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Enzyme distribution within rhizosphere: The pattern of life

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Enzymes are sensitive indicators of changes in soil, expressing the interaction between plant roots and microorganisms especially within rhizosphere. However, the C-rich rhizosphere also attracts and accommodates pathogens, such as root-knot nematode (M. incognita). The direct effects of nematodes on above and belowground plant parts are well known, but the broad range of indirect effects, especially on carbon (C) and phosphorus (P) cycles underground, remains unknown. Enzyme visualization was acquired in this study to tackle two hypotheses: i) cellobihydrolase activity will be lower after nematode infestation due to more labile C (sugars) in the rhizosphere; ii) plant roots produce more P-acquiring enzymes in response to their P stress, caused by nematodes, leading to a larger spatial extension of phosphatase than cellobiohydrolase.
Eight lupine (Lupinus polyphyllus L.) plants were grown in separated rhizoboxes, four of which were inoculated with aqueous suspension containing 50 Meloidogyne incognita. Enzyme activities of cellobiohydrolase and acid phosphatase were visualized using membranes saturated with 4-methylumbelliferone (MUF) substrates. Plant resistance and resilience to nematode infestation by both modifying their root morphology and altering rhizosphere enzyme extent. However, enzymatic response to nematode effect is enzyme specific, while hotspot area of cellobiohydrolase was 20 times lower, acid phosphatase was 6 times higher in infected plants. Most importantly, for increasing P demand due to nematode attack, the plants enhanced phosphatase production in their lateral roots. Thus, the infested roots, rather than microorganisms, play a pivotal role in producing phosphatase. Importantly, this 1 mm increment of rhizosphere extent in 2D equals a 2-fold increase in soil volume (3D) for nutrient mobilization. In conclusion, using zymography to map the footprint of nematodes in the soil, we conclude that nematode infection not only has direct effects by changing root morphology, but also induces a number of subsequent biochemical changes in the rhizosphere, affecting C and P cycling.