A cheap, simple method for mapping available phosphorus in undisturbed soils

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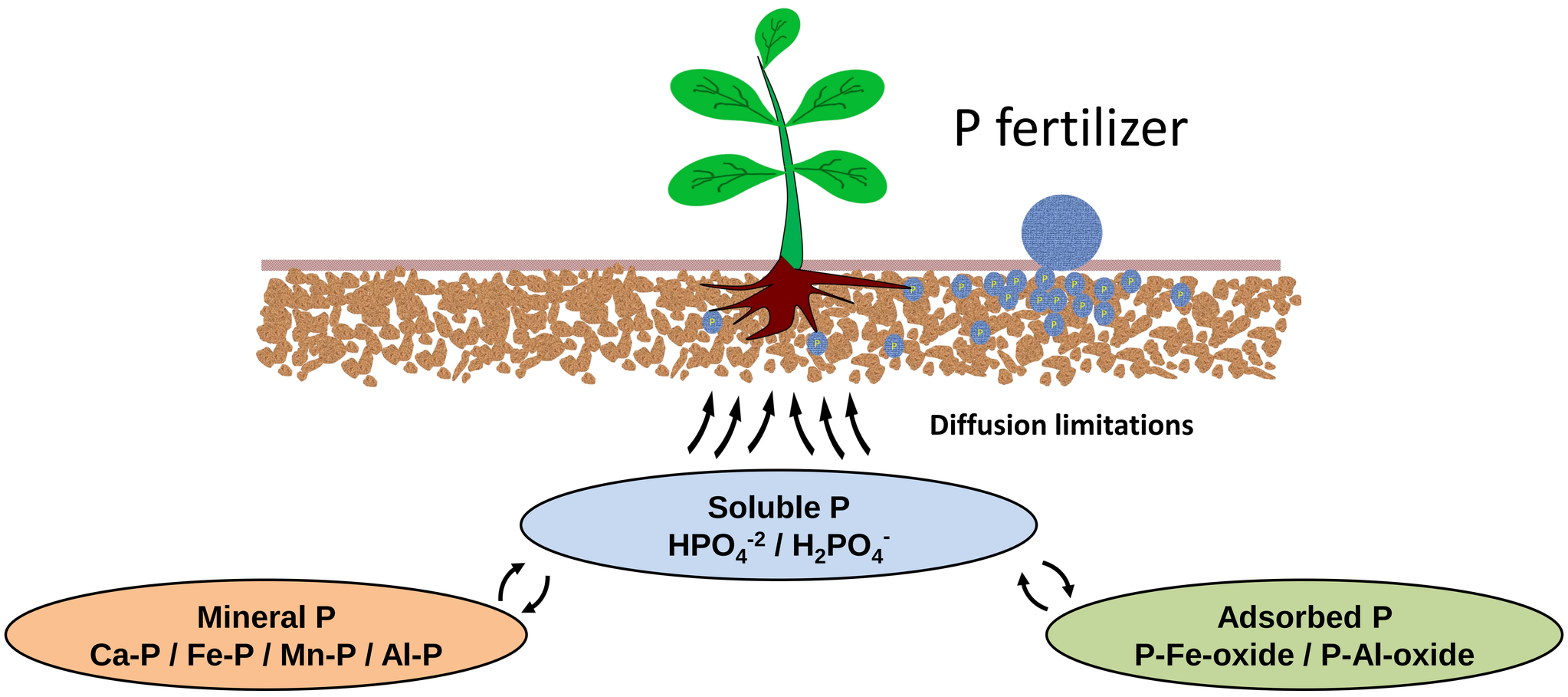
Background

