FARMING PRACTICE
SOIL AMENDMENT WITH BIOCHAR

IMPACT: GHG EMISSIONS

Reference 25

Cong, WW; Meng, J; Ying, SC 2018 Impact of soil properties on the soil methane flux response to biochar addition: a meta-analysis Agric For Meteorol. 278:107625. 10.1039/c8em00278a

Background and objective

In an effort to optimize soil management practices that can help mitigate terrestrial carbon emissions, biochar has been applied to a wide range of soil environments to examine its effect on soil greenhouse gas emissions. Such studies have shown that the soil methane (CH_4) flux response can vary widely leading to both increase and decrease in CH_4 flux upon biochar amendment. Further decrease uncertainties in our understanding of the soil CH_4 flux response to biochar amendment and identify the combination of factors that best explain variability in methane flux upon biochar amendments. First, we assess whether study-level CH_4 flux differences exhibit similar responses to a distinct level of interaction between soil and biochar properties and management practices.

Search strategy and selection criteria

A literature search was conducted using Scopus, Web of Science, and Google Scholar databases using the keywords "biochar" or "charcoal" or "black carbon" and "CH_4" or "methane" or "greenhouse gas" taking all publications published before July 2016. A minimum of three replicates per treatment was required for the study to be included in the meta-analysis. Only studies where the gas sampling frequency was 3 times or more during the entire experiment were included. Data were collected on studies that compared CH_4 emissions/uptake between a control and a biochar treatment, where the control was defined as being identical to the treatment for all variables except biochar addition.

Data and analysis

Non-independence between data points considered within a meta-analysis can arise due to the fact that one individual study can contribute several data points on the effect of biochar treatment on CH_4 flux (e.g., from testing multiple treatment factors for example). Many meta-analysis methods assume that all data points are independent, which would not be suitable for this scenario. Therefore, we used Bayesian mixed-effects meta-analysis (BMM) models to address the non-independence of observations within a single study. We adopted R package MCMCglmm to carry out Bayesian mixed-effects meta-analysis (BMM).30 For all models, studies were treated as random factors. Water saturation, soil and biochar properties and management factors and their interactions were used as fixed effects. We assessed heterogeneity across studies by the proportion of the total variance in a model accounted for by a particular random factor.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
40	Paddy soils and upland soils	Soil amendment with biochar	No amendment	Metric: CH_4 emission; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	0.6875

Results

- There is no significant soil CH_4 emission/uptake response to biochar addition across studies (dintercept estimate = −0.02, 95% credible interval, CI: −0.15–0.13), but heterogeneity arising from studies existed. Incorporating the interaction moderator with water saturation, soil texture and SOC significantly decreased the heterogeneity among studies

Factors influencing effect sizes

- Soil floading : There was a significant negative effect when taking into account interaction between upland on soil CH_4 emission (or positive effect on CH_4 uptake) after biochar amendment (dfixed effect estimate = −0.26, 95% credible interval, CI: −0.44 to −0.07
- Soil organic carbon : There was a significant negative effect when taking into account interaction between SOC concentration (10–20 g kg−1) on soil CH_4 emission (or positive effect on CH_4 uptake) after biochar amendment (dfixed effect estimate = −0.26, 95% credible interval, CI: −0.44 to −0.07
- Soil texture : There was a significant negative effect when taking into account interaction between coarse soil texture on soil CH_4 emission (or positive effect on CH_4 uptake) after biochar amendment (dfixed effect estimate = −0.26, 95% credible interval, CI: −0.44 to −0.07

Conclusion

Biochar application do not significantly change CH_4 fluxes, in average. However, there is substantial variation in the soil CH_4 flux response to biochar amendment. Interaction of soil properties tends to regulate the soil CH_4 emission/uptake response to biochar addition.