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Is the solubility of inorganic and organically complexed phosphorus in agricultural soils affected by chemical fertilizer and organic carbon additions?

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Understanding how the solubility of forms of inorganic and organically-complexed phosphorus (P) in agricultural soil is affected by inputs of organic matter (OM) could inform decisions on sustainable future farming practices. Different forms of OM provide organic P, carbon (C) and other nutrients to the system at different rates, depending upon their recalcitrance to decomposition, and the stoichiometric balance of elements between soil, OM amendment and microbial requirements.

We describe an 18-month pot experiment that tested the hypothesis that additions of organic matter will affect the solubility of P forms in soil. Mesocosms (~30 kg soil) of two agricultural top-soils, of moderate and low P availability, were amended with a commercial humic soil amendment (lignite) or crop residue (barley straw) at two addition levels. Treatments with/without chemical P fertilizer were superimposed on OM treatments. The system was planted with Lolium perenne (perennial rye grass) and exposed to a natural rain and temperature regime. Leachate was collected and analyzed for soluble P, nitrogen and dissolved organic C (DOC) at 6 weekly intervals in order to investigate solubility over time. Destructive sampling at the end of the experiment yielded plant and soil samples for comparison of C, N and P stoichiometry between the treatments.

Initial results showed increases in leachate DOC relating to crop residue OM treatments and a positive effect of P fertilizer on plant biomass in the low P soil. Concentrations of dissolved P in leachate were higher in the moderately P-sorbing soil compared to the highly P-sorbing soil. Ongoing analysis includes measures of biological activity including soil microbial biomass C, N and P by fumigation-extraction and soil phosphatase activity. Chemical measures include total C, N and P, soil carbon forms using Fourier-transform infrared spectroscopy (FTIR), total organic P and water and acid ammonium oxalate extractions. Interpretation of the final results will consider how the release of C and nutrients from OM and their subsequent impact on the system, are controlled

by microbial activity and macronutrient stoichiometry. These results should help to inform future research into improving P utilization in agriculture through balancing nutrient ratios to regulate nutrient cycling. Such research seeks to improve agronomic P efficiencies alongside wider benefits associated with the drive to increase soil C.