Soil matrix controls element cycling under alternating redox conditions

Luisella Celi, Franco Ajmone Marsan, Maria Martin

Università degli Studi di Tornio, DISAFA

Most soil processes characterizing the biogeochemical cycling of nutrients and pollutants, which have been deeply studied in oxic environments, can be substantially transformed by changing soil redox conditions. Such redox fluctuations may occur naturally or after anthropogenic causes; the latter case is typically represented by paddy rice fields. Alternation of submersion and drying induces subsequent dissolution and precipitation/sorption reactions at the soil solid interface involving redox-sensitive species together with related ones. Most redox reactions in the biogeochemical cycling of C, N and P, microbially mediated, are strongly related to the soil matrix characteristics. In particular Fe oxides, which may promptly undergo redox dissolution, represent one of the main phases controlling the immobilization/release and microbially mediated reactions of nutrients in anaerobic environments. Together with nutrients, also the cycling of contaminants are directly or indirectly affected, so that immobilized forms in oxic soils may become easily bioavailable under reducing conditions and enter the food chain. For instance, paddy rice may become one of the major ways of arsenic intake in human diet. At oxidizing/reducing interfaces with alternating submersion conditions, the composition and equilibria of As forms are strongly controlled by interaction with iron oxides and organic matter dynamics. Changes in the redox environment can have dramatic consequences on heavily contaminated sites, such as mining sites, industrial and urban environments, where different inorganic and organic contaminants are interconverted from immobilized into available forms, depending on their interaction with soil solid phases. Thus, the effect of alternating redox conditions on speciation of nutrients and contaminants is strongly related to the soil matrix which drives element fluxes through soil, water, plant and/or atmosphere.

Effect of raw and alkaline-stabilized biosolids on corn biomass and soil available P in three soils

Samantha Halloran[1], Mehdi Sharifi[1*], Gordon Price[2], Chris Metcalfe[1], Aime Messiga[1]

[1] Trent University, Environmental & Life Sciences Dept.
[2] Dalhousie University, Engineering

Alkaline-stabilized biosolids can provide nutrients for crops, particularly P, however their effects on soil P dynamics have not been fully explored. We investigated the effects of primary treated (RB) and alkaline-stabilized biosolids (ATB) on corn biomass and soil P on three soils from different regions. The soils (Mt. Hope and Lindsay, ON; Bible Hill, NS) were amended with six fertility treatments (ATB at 14, 28 and 42 Mg ha^{-1} dry weight, RB at 42 Mg ha^{-1} dry weight, inorganic fertilizer (FERT), and control (CONT) with zero P). Corn was seeded into pots in a controlled environment chamber, and above ground biomass was harvested after 10 weeks. Plant dry matter (DM) was measured and plant tissues were analyzed for P concentration. Soil was analyzed for P forms including Olsen P and other properties. Corn DM was highest in all ATB treatments (16% increase of ATB_{42} over CONT), but was similar between CONT and FERT. Olsen P also increased with ATB, but the extent differed among soils. The highest Olsen P values were obtained with ATB_{28} and ATB_{42} for Bible Hill (48.9 mg kg^{-1}) and Lindsay (30.2 mg kg^{-1}), but RB42 (27.7 mg kg^{-1}) at Mt Hope indicating that on these soils, P added with biosolids, rather than plant uptake, controlled soil P changes. Total P across all soils increased with increasing ATB rate, but the highest values were obtained with RB42 (1097-1285 mg kg^{-1} for the three soils). Soil pH increased with increasing ATB rate only on Bible Hill soil which had the lowest initial pH (6). We conclude that use of treated biosolids can provide high corn DM while maintaining Olsen P and reducing the acidity of low pH soils, indicating that these products can be an alternative nutrient source and lime material.