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Predicting phosphorus availability from chemically diverse conventional and recycling fertilizers

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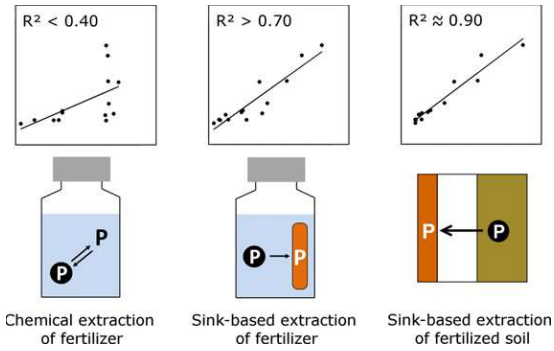
HIGHLIGHTS

- Sink extraction was used to quantify available P in chemically diverse fertilizers.
- A second sink method was used for measuring P in fertilized soil samples.
- Both quantities closely correlated with plant P, outperforming classical methods.
- These novel approaches may assist fertilizer development from waste streams.

GRAPHICAL ABSTRACT



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ABSTRACT

Fertilizers produced from heterogeneous, phosphorus-rich biowastes are becoming increasingly relevant. Treatment and processing (combustion, pyrolysis, anaerobic digestion, etc.) increase the diversity of their physico-chemical composition even further.

We investigated several approaches to characterize P availability from a set of 13 contrasting fertilizers. We tested them directly using standard fertilizer extractions, as well as a continuous, sink-based P extraction (iron bag) method. We also performed Olsen, CAL and diffusive gradients in thin films (DGT) tests on fertilized soil.

Standard extractions correlated only weakly, whereas the iron bag method correlated highly ($0.73 < R^2 < 0.85$) with plant P uptake. Among the tests conducted on fertilized soils, DGT was equivalent or slightly better than Olsen, showing R^2s of about 0.90 for P uptake and plant growth.

Our results suggest that the validity of standard P fertilizer tests needs to be reassessed in the context of increasingly diverse recycling fertilizers.

1. Introduction

Phosphorus is an essential plant nutrient which often limits plant growth. Awareness about the limited global rock phosphate reserves and their strong concentration in few main producer countries has raised public concern and interest in recovering and recycling P from diverse waste flows (Schoumans et al., 2015). The major residual P flows to be tapped are slaughterhouse waste, waste water and municipal sewage sludge, from which P is currently often lost (van Dijk et al., 2016). Moreover, efficient use of animal manures is often complicated due to strong regional concentrations of animal farms, which are often located

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