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Response of microbial carbon use efficiency and biomass turnover to crop rotational diversity

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Soil organic carbon sequestration in agroecosystems has received wide attention in recent years, as it can mitigate a portion of anthropogenic carbon emissions. Although agricultural management practices, such as crop rotation, reduced tillage or crop residue management, have been shown to have the potential to increase soil organic carbon storage, the underlying mechanisms are yet to be understood. Traditional soil carbon concepts and models suggest that building soil carbon in agricultural systems requires increasing carbon inputs through additions of slowly decomposing crop residues, or reducing carbon loss by minimizing soil disturbance to slow decomposition processes. These management practices, however, have shown inconsistent effects on soil organic carbon storage so far. A growing body of research indicates that soil microbial physiology plays a fundamental role in soil organic carbon sequestration and stabilization. Heterotrophic soil microorganisms take up organic carbon, which is partitioned between respiration (loss of carbon as carbon dioxide) and growth (incorporation of carbon into biomass), with the latter having the potential to be stabilized in soils. This partitioning factor is described as microbial carbon use efficiency – a critical parameter in soil biogeochemistry models. Further, since microbial anabolism generates products that can be sequestered, microbial growth rates and biomass turnover are also integral to soil carbon accumulation rates.

Here we assess how crop diversity affects soil microbial physiological parameters across five long-term experiments in Central U.S. and Canada along a soil-climate gradient. Specifically, we analysed microbial carbon use efficiency, growth and biomass turnover in corn-based crop rotations ranging from corn monocultures to five crops in rotation. Crop rotations are characterized by a greater diversity of plants and plant litter inputs as well as by higher litter quality and have been shown to sustain soil quality and productivity by enhancing soil carbon, nitrogen, and microbial biomass. Therefore, we hypothesized that microbial carbon use efficiency, growth and biomass turnover increases with increasing crop rotational diversity. The present study will provide novel insights into how agricultural management practices affects microbial physiology, which will help to model and predict soil organic carbon dynamics in agroecosystems.