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High resolution determination of soil solution phosphorus concentrations in the vicinity of *Brassica napus* L. roots

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Modelling of the dynamics of phosphorous uptake shows that its gradients within the rhizosphere are very steep, making their determination challenging, as high spatial resolution is required. Major constraints include the difficulties of sampling extremely low volumes at defined localized positions. The diffusive gradients in thin-films (DGT) technique can potentially overcome these problems. High resolution (sub-mm) measurements of ion concentrations in sediments have already been performed using this method. In the present work it is applied to rhizosphere soil adjacent to plant roots.

Brassica napus L. plants were grown in rhizotrons to obtain roots growing directly on the surface of a soil block. When several roots were visible at the soil surface, rhizotron cover plates were removed and Fe-oxide DGT gels were applied onto the soil surface. The layered gel sheets were placed so that they directly overlaid vital roots and the adjacent rhizosphere soil. After removal, DGT binding gels were dried and analyzed for P contents by LA-ICP-MS. P concentrations at the soil-gel interface (CDGT) and effective soil solution P concentrations (CE) were calculated for each ablation spot. Photographic images of the roots and the soil surface subjected to sampling were overlaid by CDGT and CE concentration maps. By these means, soil solution P concentration gradients in the rhizosphere were visualised and quantified for the first time at submillimeter resolutions.

Knowledge of soil solution P concentrations in close vicinity to roots provides a better understanding of nutrient uptake processes and can be used directly to test and refine mathematical models of nutrient acquisition by plant roots. The method presented here for the determination of solute concentrations in the rhizosphere is not restricted to phosphorus. It should be applicable to all elements that can be sampled using DGT and measured by LA-ICP-MS.

Keywords: rhizosphere, soil solution, phosphorus, DGT, LA-ICP-MS