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Field versus laboratory studies - comparing turnover rates of ^{14}C-labelled citrate in soil

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Compound specific mineralization studies as well as soil respiration measurements provide a powerful tool to trace the fate of various carbon substrates in soil and to estimate changes in carbon fluxes and turnover rates as a response to anthropogenic perturbation such as climate change, pollution and agriculture. These measurements of carbon (C) turnover are frequently made in the laboratory where it is easier to control the experimental conditions. However, factors such as the absence of plants and associated mycorrhizas, physical disturbance (sampling and sieving), alteration in redox status, exposure to light and changes in temperature might potentially alter microbial activity and consequently CO_2 production. Therefore the aim of this study was to compare in-situ biodegradation rates in the field on three contrasting land use regimes (arable, woodland, grassland) with mineralization rates in laboratory using ^{14}C labelled citric acid as a model LMW carbon substrate. In both the laboratory and the field we showed that $^{14}CO_2$ evolution followed a bi-phasic pattern that conformed well to a double first-order kinetic model. While the first rapid mineralization phase showed a similar half-life for citrate under all laboratory and field conditions (4.93 ± 0.74h), the second slower mineralization phase had a significantly longer half-life when performed in the field. Overall, our results suggest that citrate depletion from the soil solution was largely independent of our experimental conditions whilst the turnover of the citrate-derived C immobilized in the microbial biomass was significantly affected by the incubation conditions. We conclude that laboratory incubation studies may lead to a significant overestimation of soil organic matter turnover rates and that the laboratory provides a poor surrogate for field experimentation.

Keywords: Bias, Biodegradation, Carbon models, Decomposition, Carbon turnover