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Harnessing typha australis biochar for enhanced soil fertility and pearl millet productivity in semi-arid systems

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Abstract

In Senegal, agriculture, a key sector for economic and social development, faces major challenges, including climate change and soil degradation. Millet, the main food crop occupying 51 % of cereal acreage, is experiencing stagnant yields due in part to declining fertility. The objective of this study is to evaluate the effects of increasing doses of biochar made from Typha australis, an invasive plant, on soil chemical properties and millet productivity. The study was conducted in the Senegalese peanut basin using a completely randomised block design with five treatments, repeated four times: T0 = control; T1 = recommended dose of inorganic fertiliser (NPK + urea); and the recommended rate of mineral fertiliser rate combined with 10 t ha^{-1} (T2), 20 t ha^{-1} (T3), and 30 t ha^{-1} (T4) of biochar. The application of high rates of biochar, particularly T3 and T4, significantly increased pH, electrical conductivity, and exchangeable K. Soil organic matter content and organic matter increased consistently with biochar, while Ca, Mg, Na, and CEC were mainly influenced by year. Biochar application (T3 and T4) decreased time to heading, flowering, and maturity compared to the control treatment. Addition of higher rates of biochar (T3 and T4) also enhanced millet vegetative growth, particularly plant height (up to 249 cm) and biomass production. Grain yield was significantly influenced by treatments, with highest values recorded under T3 (2750 kg ha^{-1}), followed by T4, while T0 consistently had the lowest yields. These results highlight the potential of T. australis-based biochar as an alternative for the valorisation of an invasive plant to restore soil fertility and support more sustainable agriculture, particularly for smallholder farmers.

Keywords: Biochar, pearl millet, semi-arid systems, soil fertility, Typha australis

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