

Sorption of phosphorus in the soil

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Phosphorus (P) is a key element for plant nutrition, and so one would expect that the soil chemistry of phosphorus is well known. However, despite more than 100 years of soil chemical research, there are still many fundamental aspects of P in soils that we know very little about.

Partly this is because the soil chemistry of P is rather complex. In solution, P generally occurs as orthophosphate ions, although colloidal transport of P-containing particles should not be disregarded. Phosphorus can be bound to soil particles in a variety of forms. In natural soils, P may be adsorbed to iron and aluminium (hydr)oxide surfaces. At high pH, P may be bound in calcium phosphate minerals. In addition, the biological cycling of P is substantial and therefore soils also consider appreciable amounts of organically bound P. In soils exposed to high loads of P, additional phases such as aluminium and iron phosphate minerals can form. Loss of P from soils is due to both leaching and to plant uptake followed by harvest; in agricultural systems, the latter process predominates.

The distribution between different P forms in the soil is not well understood. Traditionally, soil chemists have used various extraction schemes to estimate the amount of P bound in different phases, but such methods are clearly associated with many pitfalls and errors. Recently, more advanced characterization methods such as nuclear magnetic resonance (NMR) spectroscopy and X-ray absorption near-edge structure (XANES) spectroscopy have allowed researchers to more accurately determine the various P forms in soils, but even these methods have their limitations.

Soil infiltration systems consist of sandy soil materials that possess a P adsorption capacity that usually can be expected to be small. However, P may to some extent also be precipitated with Al, Fe or Ca weathered from the soil or supplied from the wastewater. Some P may also be bound in organic forms or taken up by plants.

It is argued that better assessments of the risk for P loss from soil infiltration systems can be made by transferring research results from the agricultural sector. In Sweden and Finland, P fertilization experiments have been carried out for up to 50 years on a number of locations. These experiments, originally designed for agronomic purposes, now represent a valuable resource for scientists interested in the long-term dynamics of P in soils. Examples from past and ongoing research at these sites will be shown, and their implications for our knowledge of P in soil infiltration systems will be discussed.