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Quantifying and mapping citrate exudation in soil-grown root systems

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1. Introduction



Root exudates

- Root derived primary and secondary metabolites
- Exuded by the plants into the rhizosphere
- Rhizosphere is 'the volume of soil that is influenced by root activity' (P. Hinsinger, 1998)



(McCully, 2005; http://www.regional.org.au/au/allelopathy/2005/1/1/2726_mccullyme.htm/)



1. Introduction

Root exudates



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1. Introduction

Citrate exudation

- Huge role in P acquisition
- Solubilisation of P bound to iron or aluminum (hydro)oxides
- P deficiency triggers an overexpression of the protein responsible for citrate exudation
- Knowledge about the quality, quantity and spatial allocation of citrate is of immense importance to understand plant performance and ultimately optimize agricultural productivity and quality



Spezifische Adsorption des H₂PO₄ an Fe-Oxid



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1. Introduction

Citrate sampling

- Difficulties to sample and localize root exudates such as citrate:
 - Microbial degradation
 - Sorption to solid soil phase

Most applied methods do not represent the "real field conditions"

Aim:

This study aims to develop a passive sampling, localization, quantification and imaging technique for *citrate* exuded from plant roots grown in rhizotrons





2. Method development

- Based on Diffusive Gradients in Thin Films (DGT)
- ZrOH polyacrylamide hydrogel
- Characterization of ZrOH gels for citrate sampling
 - Adsorption kinetics
 - Elution efficiency
 - Capacity
- Quantification and localization of citrate in a non-destructive way from soil-grown roots



Photo: dgtresearch.com

Results - Gel characterisation *Adsorption kinetics*

- ZrOH is feasible as citrate binding agent
- Citrate elution efficiency
 - 0.5 M NaOH for 24 h
 - 89%





- **Results Gel characterisation** *Capacity*
- pH 4 = 95 \pm 5 µg citrate cm⁻² gel
- pH 8 = 64 \pm 2.2 µg citrate cm⁻² gel

$$C_{DGT} = \frac{M\Delta g}{DtA}$$



Plant experiment



() BY

(cc)



Results – Plant experiment









4. Conclusion

- Citrate sampling with ZrOH gels could represent an easy and reliable method for soil sampling and be an alternative to already established sampling methods
- Changing binding materials, this approach may be used also for other compound classes
- Combination of other imaging techniques



Thank you for your attention!

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