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More than Meets the Dye: Evaluating Preferential Flow Paths as Microbial Hotspots

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Abstract:

Preferential flow paths have been suggested to function as microbial hotspots. This idea is speculative, based on biomass counts rather than assessments of activity of the microbial population. In this study we used O_2-sensitive optodes, or optical sensor devices, to observe O_2 depletion by soil microbes as a reference for microbial activity along three artificially constructed preferential flow path geometries. The flow paths were constructed using contrasting fine (210 – 297 μm) and coarse (595 – 841 μm) sand textures in the geometries of (i) coarse sand in the center surrounded by fine sand, (ii) half coarse sand on the left and half fine sand on the right, and (iii) fine sand in the center surrounded by coarse sand. A soil slurry, containing soil microbes and glucose as an added source of C, was flowed through the sands to create nutrient gradients due to nonuniform flow. Results suggest that O_2 depletion is greatest along the boundary between preferential flow paths (coarse sand) the bulk matrix (fine sand). While the results offer insight into the locations of microbial activity, the exact positioning remains unclear. Our work suggests that preferential flow plays a key role in the spatial distribution of microbial hotspots in soil and demonstrates the nexus between soil physical and microbial processes. We show that O_2-sensitive optodes were effective in monitoring O_2 depletion due to microbial activity along the paths. To address issues related to C cycling under the changing environment, biophysical processes in flow paths must be better understood.

Keywords: microbial hotspots, O_2-sensitive optodes, nutrient gradients, O_2 depletion, preferential flow paths, biophysical processes