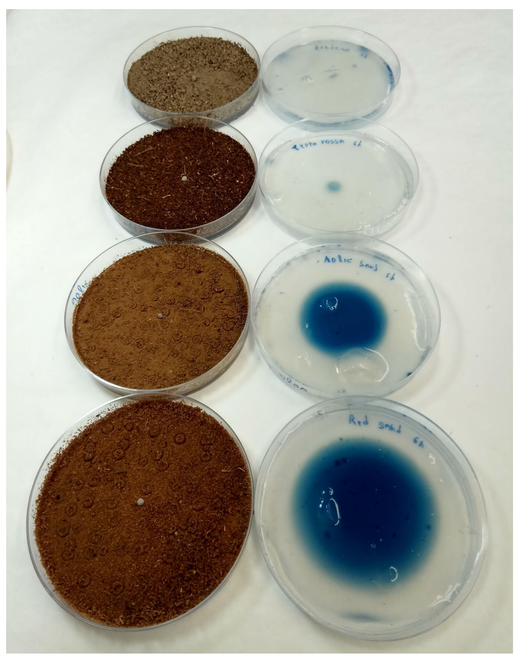
The low mobility of Phosphorus (P) in soils imposes a major constraint on the effectivity of P fertilizers. Investigations of P mobility in soils have commonly utilized column experiments, which represent the mobility of phosphorus in conditions of bulk flow. This may largely mask the diffusion-dependent movement of P, which is considered the dominant actual movement mechanisms towards roots in the soil environment. Methods used to investigate P diffusive movement in soils are either laborious (such as manual detailed separation of subsamples) or expensive (such as Energy-dispersive X-ray spectroscopy). In contrast, we propose a simple and cheap method to map the distribution of available-P in soil using agar gel and an ammonium-molybdate reagent for staining and mapping the labile P

Abiotic processes controlling P mobility in soil and schematic P distribution in relations to plant and fertilizer



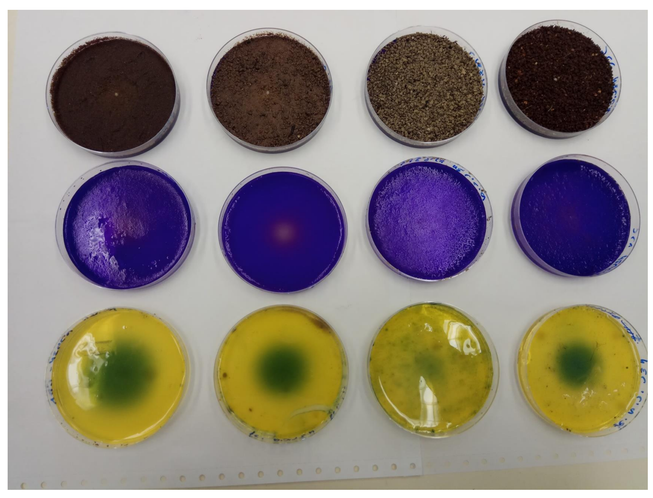
Results

Left, soil incubated on an agar layer. a grain of mono-calcium phosphate fertilizer was applied at the centre of each dish 6 hours prior to washing. Top to bottom: Rendzina (highly calcareous), Terra-rossa (high Fe-oxide), Aeolic Sand (medium calcite content), and Brown-Red Sand. Right, replicas of the agar layer after soil removal and P staining (blue area).



The applicability of the method was demonstrated to compare P diffusion in diverse soils differing in texture and carbonate content. To this end, a series of petri dishes was prepared containing a thin layer of agar gel (2mm) over which a thin layer (2mm) of the tested soils was spread evenly and wetted so that no loose water was present. The series of dishes was incubated for different time periods with a grain of mono-calcium phosphate fertilizer on top of the soil at the centre of each dish. Following the incubation period, the soil was washed off and staining with ammonium-molybdate was performed. The blue staining showed visually distinct patterns around the previous location of the fertilizer. The radii of the stains differed in accord with the incubation time and soil properties (e.g., P adsorption capacity and pH) of the soil.

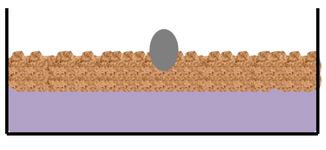
Top, Soil incubated on an agar layer impregnated with pH indicator, a grain of superphosphate fertilizer was applied at the center of each dish 24 hours prior to washing. Left to right: Brown-Red Sand (sandy soil), Aeolic Sand (medium calcite content sandy soil), Rendzina (highly calcareous silty soil) and Terra-rossa (high Fe-oxide clyaye soil).
Middle, replicas of the agar layer after soil removal indicate pH decline (yellow area) in the soils related to P dissolution-precipitation processes .
Bottom, replicas after application of a second agar layer containing ammonium-molybdate reagent indicating the distribution of phosphorus



The technique

A layer of agar gel with pH indicator is prepared and the soil of interest is distributed on it

Soil of interest
Agar with pH indicator



After incubation, the soil is rinsed off and the pattern of pH remains within the gel

Agar with pH indicator

A layer of agar with P indicator is applied onto the agar impregnated with P, the pattern of P distribution is exposed

Agar with P indicator
Agar with pH indicator

Prospects

The technique requires optimization including a calibration procedure to translate colour intensity into phosphorus concentrations.

Future prospects include using the method to map P distribution and diffusion rates around plant roots and around novel P fertilizers.