

Nutrient recovery from treated wastewaters by biochar and zeolite: implications for soil fertility

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The increasing demand for food due to the mounting world population, coupled with the exhaustion of phosphorus (P) mines and the rising use of more and more expensive nitrogen (N) fertilizers, impose to find alternative sources of such nutrients. The recovery of N and P from treated urban wastewaters through the use of adsorbent materials and their reuse as enriched nutrient amendments to improve soil fertility may be a valid alternative. Zeolites and biochar are suitable materials for the adsorption of nutrients from treated urban wastewaters. Zeolites are crystalline microporous tectosilicates with a negatively charged structure, due to Al replacing Si, compensated by weakly bonded exchangeable cations. They are commonly used for ammonium recovery, showing an absorption capacity higher than 93% within the first 10 minutes of contact with the liquid phase. Once the zeolites are exhausted, they can be either regenerated by washing with NaCl, allowing also the recovery of ammonium, or directly applied to soil as slow-release fertilizers. Several studies have analysed the absorption capacity of zeolites at laboratory and pilot scale, but only few at plant full-scale. On the other hand, biochar is obtained by pyrolysis of plant biomass at 300-800°C and in the absence of oxygen. Studies carried out to investigate the potential of biochar to act as adsorbent for the removal of P from aqueous solutions are few and, often, contrasting each other. This is probably due to the performance and properties of biochar that are highly influenced by many factors such as temperature, heating rate and residence time during pyrolysis, the feedstock used as raw material and its particle size. For this reason, the research on the adsorption and desorption properties of biochar is in its early stages, being several questions still unanswered. Even few are studies about the role of P-enriched biochar to improve the availability of P for plants in agricultural soils. Based on the above considerations, the objectives of the PhD project, carried out within the Wider Uptake project (Horizon2020 EU project), are: (i) to identify the most suitable zeolite and biochar for the recovery of inorganic N and P from treated urban wastewaters at plant full-scale, (ii) to study the mechanisms of P adsorption on biochar, (iii) to evaluate the impact of P-enriched biochar and of ammonium recovered from zeolite on soil chemical and biochemical properties.