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Influence of soil properties and application rates on woody biochar potential for carbon mineralization and fertility sustainability of over-fertilization soils

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Positive, negative or no priming effects on C mineralization has been observed following biochar (BC) additions to soils. However, uncertainty still remains about the influence of BC on soil organic carbon (SOC) mineralization in over-fertilization rural soils with compost. To test the hypothesis that whether BC can be used in over-fertilization rural soils to stabilize compost organic matter and diminish C mineralization, 434 days in vitro C mineralization kinetics of incubation experiment using three Taiwan rural soils (topsoil, one slightly acid Oxisols (SAO), one mildly alkaline Inceptisols (MAI), and one slightly acid Inceptisols (SAI)) over-fertilization with swine manure compost (adding 5%, 2 times recommended amount) were conducted to investigate the effects of adding BC produced from lead tree (*Leucaena leucocephala* (Lam.) de. Wit) at 750° on SOC mineralization at the rates of 0% (0%BC), 0.5% (0.5%BC), 1.0% (1%BC) and 2.0% (2.0%BC) (w/w). BC addition significantly decreased (7∼9%) the cumulative CO_2 emissions in SAO, non-significantly decreased (3∼5%) in MAI, and significantly increased (8∼15%) in SAI. Respiration per unit of total organic carbon (total mineralization coefficient, TMC) of three studied soils significantly decreased with biochar addition increased. The four treatments in SAO soil had significantly lower TMC value than MAI and SAI soil, indicated that the organic matter of SAO soil is conserved more efficiently and maintains the activity of the microorganisms responsible for soil organic matter biodegradation. After incubation, biochar has a mineralization potential in soils, even positive or negative, depending on different soil type. The soil pH, exchangeable bases and CEC only showed minor increase with biochar addition increased. The observed variations in Mehlich 3 extractable plant nutrient concentrations reflected the combined effects of fertilization (nutrients added with the biochar and manure compost), the leaching of nutrients, and the adsorption of nutrients by the soil and added biochar. Adding biochar generally increased the levels of plant macronutrients and reduced the concentrations of micronutrients. Three studied soils over-fertilization with manure compost were less sensitive to the addition of BC which could be attributed to higher buffer capacity and finer texture (silt + clay $>$ 60%). In addition, adding 2.0%BC in SAO soil and 1.0%BC in MSI and SAI soils led to substantial improvement in some soil fertility, for example, total carbon, total nitrogen, total phosphorus, soil pH, available K and P.