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Effect of biochar origin and soil pH on greenhouse gas emissions from sandy and clay soils

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Biochar addition is a potential option for reducing GHGs emissions through carbon (C) sequestration and N2O mitigation. However, the influences of biochar on C and nitrogen (N) transformations in soil are still unclear, resulting in a poor understanding of the mechanisms of N2O mitigation effects of biochar. Here we carried out several soil incubation experiments to investigate the influence of two common biochars addition (corn cob and olive pulp) with ammonium sulfate on CO_2 and N2O emissions from two contrasting soil types (acidic sandy and alkaline clay soil). Four extracellular enzymes activities that related to C and N cycling, i.e. cellobiohydrolase, chitinase, xylanase and β-glucosidase, were analyzed to gain insights into the underlying mechanisms of biochar's effects on CO_2 and N2O evolutions. Furthermore, Illumina MiSeq sequencing were used to investigate the effects of different biochar addition on microorganism communities. Contrasting effects of two biochars on CO_2 and N2O emissions were observed in the two different soils. The corn biochar addition had no significant effect on CO_2 and N2O emissions in the alkaline clay soil, but significantly decreased CO_2 emissions by 11.8% and N2O emissions by 26.9% in the acidic sandy soil compared to N-fertilizer only treatment. In contrast, olive biochar addition showed no significant effect on CO_2 emissions but decreased N2O emissions by 34.3% in the alkaline clay soil, while in the acidic sandy soil addition of olive biochar triggered about a twofold higher maximum CO_2 emission rate and decreased N2O emissions by 68.4%. Up to 50-130% higher specific CO_2 emissions (per unit of C-related enzyme activity: cellobiohydrolase, chitinases and β-glucosidase) were observed after addition of olive biochar compared to corn biochar addition in the acidic sandy soil. Specific microbial species showed clear responses to the amendments of mineral N and biochars. In the acidic sandy soil, the amendment of olive biochar resulted in a significant decrease in the proportional abundance of Acidobacteria, accompanied by a significant increase in soil pH. We concluded that biochar's effects on N2O and CO_2 emissions are more pronounced in acidic soils and the higher CO_2 emissions induced by olive mill biochar in sandy soil were attributed to its liming effect.