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Hotspot localization but not the duration of hot moments in the rhizosphere is affected by root hair length

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Abstract
The rhizosphere, the narrow zone influenced by a broad range of compounds released by plant roots, is a hotspot of microbial activities. Microorganisms decompose root exudates and drive biogeochemical processes via enzymes production. Here, for the first time, we combined in situ soil zymography and the Rapid Automated Bacterial Impedance Technique system (RABIT) to localize enzymatic hotspots (β-glucosidase and leucine aminopeptidase) and estimate duration of microbial hot-moments in the rhizosphere.
Wheat and soybean were selected as plants contrasting in root morphology: soybean has short root hairs while wheat has long root hairs. The zymograms and dispersion index analysis showed that the hotspots of β-glucosidase activity in wheat rhizoboxes were 6 times higher than under soybean. The hotspots of β-glucosidase activity under wheat and soybean were localized and aggregated at rhizoplane (dispersion index > 1). In contrast, the hotspot percentage of leucine aminopeptidase under wheat and soybean was similar, but spatial distribution of leucine-aminopeptidase activities under soybean demonstrated dispersed pattern in the whole rhizobox (dispersion index < 1) in contrast with wheat which were aggregated along the roots.
Following zymography, rhizosphere and bulk soil was sampled by micro spatulas and CO_2 emission during 72 h of incubation was quantified. For the first 18h rhizosphere respiration was higher than from bulk soil. Thereafter, the available substrate depleted and CO_2 emission rate from the bulk soil was similar or even higher than of rhizosphere soil. Moreover, nutrient addition to soil decelerated the peak CO_2 emission ($\sim$24 h) and extended the duration of the hot moment for a factor of 2.7 (> 32 h).
For the first time, we linked enzymatic activity in rhizosphere hotspots of various extend with their CO_2 emission rate. We could not prove any relation between rhizosphere hotspot extend and the duration of the hot moment of rhizodeposits decomposition. Concluding, root hairs increase hotspot percentage of enzyme activities but hotspot abundance does not affect the duration of hot moments of rhizodeposits decomposition.