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Can ferric iron reduction in paddy soils compensate phosphorus limitation of rice plants and microorganisms?

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Biogeochemical cycles of phosphorus (P) and iron (Fe) are tightly intertwined, especially in highly weathered and acidic subtropical and tropical soils rich in ferric Fe (Fe(III))oxides. In low-redox and P-deficient paddy soils, the quantitative contribution of the reductive dissolution of Fe(III)-bound P (Fe-P) to the demands of rice plants (*Oryza sativa* L.) and microorganisms remains unclear. We hypothesized that Fe(III) reductive dissolution can cover the P demand of microorganisms but not of rice plants during the initial growth stages, when P demand is high but the root system is still limited. We grew pre-germinated rice plants for 33 days in flooded rhizoboxes filled with a paddy soil of poor P availability. ^{32}P-labeled orthophosphate sorbed to ferrihydrite (80 kg ha^{-1}) was supplied either (1) in polyamide mesh bags (30 µm mesh size) to prevent roots from directly mobilizing Fe-P (Pellets-mesh bag treatment), or (2) in the form of pellets directly to the soil without mesh bags to enable roots' accessing the Fe-P (Pellets-no-mesh bag treatment). With the application of Fe-P directly to the soil, P was more available resulting in the increases in microbial biomass carbon (MBC) by 18–55% and nitrogen (MBN) by 4–108% in rooted soil as compared to the pellet not available to roots directly. The maximum enzyme activities (V_{max}) of phosphomonoesterase and β-glucosidase followed this pattern. During rice root growth, MBC and microbial biomass phosphorus (MBP) in both rooted and bottom bulk soil gradually decreased by 28–56% and 47–49%, respectively. In contrast to our hypothesis, the contribution of Fe-P to MBP strongly decreased from 4.5% to almost zero during 10–33 days after rice transplantation, while Fe-P compensated up to 16% of the plant P uptake 33 days after rice transplantation, thus outcompeting microorganisms.