Plant Availability of Phosphorus in Five Gasification Biochars

The innovation and expansion in the bioenergy sector produce increased amounts of solid residues, e.g., ashes and biochars, which may derive from more diverse origins of biomass. Recycling of nutrients like phosphorus (P) in such residues to agricultural soils contributes to sustainability in both energy and agriculture systems. In this study, the P availability was tested in five gasification biochars (GBs) produced via a novel low-temperature (<750°C) gasification technology. The feedstocks used were wheat straw (STR), shea nut shells (NUT), poultry manure (POUL), and two types of sewage sludge mixed with wheat straw (SSA and SSB). A 16-week laboratory incubation study of the materials was conducted with three contrasting soils and resin-extractable P (available P) and pH were monitored. Another mini-plot experiment was done to examine the effects of GBs on spring barley on a loamy sand soil. Neither barley yield nor P uptake showed significant increase after application of the GBs or a mineral P fertiliser, indicating non-limiting P status in this soil and non-adverse effect on the crop growth. During the incubation, all GBs increased soil pH markedly, especially in the STR- and NUT-amended soils and in acid soils. Of the P applied in STR, NUT, and POUL 21–29% was recovered as resin-extractable P in the two acid soils after incubation, while in the alkaline soil the recovery from STR (49%) almost matched that from triple superphosphate (52%). Recoveries from SSA and SSB were similarly low (<14%). A significant positive relationship was identified between the resin-extractable P and the resulting pH in soils amended with some GBs with low P contents. These results revealed varying P availability of low-temperature GBs, which depends on the feedstock type and pH level in the soil, and it also showed a varying ability of GBs to substitute mineral P fertilisers.

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