Redox Controlled Changes in Phosphorus Solubility and Solid-phase Speciation in an Acid Sulfate Paddy Soil Amended with Oil Palm Biochar and Ash

WORACHART WISAWAPIPAT* , KAMOLCHANOK CHAROENSRI AND JIRAWAT RUNGLERTTRAKOOLCHAI

Department of Soil Science, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand (*correspondence: worachart.w@ku.th)

Acid sulfate soils in Thailand have been recently shifted from paddy rice cultivation to oil palm production. However, there is limited understanding pertaining to the solubility and speciation of phosphorus (P) in these acid sulfate soils, a critical prerequisite for sustainabe and effective P management. Herein, we investigated P fractions and speciation of an acid sulfate paddy soil treated with oil palm ash (OPA) and oil palm biochar (OPB) during soil reduction (40 days) and a subsequent soil reoxidation (28 days) using a sequential extraction technique (SEP) and P *K*-edge X-ray absorption near-edge structure (XANES). The results of the SEP demonstated that iron and aluminum (hydr)oxide-associated inorganic P (69-75% of the total P) constituted the largest fraction of the soil, followed by residual P (19-26% of the total P), and exchangeable P (4.1-7.2% of the total P). The soil solution P and detrital P constituted insignificant fractions, corresponding only to 0.33-0.75% and 0.49-1.41% of the total soil P, respectively. The OPA-amended soil clearly increased exchangeable P fraction relative to that of the control. The incorporation of OPB to the soil did not affect P fractions, which is due largely to the nature of the OPB (oil palm shell) possessing less chemically reactive surfaces. Results from P XANES showed that the soil was composed primarily of P sorbed to ferrihydrite, followed by P sorbed to gibbsite and variscite ($AlPO_4 \cdot 2H_2O$), respectively. A minor fraction of organic P in the form of lecithin was present. During the first day of soil reduction, gibbsite-bound P was transformed into variscite. Subsequently, the freshly authigenic variscite was inversely transformed as gibbsite-bound P during 28 days of soil reoxidiation. The OPA incorporation was likely to impede the formation of gibbsite-bound P. Our results shed light on P dynamics in acid sulfate paddy soils under flooded and aerated conditions, which will be of great importance in P fertilizer management for intermittently-flooded rice cultivation.