USE OF PHOSPHITE AS A FERTILIZER FOR TRANSGENIC COTTON

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Abstract

Transgenic plants expressing the bacterial phosphite dehydrogenase (ptxD) gene have the ability to convert phosphite (Phi) into phosphate (Pi) which is the metabolizable form of phosphorus (P). Phosphites are alkali metal salts of phosphorous acid widely used in agricultural production as a fungicide. At high rates of Phi application, it may become toxic to plants and suppress plant growth. However, transgenic plants such as cotton (*Gossypium hirsutum* L.) with the ptxD gene allow the use of Phi as a selective source of P, hindering the growth of weeds. As a fertilizer material, Phi binds to soil but less strongly than phosphate (Pi). However, soil properties such as pH, Al/Fe oxides, and clay mineral contents can affect Phi binding to soil. In addition, Phi can be oxidized by soil microflora and be converted to phosphate (Pi). Little is known about Phi interaction (soil adsorption, desorption, and microbial transformation processes) with soils of the southern U.S. Coastal Plain used for cotton production. Therefore, laboratory experiments were conducted with the objective of evaluate Phi interaction with three Coastal Plain soils for the potential use of Phi as fertilizer source in transgenic cotton production and weed suppression. Surface horizons samples collected from 0 – 15 cm depth of three Ultisols: Norfolk (Fine-loamy, kaolinitic, thermic Typic Kandiudults), Dotham (Fine-loamy, kaolinitic, thermic Plinthic Kandiudults), and Uchee (Loamy, kaolinitic, thermic Arenic Kanhapludults). The three soils were characterized for pH, organic carbon, and cation exchange capacity, plant available Pi – Mehlich 1, total phosphorus, texture, clay mineralogy (kaolinite, gibbsite, and goethite) and oxalate extractable aluminum (Al) and iron (Fe) oxide content. The three soils were used to perform the following three experiments: 1) Phi sorption isotherms; 2) Phi desorption; and 3) A 112-day (16 weeks) laboratory incubation test was performed in sterilized and non-sterilized soils. Phi was applied at a single rate of 57 mg P per kilogram of soil (148 kg P_2O_5 per hectare) of commercial potassium Phi (Ele-Max, Helena Agri-Enterprises). In all experiments, Phi was determined in water extracts by ion chromatography. Results showed that Phi sorption was well described in all three soils by the non-linear Freundlich model. Phi sorption decreased according to Uchee > Dothan > Norfolk most likely due to decreasing soil pH and content of Al and Fe oxides and kaolinite. Phi desorption tests indicated that the trend Norfolk > Dothan > Uchee was consistent with Phi sorption controlled by the soil properties. Overall, the sorption of Phi to soil particles reduced the rate of Phi bioavailable in the soil solution. All three soils, sterilized or not, showed the same trend of reduction in Phi concentration with time most likely by sorption to soil particles. A less pronounced reduction in Phi concentration with time in the sterilized soils might indicate microbial oxidation of Phi into Pi but additional soil microbial analysis are needed to confirm it. Acid Coastal Plain soils can be adapted to transgenic ptxD cotton production but more research is needed to reduce soil available Pi and soil acidity to maximize bioavailability of Phi for both growing transgenic cotton and weed growth suppression.