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Characterisation of coffee pulp biochar and its impact on soil properties and microbial population

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Abstract

Different types of agricultural waste can produce biochar, but the waste material and burning method determine its properties. This study aimed to produce biochar from coffee pulp, which are readily available in northern Thailand, and investigate its effect on soil properties and microbial populations. The research was conducted at the Faculty of Agriculture, Chiang Mai University. The kiln method was used to convert coffee pulp into biochar, which was then studied for its physical and chemical properties using a Field Emission Scanning Electron Microscope (FE-SEM) coupled with an Energy Dispersive X-Ray detector. Additionally, the biochar was mixed with soil to assess its ability to improve soil quality. The experimental design employed was a Completely Randomised Design (CRD), comprising five treatments. These methods involved mixing coffee husk-derived biochar into soil at rates of 0, 2.5, 3.75, 5, and 7.5 % of soil weight. The study found that the coffee biochar had a pore size of 48.35 μm and contained carbon (66.60 %), oxygen (19.13 %), potassium (11.63 %), molybdenum (1.43 %), phosphorus (0.93 %), chlorine (0.23 %), and silicon (0.07 %). Mixing coffee biochar with soil showed no statistically significant differences ($p > 0.05$) in total N (TN), Available P (Avail. P), Exchangeable K (Exch. K), Ca (Exch. Ca), Mg (Exch. Mg), Soil Organic Matter (SOM), pH, EC, Dissolved Organic Carbon (DOC), and Microbial Biomass Carbon (MBC). However, Soil Microbial Respiration (SMR) exhibited significant differences ($p > 0.05$), with the highest release observed in the 7.5 % of biochar treatment. The analysis of fundamental nutrient elements revealed that TN, Avail. P, and Exch. K increased with increasing biochar levels, while Exch. Ca and Mg decreased. SOM and DOC increased, but MBC decreased with increasing biochar application. The addition of coffee biochar led to a reduction in fungal populations, with a maximum reduction of 68 % in the 5 % biochar treatment. However, it also increased the presence of microbes capable of producing cellulase enzymes for cellulose degradation and microbes capable of decomposing the substrate. In summary, while coffee biochar did not significantly affect most soil properties, it impacted microbial populations, reducing fungi but increasing beneficial microbes for decomposition and cellulose degradation.

Keywords: Agricultural waste, coffee biochar, microbial populations, soil properties

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