Carbon Mineralization in two Ultisols Amended with Different Sources and Particle Sizes of Pyrolyzed Biochar

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Abstract

Biochar produced during pyrolysis has the potential to enhance soil fertility and reduce greenhouse gas emissions. The influence of biochar properties (e.g., particle size) on both short- and long-term carbon (C) mineralization of biochar remains unclear. There is minimal information on the potential effects of biochar particle sizes on their breakdowns by soil microorganism, so it is unknown if the particle size of biochar influences C mineralization rate and/or stability in soils. In order to evaluate the effect of different sources and particle sizes of biochar on C loss and/or stability in soils, an incubation study on C mineralization of different biochar sources and particle sizes was established using two soils: Norfolk soil (fine loamy, kaolinitic, thermic, typic Kandiudults) and Coxville soil (fine loamy kaolinitic, thermic, Paleaquults). In separate incubation vessels, these soils were amended with one of two manure-based biochars (poultry litters, **PL**; swine solids, **SS)** or one of two lignocellulosic-based biochars (switchgrass, **SG**; pine chips, **PC**) which were processed into two particle sizes (dust, <0.42 mm; pellet, >2 mm). The amount of CO_2 evolved varied significantly between soils ($p \leq 0.0001$); particle sizes ($p \leq 0.0001$) and the interactions of biochar source ($p \leq 0.001$) and forms of biochars ($p \leq 0.0001$) with soil types. Averaged across soils and sources of biochar, CO_2-C evolved from dust-sized biochar (281 mg kg^{-1}) was significantly higher than pellet-sized biochar (226 mg kg^{-1}). Coxville soils with SS biochar produced the greatest average CO_2-C of 428 mg kg^{-1} and Norfolk soils with PC had the lowest CO_2-C production (93 mg kg^{-1}). Measured rates of carbon mineralization also varied with soils and sources of biochar (Norfolk: PL>SS>SG≥PC; Coxville: PC>SG>SS>PL). The average net CO_2-C evolved from the Coxville soils (385 mg kg^{-1}) was about three-fold more than the CO_2-C evolved from the Norfolk soils (123 mg kg^{-1}). Our results suggest different particle sizes and sources of biochar as well as soil type can influence biochar stability.