FARMING PRACTICE
SOIL AMENDMENT WITH BIOCHAR

IMPACT: GHG EMISSIONS

Reference 21

Wu, Z; Zhang, X; Dong, YB; Li, B; Xiong, ZQ 2019 Biochar amendment reduced greenhouse gas intensities in the rice-wheat rotation system: six-year field observation and meta-analysis Agric For Meteorol. 278:107625. 10.1016/j.agrformet.2019.107625

Background and objective

Biochar amendment to cropland has been recommended as a potential strategy to mitigate climate change. However, estimations of the long-term greenhouse gas (GHG) emissions, namely, the methane (CH_4) and nitrous oxide (N_2O) mitigation potential, from agricultural systems are limited. Investigation of the effect of biochar application to soil, with a special focus on field conditions in agricultural systems, on the yield and GHG emissions. Identify the long-term effect of biochar on the yield and GHG emissions and determine their key controlling factors with respect to flooded rice systems versus upland cropping systems to discuss knowledge gaps for steering future research.

Search strategy and selection criteria

A comprehensive literature search was conducted of articles that reported CH_4 or N_2O emissions following biochar application in the Web of ScienceTM and China National Knowledge Infrastructure. 'Biochar or charcoal' was used as the keyword, and 'greenhouse gas, methane, nitrous oxide, GHG, CH_4 or N_2O' was used to refine the search of qualified studies published prior to May 2018. 1) Field studies were continued for at least a full crop season in the field. 2) Experiments measured CH_4 or N_2O fluxes and had at least one pair of data (control and treatment). 3) Soil and biochar properties, the method of biochar application and experimental durations were clearly described. 4) The means, standard deviations/errors, and sample sizes of the variables could be extracted directly from tables, graphs or contexts.

Data and analysis

The categorical random effects model was used to calculate the mean effect size to explain the response of yield and CH_4 and N_2O emissions to soil, biochar properties and other auxiliary variables. The effect sizes and 95% bootstrapped confidence interval (CI) were determined using METAWIN software. The between-group heterogeneity (Qb) across all data for a given response variable was calculated to further analyze the biochar effect among different subgrouping categories.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
60	Rice-wheat/corn rotation systems	Soil amendment with biochar	No amendment	Metric: 1) CH_4 emission; 2) N_2O emission; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	0.875

Results

- Biochar decreased the soil CH_4 (only for paddy) and N_2O fluxes by 9.3% and 18.7%, respectively.
- Biochar with a higher pyrolysis temperature exerted a greater mitigation of N_2O emissions in higher C/N soil with a higher N application.

Factors influencing effect sizes

- Soil C/N ratio : Biochar with a higher pyrolysis temperature exerted a greater mitigation of N_2O emissions in higher C/N soil with a higher N application. For CH_4 fluxes, greater negative effects occurred in lower pH and C/N soils when biochar with a higher C/N was amended.
- N fertilisation rate : Biochar with a higher pyrolysis temperature exerted a greater mitigation of N_2O emissions in higher C/N soil with a higher N application
- Soil pH : For CH_4 fluxes, greater negative effects occurred in lower pH and C/N soils when biochar with a higher C/N was amended.
- Biochar C/N : Biochar with a higher pyrolysis temperature exerted a greater mitigation of N_2O emissions in higher C/N soil with a higher N application. For CH_4 fluxes, greater negative effects occurred in lower pH and C/N soils when biochar with a higher C/N was amended.
- Time scale : The reduction in N_2O emissions in biochar-amended soil persisted over the studied years after a single amendment in field experiments. Biochar application did not change soil CH_4 fluxes in field studies for a shorter period (<0.5 year) but significantly decreased soil CH_4 fluxes by 18.0-50.1% in experiments sustained over several years.

Conclusion

Biochar application appeared to be a good strategy to mitigate global warming in fertilized soils over a long period on a global scale.