Tagungsnummer
V208

Thema
Kommission III: Bodenbiologie und Bodenökologie

Biogeochemische Hotspots im Boden

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Titel
"Non-metabolizable" glucose analogue shines new light on priming
mechanisms: Triggering of microbial metabolism

Abstract
The rhizosphere and detritusphere are characterized by increased carbon availability, including low-molecular weight organic substances. Such easily biodegradable organic substances can change the mineralization rates of pre-existing soil organic matter, a phenomenon termed priming. Priming of soil organic matter decomposition has attracted much research interest, yet a conclusive mechanistic explanation remains elusive. One proposal is that low molecular weight organic substances might "trigger" an acceleration of microbial metabolism. For the first time, we applied a glucose analogue to soil to demonstrate triggering of microbial metabolism, and to estimate its relative contribution to priming. "Non-metabolizable" glucose analogues have been widely used in pure culture studies to mimic glucose, but never in soil biochemistry. We hypothesized that analogue molecules will elicit a metabolic response in microorganisms despite limited catabolism, and thereby confirm the proposed triggering.
The effect of ^{14}C-labeled 3-O-methyl-D-glucose (OMG) – a common "non-metabolizable" glucose analogue – on soil organic matter mineralization was compared to that of ^{14}C-labeled D-glucose. OMG was mineralized, but its mineralization was initially impeded and substantially delayed, relative to glucose. OMG caused brief but strong priming in the first 24 h, increasing unlabeled CO_2 efflux by 173%, 89% and 36% above control for additions of 0.49, 2.4 and 4.9 mmol OMG g^{-1} soil, respectively. In contrast, glucose caused low or negative priming on the first day. On the first day after OMG addition, a negative correlation between priming and OMG mineralization indicated that triggering is a valid mechanism of microbial activation during a famine-feast transition, but is short-lived. Glucose mineralization peaked on the second day for medium and high additions, coinciding with peaks in positive priming. Maximum substrate mineralization also coincided with peaks in priming for medium and high OMG levels, but these occurred 9 and 11 days after addition, respectively. This revealed non-triggering priming mechanisms, which contributed most to priming and were closely coupled to substrate mineralization. By separating energy- and substrate-dependent metabolic processes from triggering processes, the glucose analogue 3-O-methyl-D-glucose enabled triggering to be demonstrated, but triggering by glucose occurs without contributing greatly to priming.