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Intracellular energy storage mediating soil microbial resource stress

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A diverse range of soil microorganisms accumulate energy to secure their future needs under resource fluctuation or deficiency. Microbial intracellular storage can substantially mediate the stress of resource variability across time, thereby supporting growth and reproduction. Microbial storage is well known in industrial applications and under pure culture conditions, yet few studies address its importance in the soil. To evaluate how widespread microbial energy storage is in soil, we quantified the contents of two intracellular storage compounds, polyhydroxybutyrate (PHB) and triacylglycerides (TAGs), from seven permanent grasslands in Germany differing in field management (grazing/mowing and fertilizing) and soil types. In winter 2021, soil was collected from two depths, 5-10 cm called topsoil, and >30 cm called subsoil, to capture different soil carbon inputs from grass roots. The storage compound contents were determined by gas chromatography–mass spectrometry (GC-MS). We hypothesized that the carbon input controls the storage compound levels. From topsoil to subsoil, as root carbon inputs (estimated from the fresh root weight) drop with depth, microbial storage levels follow suit. Dissolved organic carbon (DOC) was measured to qualify carbon availability to microorganisms, and microbial biomass carbon (MBC) was to assess microbial biomass. The root weight in the topsoil was 20-50 times higher than in the subsoil, while MBC and DOC contents were 3-4 and 1.5-2.5 times higher, respectively. Storage levels and MBC decreased with depth, and showed a positive correlation with DOC. This experiment allowed us to quantify intracellular storage occurrence in soils and to understand how its distribution related to root carbon input. These results point out that microbial intracellular carbon storage might accumulate according to the available carbon level (root carbon inputs) for microorganisms. Thus, this carbon plays a pivotal role for microbial ecology of soils as it prepares the microbial cells to survive throughout the winter when less carbon is provided by plants.