EGU21-3037
https://doi.org/10.5194/egusphere-egu21-3037
EGU General Assembly 2021

Integrated carbon-nitrogen-phosphorus cycling for sustainable agriculture – a knowledge gap and investigation of the role of phosphatase enzymes

Victoria Janes-Bassett[1,2], Phil Haygarth[1], Martin Blackwell[3], Malika Mezeli[1], Gavin Stewart[4], Gordon Blair[2], and Jess Davies[1]
[1]Lancaster University, Lancaster Environment Centre, Lancaster, UK
[2]Lancaster University, School of Computing and Communications, Lancaster, UK
[3]Rothamsted Research, Sustainable Agricultural Systems, North Wyke, UK
[4]Newcastle University, School of Natural and Environmental Sciences, Newcastle upon Tyne, UK

Phosphorus is closely linked to other nutrient cycles, notably carbon and nitrogen, therefore, to understand potential risks to food production models are required that simulate integrated nutrient cycling over long timescales. The soil-plant system model N14CP meets these requirements and simulates both semi-natural and agricultural environments. N14CP has been validated both spatially and temporally across a range of long-term agricultural experimental sites comparing soil C, N and P, and crop yields, and in most instances performs well. However, under experimental conditions where N is applied in the absence of P, the model indicates exhaustion of P reserves and a decline in yields that is not observed at these sites, highlighting a gap in the model process representation. Potential sources of this 'missing P' such as enhanced atmospheric deposition, weathering and flexible plant stoichiometries were explored yet cannot account for this deficit. We hypothesise that access of organic P through other mechanisms not fully represented within the model, such as phosphatase enzymes, could be part of this explanation.

In order to test this, we conducted a meta-analysis of phosphatase enzyme activity in agricultural settings, comparing response to P sufficient and deficient conditions. Results suggest phosphatase enzyme activity is higher in P deficient conditions compared to inorganic P addition, yet lower compared to organic P addition. Meta-regression analysis indicates magnitude of P addition and pH of substrate are significant factors influencing enzyme response. However, due to numerous additional processes and adaption strategies in response to P deficiency and the difficulty isolating the role of phosphatase enzymes it is not possible to determine the degree to which this mechanism alone accounts for the missing P. We discuss the continuing need for additional empirical evidence to understand the cycling of organic P, and the development of models to include these processes to inform sustainable land management and ensure long-term food security.