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Three-source-partitioning of soil carbon pools and fluxes and priming effects induced by carbohydrates of different availability

E. Blagodatskaya (1,2), N. Khomyakov (3), O. Myachina (3), S. Blagodatsky (2,4), Y. Kuzyakov (1,3)

(1) University of Goettingen, Soil Science of Temperate Ecosystems Büsgen-Institute, Goettingen, Germany (sblag@mail.ru), (2) Institute of Physicochemical and Biological Problems in Soil Science, Russian Academy of Sciences, Pushchino, Russia , (3) Dep. of Agroecosystem Research, University of Bayreuth, D-95440 Bayreuth, Germany, (4) University of Hohenheim, Department of Plant Production and Agroecology in the Tropics and Subtropics, Stuttgart, Germany

Soil organic matter (SOM) is not uniform and includes: 1) fresh input of plant-derived organics, i.e. root exudates and rhizodeposits, 2) partially decomposed plant residues and 3) old humus material. The partitioning of these three carbon sources in soil C pools (microbial biomass and dissolved organic matter) and quantification of their contributions in soil CO_2 ?uxes is a current challenge in soil science aiming to reveal the C pathways and drivers in terrestrial ecosystems. We applied uniformly labeled ^{14}C-cellulose and ^{14}C-glucose (as low and easily available substrates, respectively) in Ap of loamy Haplic Luvisol developed under C_3 vegetation. *Miscanthus x giganteus* (Greef et Deu) – a perennial C_4 plant – was grown for 12 years before the experiment with glucose/cellulose addition. Natural differences in the abundance of ^{13}C between C_4 and C_3 plants were used to distinguish between old SOC ($>$ 12 years) and recent *Miscanthus*-derived C ($<$ 12 years). This enabled us to estimate mechanisms and sources of priming effects (PE) during decomposition of applied substrates with varying availability. The real and apparent priming effects were distinguished by partitioning of microbial C for substrate-C and SOM-derived C. Microbial specific growth rates and activity of hydrolytic enzymes were determined to reveal the mechanisms of real PEs.

Both short-term apparent and long-term real PEs were induces by glucose, while the cellulose input caused only real PE. Remarkably, the shift to the domination of slow-growing microorganisms was observed during real PEs independently of substrate quality. This is the first direct confirmation of the hypothesized presumable contribution of K-strategists to real priming. 2.5-3 times increase in beta-glucosidase and phosphatase activity coupled with real PE in soil treated with glucose indicated that strong limitation and microbial starvation after glucose consumption caused the PE. Contrary to that the 75% increase in cellobiohydrolase activity (enzyme decomposing cellulose) indicated the co-metabolism as a possible mechanism of PE induced by cellulose.

We conclude that 3-source-partitioning based on a combination of ^{14}C labeling and estimation of ^{13}C natural abundance is a very useful tool in clearly separating sources and evaluating mechanisms of priming effects.