NIT EUROPEA DE LA RECERCA

20 Setembre 2024 Lleida CATALUNYA

DGT as a tool to assess the phosphorus P availability in soils

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Introduction

Phosphate production in numbers

- **223 million tons**

world mining production in 2020

- **71 billion tons**

economically extractable phosphate rock reserves worldwide

In face of the unique chemistry of P and its slow diffusion in soils, only a small portion of P is available for plant uptake. Because of this, the Diffusive Gradients in Thin-films (DGT) technique has been used as an in situ sampler that extracts nutrients from the soil by diffusion mimicking plant root uptake processes. This study aims to explore the soil P availability combining the experimental data (by using the DGT technique and the diffusive equilibration in thin films (DET)) with the simulation by using the existing model DGT-Induced Fluxes in Sediments (DIFS) and the new proposed Analytical Solution.

Results
DGT/DIFS and DET/Analytical solution

The evolution of DET concentrations is compared with the analytical solution (derived from Laplace transforms) assuming full lability of the soil complexes.

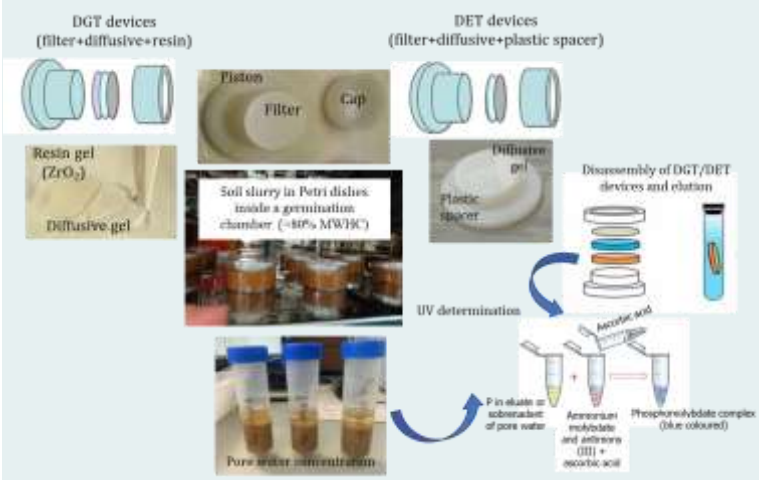
Using common parameters, simultaneous fittings of DGT / DIFS and DET / Analytical solution in a high fertility soil were performed.

Analytical Solution of DET

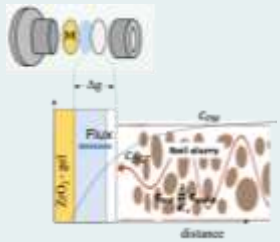
$$c_M = \frac{c_{pw}\sqrt{D_M^g}}{(l-z)\left(1+\frac{\phi_g}{\phi_s}\sqrt{\frac{D_M^g}{D_M^s}}\right)}\sum_{n=0}^{\infty}\left(\left(\frac{-\phi_s\sqrt{D_M^s}+\phi_g\sqrt{D_M^g}}{\phi_s\sqrt{D_M^s}+\phi_g\sqrt{D_M^g}}\right)^n\right)\left(2\,\mathrm{Exp}\left[\frac{-(z+2nl)^2}{4D_M^g t}\right]\sqrt{\frac{t}{n}}-\frac{(z+2nl)}{\sqrt{D_M^g}}\,\mathrm{Erfc}\left[\frac{(z+2nl)}{2\sqrt{D_M^g t}}\right]\right)-$$

$$-\sum_{n=0}^{\infty}\left(\left(\frac{-\phi_s\sqrt{D_M^s}+\phi_g\sqrt{D_M^g}}{\phi_s\sqrt{D_M^s}+\phi_g\sqrt{D_M^g}}\right)^n\right)\left(2\,\mathrm{Exp}\left[\frac{-(2l-z+2nl)^2}{4D_M^g t}\right]\sqrt{\frac{t}{n}}-\frac{(2l-z+2nl)}{\sqrt{D_M^g}}\,\mathrm{Erfc}\left[\frac{(2l-z+2nl)}{2\sqrt{D_M^g t}}\right]\right)$$

Methodology



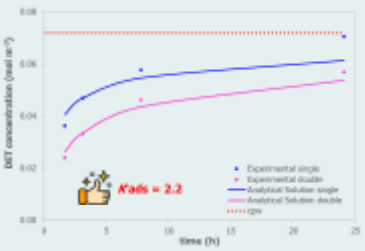
DGT/DET Theory

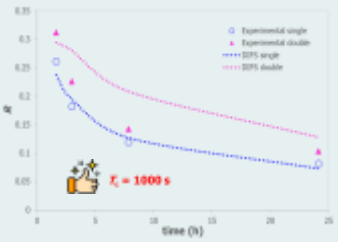


Deployment

DIFS model

Modelling





Next actions

- To extend this Analytical Solution to soils with diverse fertility levels/soil properties.
- To compare those DGT/DET data with Olsen conventional soil extraction method
- To undestand better the DET deployments (mainly after 24h).

ACKNOWLEDGMENTS

This research received support from the European Union´s Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 101034288.

El projecte NitRecerCat (GA 101061189) està cofinançat pel programa de recerca i innovació Horitzó Europa de la Unió Europea