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Effect of biochar produced at different pyrolysis temperature on the soil respiration of abandoned mine soil

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Contaminated soils near an abandoned mine site included the high acidic mine tailing have received great interest due to potential risk to human health, because leachable elements in low pH continuously release from mine site soil with ground water and precipitation event. Biochar, which is the obtained pyrolysis process of biomass, is used as a soil amendments and carbon storage. Especially, many researchers report that the biochar application to soil show increasing soil pH, CEC, adsorption capacity of various elements, as well as, enhanced microbial activity. Therefore, biochar application to contaminated soil near abandoned mine site is expected to have a positive effects on management of these site and soils through the decreased leachability of contaminants. However, effects of biochar application to these site on the soil respiration, as a common measure of soil health, are poorly understood. The objective of this study is to evaluate the effects of biochar application to abandoned mine site soil on the microbial activity with soil respiration test.

Biochar was obtained from giant Miscanthus in a slow pyrolysis process (heating rate of 10˚C min^{-1} and N_2 gas flow rate of 1.2 L min^{-1}) at the temperature of 400˚C (BC4) and 700˚C (BC7), respectively. All biochar samples were prepared with grinding and sieving for particle size control (150∼500μm). Soil sample was collected from abandoned mine site at Korea (36˚58'N, 128˚10'E). Main contaminants of this soil were As (12.5 g kg^{-1}), Pb (7.3 g kg^{-1}), and Zn (1.1 g kg^{-1}). Biochars were applied (5% by dry weight) to the soil (final mixture weight were 800g), and then moisture contents were adjusted to 100% field capacity (-0.33 bar) in the respirometer with vacuum pump.

CO_2 efflux of each samples was continuously assessed using continuous aeration system (air flow rate 25 cc min^{-1}) using air cylinder during 130hr (at 20˚C and darkness condition). The CO_2 emitted from the samples were carried to the infrared gas sensor, and these data were sent to a data logger.

During the measuring periods, the cumulative CO_2 emission were similar between the control (516.8 mg-CO_2 kg^{-1}-soil) and BC4 5% mixture (519.3 mg-CO_2 kg^{-1}-soil), while BC7 5% mixture was significantly decreased (356.1 mg-CO_2 kg^{-1}-soil) compared to other treatment and control. Because the degradation rate of biochar generally increased with decreasing pyrolysis temperature, this result suggest that the soil respiration rates of biochar amended soils are affected by physico-chemical properties of biochar during early incubation periods (about 1 weeks), For example, surface properties of used biochars, which are related to adsorption of soil organic matter and CO_2, have different properties with pyrolysis temperature such as specific surface area (BC4=5.08 m^2g^{-1}; BC7=260.75 m^2 g^{-1}, respectively), average pore diameter (BC4=4,673 nm; BC7=2,606 nm, respectively), and functional groups of biochar surface. However, there was not clear evidence of biochar-mine soil interaction process, because of the short observation periods. Future work should focus on the adsorption of CO_2 and soil organic matter of biochar and soil-biochar interaction with long time periods and various biological test.