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Biosolids Derived DOM Increases Phosphate Adsorption in Mediterranean Soils

Yaniv Freiberg[1,2], Pinchas Fine[1], Michael Borisover[1], and Shahar Baram[1]
[1]Institute of Soil, Water and Environmental Sciences, Volcani Center, ARO, PO Box 15159, Rishon LeZion 7528809, Israel (yaniv.freiberg@mail.huji.ac.il)
[2]Robert H. Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot 76100, Israel

Contradictory data exists on the impact of dissolved organic matter (DOM) from biosolids on ortho-phosphate (IP) binding to soils constituents. On the one hand, DOM contain carboxylic acid and phenolic groups who compete with IP on common adsorption sites. On the other, biosolids addition was reported to increase the adsorption capacities of some soils. This study aims to investigate the effect of DOM extracted from compost sewage sludge (most of which smaller then 1kDa) on the Langmuir sorption capacity and affinity of IP to five soils encompassing a wide range of mechanical, chemical, and mineralogical properties. It's important to note that the dominant cation in the used soils is Ca^{2+}. Sorption experiments were conducted using two different solutions (10mM NaCl and 5mM $CaCl_2$) with and without DOM (810 mg OC kg^{-1}). Without DOM, in all of the montmorillonitic soils, the obtained IP adsorption capacities were higher in the 5mM $CaCl_2$ than in 10mM NaCl solutions, with no effect on kaolinitic soils. While DOM addition to 10mM NaCl solution increased the IP adsorption capacities by 9 to 94%, in 5mM $CaCl_2$ no effect has been observed. In 10mM NaCl, increased adsorption capacities were accompanied by a significant decrease in the adsorption affinities.

Our results show that both Ca^{2+} and DOM can affect IP sorption parameters of montmorillonite-dominated soil. In such soils, when the ionic strength is higher than the flocculation value of the clays, and the pH is higher than the clays' point of zero charge, face-to-face interactions lead to tactoids formation. Thus, reducing the spillover effect, and increasing the amount of free sorption sites on the clays' broken edges (as observed in the case of 5mM $CaCl_2$ without DOM). Furthermore, when DOM is added to montmorillonite-dominated soil, it can complex with the clay's negative planer surfaces through a multitude of reactions (in our case, mostly with Ca^{2+} bridging) and adsorb IP. Thus, increasing the overall adsorption capacity while reducing the affinity. Both clay flocculation and complexation processes occur concomitantly. In kaolinite, isomorphic substitutions and conformational changes rarely occur. Hence, Ca^{2+} addition will not foster tactoid formation or DOM complexation. To conclude, DOM effect on IP sorption is not straight forward and depended on the soil and biosolids used, and the overall affect is the equilibrium of multiply reactions the occur simultaneously.