SEWAGE SLUDGE ASHES USED AS PHOSPHORUS FERTILIZER – THE ROLE OF ALUMINIUM

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Phosphorus (P) is an essential nutrient for plant growth and thus Phosphate (PO_4^{3-}) is a main component of commercial fertilizer.[1] The main sources for phosphorus are phosphate minerals like apatite, ranked as a limited resource.[2] A promising way to recycle phosphate is to start from sewage sludge, generated during the cleaning processes for wastewater. For precipitation and flocculation of phosphate in the wastewater treatment plant, different reagents are used which contain iron- and aluminum sulfates. The applied ratio between iron and aluminum differs from plant to plant, depending on internal and external factors. As a results, sewage sludges from different sources feature strongly varying Al : Fe-ratios.

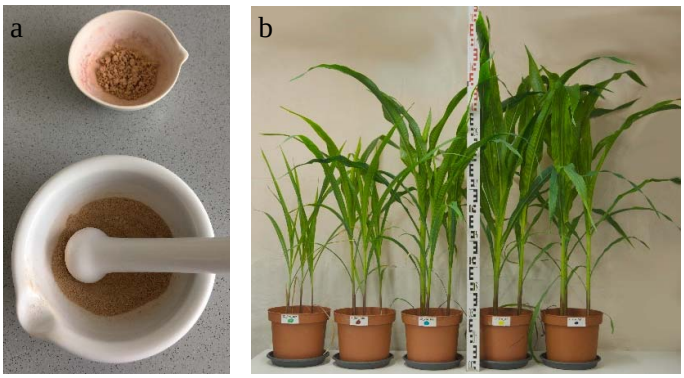

Figure 1: a) Al-precipitated sewage sludge ash, b) Pot experiment with maize treated with different sewage sludge ashes.

We are supporting a local sewage treatment association in the development of a regional phosphorus recycling strategy based on the combustion of sewage sludge in a high temperature oven. While most of the wastewater treatment plants within the project use iron-sulfates with a minimum amount of aluminum salts as flocculation agents, one plant uses an inverse ratio (high Al- and minimum Fe-content). After burning sewage sludge, the obtained ashes usually contain P in form of Whitlockite (ca. $Ca_{9,5}Mg_{0,78}Fe_{0,22}(PO_4)_7$), a mineral with very low solubility both in water, but also in ammonium citrate solutions, a model system for the plant root environment. These ashes are therefore not suitable as P-fertilizers.

Interestingly, we observed that ashes from the wastewater treatment plant using Al-salt for precipitation showed increased P-solubilities compared to “Fe-ashes”. We therefore carried out a detailed chemical analysis of such “Al-ashes” and also used the material in pot experiments e.g. with maize in the greenhouse to directly assess their P-fertilizer efficiency. Additionally, we analyzed various above and belowground functional plant traits to understand how sewage sludge ashes act as P-recycling fertilizers.

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[1] H. Marschner, Marschner's Mineral Nutrition of Higher Plants, Academic Press, 3. Edition, 2012.

[2] Bundesministerium für Wirtschaft und Energie, Rohstoffstrategien der Bundesregierung, Berlin 2019.