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

Jessica Bollyn* and Erik Smolders1
1 KU Leuven, Department of Earth and Environmental Sciences, Leuven, BELGIUM
* jessica.bollyn@ees.kuleuven.be

Introduction
Iron oxyhydroxide nanoparticles (NPs) have typical traits:
• Large surface area
• Strong binding capacity for phosphate (PO₄)
• High mobility
However, this also results in high mobility
→ exploit this to develop efficient P fertilisers for strong P fixing soils in the tropics

Hypothesis
Highly mobile PO₄ coated NPs
NP will move towards the plant rhizosphere, avoiding P fixing by the soil
Localised PO₄ release in the rhizosphere to establish chemical equilibrium
High efficiency P fertiliser

Colloidal Stability
• PO₄-coated NPs tested under environmentally relevant conditions of pH and cation concentrations
• Different additives (e.g. polyphosphates) tested to improve colloidal stability at high PO₄ loading
• Good performance: natural organic matter (NOM), hexametaphosphate (HMP) & phytic acid (PA)

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 PO₄ coated NPs
• Short-term hydroculture experiments with spinach (Spinacia oleracea)
• Assess yield with different NP-treatments under equal ‘free PO₄’ 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 Velociometry
• AF4: Asymmetric Flow Field Flow Fractionation

This work was funded and supported by

For more information about the author: