 52074 Aachen, Germany

E-mail contact: thordis.zegarski@ufz.de

Isotope tracers (radioactive and stable) are generally used in the estimation of a compound turnover in soil studies. Degradation of anthropogenic pollutants, e.g. pesticides, in soils generally leads to mineralization products, intermediate metabolites and non-extractable residues formation. Most studies targeted on compound turnover mass balance are limited to radiotracers (14C) and focus on the quantitation of mineralization and extractable and non-extractable residues. Radiolabelled compounds, however, do not allow identifying the detailed chemical identity of metabolisation products, and the chemical structure of non-extractable residues. Since elucidating the fate of pesticides and the risk associated with their residues in soil becomes more and more important to degradation studies, the chemical structure of non-extractable residues needs to be identified. Stable isotope-labelled pesticides, especially colabelled compounds, allow new insights into degradation pathways and formation of non-extractable residues. In addition, the chemical composition of the compounds immobilized as NER can be elucidated by silylation- or chemical degradation studies and analysis of humic matter fractions by combining GC/MS and GC-irMS techniques.

Parts of the non-extractable residues may be biogenic, since pesticide-derived carbon and nitrogen are assimilated by the microorganisms and used to build their biomass. As a result they are incorporated into fatty acids and amino acids. After cell death these compounds can be released to form biogenic residues in soil organic matter (SOM). Stable isotope labelling enables tracking pesticide derived nitrogen and carbon, and the contribution of microbial biomass to NER formation and gives a better understanding of biogenic residue formation and additional information on the 13C/15N-label distribution within a complex soil system. We will demonstrate the potential of this approach using a 13C/15N colabelled pesticide as an example. This presentation will provide a general overview about the application of stable isotope tracer techniques and their potentials and limitations in studies on pesticide degradation in soils.

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