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Phosphate-coated iron oxyhydroxide nanoparticles as high efficiency P-nanofertilisers in tropical soils

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Introduction

Iron oxyhydroxide nanoparticles (NPs) have typical traits:

- Large surface area
- Strong binding capacity for phosphate (PO_4)
- High mobility

→ exploit this to develop **efficient P fertilisers** for **strong P fixing soils** in the tropics

Hypothesis

Highly mobile **PO_4-coated NPs**

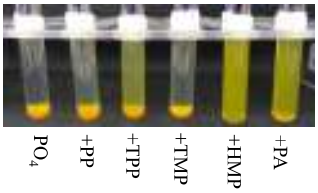
NPs will move towards the plant **rhizosphere**, avoiding P fixing by the soil

Localised PO_4 release in the rhizosphere to establish chemical equilibrium

High efficiency P fertiliser

Colloidal Stability

- PO_4-coated NPs tested under **environmentally relevant conditions** of pH and cation concentrations
- Different **additives** (e.g. polyphosphates) tested to improve colloidal stability at high PO_4 loading
- Good performance: natural organic matter (NOM), hexametaphosphate (HMP) & phytic acid (PA)



PO_4 as KH_2PO_4; PP = Sodium pyrophosphate tetrobasic; TPP = sodium tripolyphosphate; TMP = trisodium trimetaphosphate; HMP = sodium hexametaphosphate; PA = phytic acid sodium salt hydrate; NOM as Suwannee River Natural Organic Matter

Fertilizer potential in tropical soils

Long-term **pot trials** with **tropical soils**

- **Plant growth** response with P-nanofertilisers
- Monitor NP properties in **soil solution** by rhizon sampling and AF4-DLS-ICP-MS measurement

Bioavailability of PO_4-coated NPs

- **Short-term hydroculture** experiments with spinach (*Spinacia oleracea*)
- Assess **yield** with different NP-treatments under equal 'free PO_4' concentration
- Chemical analysis:
  - 'Total P' by ICP-MS
  - 'Free P' by dialysis
  - Hydrodynamic diameter by DLS
  - Zetapotential by LDV
  - P-content of plants after acid digestion

Outputs

- Understanding the **role of NPs** in plant P uptake
- First step in development of **P-nanofertilisers**, specifically for tropical soils

Potential

High efficiency P-nanofertilisers
- can increase crop yields in tropical regions, once the technology has been made economically viable.
- are beneficial for more sustainable agriculture.

Abbreviations of measurements techniques used in this study:
- ICP-MS: Inductively Coupled Plasma-Mass Spectrometry
- DLS: Dynamic Light Scattering
- LDV: Laser Doppler Velocimetry
- AF4: Asymmetric Flow Field Flow Fractionation

This work was funded and supported by

fwo Research Foundation Flanders

For more information about the author: