Biol Fertil Soils
DOI 10.1007/s00374-014-0954-3

ORIGINAL PAPER

Short-term effects of maize residue biochar on phosphorus availability in two soils with different phosphorus sorption capacities

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Received: 21 May 2014 / Revised: 19 August 2014 / Accepted: 25 August 2014

Abstract This study investigated the effects of maize (*Zea mays* L.) straw biochar on phosphorus (P) availability in two soils with different P sorption capacities (iron and aluminum dominated slight acid Red earth and calcium dominated alkaline Fluvo-aquic soil). A 42-day incubation experiment was conducted to study how applications of biochar at different rates (0, 2, 4, and 8 % soil, *w*/*w*), in combination with and without mineral KH_2PO_4 fertilizer, affected contents of soil Olsen-P and soil microbial biomass P (SMB-P) and phosphomonoesterase activity. In addition, P sorption characteristics of soils amended with biochar, as well as main properties of the biochar and the soils, were determined. Application of 8 % biochar after 42 days of incubation substantially increased soil Olsen-P from 3 to 46 mg kg^{-1} in Red earth and from 13 to 137 mg kg^{-1} in Fluvo-aquic soil and increased SMB-P from 1 to 9 mg kg^{-1} in Red earth and from 9 to 21 mg kg^{-1} in Fluvo-aquic soil. The increase was mainly due to high concentrations of P in the ash fraction (77 % of total biochar P). Biochar effect on soil Olsen-P and SMB-P increased by higher biochar application rates and by lower P sorption capacity. Biochar application significantly reduced acid phosphomonoesterase activity in Red earth and alkaline phosphomonoesterase activity in Fluvo-aquic soil due to large amount of inorganic P added. We conclude that maize straw biochar is promising to potentially improve soil P availability in low-P soils, but further research at field scale is needed to confirm this.

Keywords Biochar · Fluvo-aquic soil · Phosphorus availability · Phosphorus sorption capacity · Red earth · Soil Olsen-P

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Introduction

Crop residues are valuable agricultural resources as they contain considerable amounts of nutrients. Return of these nutrients, with a satisfactory availability for crop uptake, to the soil is a challenging research and practice task. Burning of crop residues is a traditionally prevalent practice to return the nutrients to soils in many countries including China, but this generates environmental problems including air pollution, emissions of greenhouse gases, serious fine dust problems, and even change of air circulation and monsoon patterns (Gustafsso et al. 2009; Huang et al. 2012). Processing crop residues to produce biochar and applying biochar to soil is recognized as a better way of disposal of crop residues compared with direct burning of residues in the field (Chun et al. 2004; Qian et al. 2013). Moreover, biochar derived from crop residues is increasingly regarded as a multifunctional material for agricultural and environmental applications (Chen et al. 2011). Biochar has many positive effects on soil quality, e.g., increasing soil organic matter content and pH, retaining soil moisture and nutrients, improving soil structure and stimulating microbial activity, and thus promoting plant growth (Asai

Published online: 07 September 2014