EVALUATION OF THE LONG-TERM EFFECTS OF PRE-CONDITIONED BIOCHAR ON SOIL ORGANIC CARBON IN TEMPERATE SOILS USING THE CENTURY SOIL ORGANIC MATTER MODEL

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Biochar contains a limited quantity of available mineral nutrients, requiring its addition in large quantities, in temperate soils, and in association with nitrogen (N) fertilizer and/or manure. Alternatively, biochar could be pre-conditioned with urea ammonium nitrate (UAN-enriched biochar), requiring lower inputs of biochar. The objective of this study was to evaluate the long-term (150 years) impact of the addition of UAN-enriched biochar on soil organic carbon (SOC), and soil active, slow and passive carbon (C) fractions compared to other commonly used agroecosystem management practices in a coarse and medium textured soil using the Century Soil Organic Matter Model. Results showed that after 150 years, treatments with biochar had an increase in SOC in both soil types, whereas the other agroecosystem management practices (eg. continuous maize, no till, maize-soybean rotation) decreased in SOC. Manure addition only increased SOC in the coarse textured soil, but decreased in the medium textured soil. An evaluation of the active, slow and passive C fractions revealed significant differences ($P<0.05$) among the various agroecosystem management practices for both soil textures. There was a significantly greater ($P<0.05$) quantity of C accumulation in the slow and passive fractions in biochar treatments. There was also a significant difference ($P<0.05$) between soil types with respect to each C fraction and agroecosystem management practice. Results from this study showed that the application of UAN-enriched biochar, compared to all other management practices, leads to an increase in SOC and the long-term stabilization of C in soil.

Amending intensively managed temperate soils with biochar is a more recent approach to agriculture, with research is still in its infancy. A knowledge gap remains on the effect of biochar on greenhouse gas (GHG) emissions, as most studies conducted to date were short-term (<4 months) in the field or used laboratory incubations; neither of which capture temporal variations in emissions. Therefore the objective of this study was to evaluate soil CO_2 and N_2O emissions in a conventional agricultural production system amended with biochar and under a maize (*Zea mays*) crop in southern Ontario, Canada. The treatments include: poultry manure (6 t/ha) and nitrogen fertilizer (135 kg/ha) (MN); manure (3t/ha) and biochar (3t/ha) (MB); and manure (3 t/ha), fertilizer (135 kg/ha) and biochar (3 t/ha) (MNB). Results show that after the first year of biochar addition, CO_2 emissions were not significantly different ($P<0.05$) among treatments with values ranging from 113 mg CO_2-C/m^2/h in the MN treatment to 111 mg CO_2-C/m^2/h and 95 mg CO_2-C/m^2/h in the MB and MNB treatments. However, CO_2 emissions were significantly different among seasons, with the greatest emissions occurring in the spring, followed by the summer and autumn. Although the MB treatment had lower N_2O emissions (57 µg N_2O-N/m^2/h) compared to the MN (76 µg N_2O-N/m^2/h) and MNB (71 µg N_2O-N/m^2/h) treatments, these differences were not significant ($P<0.05$). However, N_2O emissions were significantly greater ($P<0.05$) in the spring compared to the summer and autumn. Correlation analysis showed that CO_2 emissions were significantly negatively correlated ($P<0.05$) to soil moisture ($r^2=0.0004$), and significantly positively correlated ($P<0.05$) to soil temperature ($r^2=0.232$). N_2O emissions were significantly (positively) correlated ($P<0.05$) to soil moisture ($r^2=0.004$), temperature ($r^2=0.055$), and soil NH_4^+ ($r^2=0.114$) and NO_3^- ($r^2=0.103$) in all treatments.