FARMING PRACTICE
SOIL AMENDMENT WITH BIOCHAR

IMPACT: GHG EMISSIONS

Reference 23

Awad, YM; Wang, JY; Igalavithana, AD; Tsang, DCW; Kim, KH; Lee, SS; Ok, YS 2018 Biochar Effects on Rice Paddy: Meta-analysis Adv. Agron. 148 10.1016/bs.agron.2017.11.005

Background and objective

Rice is staple for nearly half of the world population. Biochar (BC) improves crop yields, reduces greenhouse gas (GHG) emissions, and immobilizes heavy metals in the soil. This study was aimed to meta-analyze the data from the published articles focused on the various BCs' effects on rice yield, soil acidity, GHG emissions, and bioavailability of Cd and Pb.

Search strategy and selection criteria

Data were compiled from the published articles related to the effects ofBC application on soil acidity, grain yield, GHG emissions, and bioavailability of Cd and Pb in rice paddy soils. The articles were collected and sorted by experiment types using the electronic databases of ISI Web of Science and Google Scholar. The data were selected with a limitation ofexperiment duration for a column exper- iment having longer than 45 days, a pot experiment having longer than 3 months, and a field experiment having longer than a year.

Data and analysis

The repeated measurements in the data set were meta-analyzed using the MetaWin software version 2.1 based on a mixed model effect to calculate the effect size (d stands for Cohen's measure to standardize the quantity for difference between the means). The chi-square test was per- formed to investigate the effects ofBC on rice grain yield, available Pb and Cd in soil, uptake of Pb and Cd by rice plant, and GHG emissions in each group. The data categorized in various groups were meta-analyzed to calculate the mean effect sizes (E)and 95% CI (Table 1). The meta-analysis software was run at 4999 times of iterations.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
40	Column, pot and field experiments on rice (paddy soils)	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	0.5625

Results

- Biochar application significantly reduces CO_2 and N_2O emissions in paddy soils, while having no significant effect on CH_4 emissions.
- Meta-analysis showed that biochar produced at a pyrolysis temperature of 550–600°C decreased cumulative CO_2,CH_4, and N_2O emissions from rice paddies with -1.838 to -0.098, -0.833 to 0.008, and -2.313 to -0.830 CI95%, respectively, compared to the control. The biochars produced at high pyrolysis temperatures (>500°C) generally showed a relatively high efficacy in reducing GHG emissions.

Factors influencing effect sizes

- Biochar feedstock : Feedstock type showed negative or positive medium effect size (-0.467 E- to 0.776 E+) on cumulative CO_2 emission from rice paddies. Rice husk BC increased the cumulative CO_2 emission by 12.8% with a large E+ value of 3.2. In contrast, the BCs derived from wood and manure/ sludge feedstocks reduced cumulative CO_2 emission from rice paddy soils with significant effects (-2.57 to -6.74 E-). The largest decrease (23.6%) in cumulative CO_2 emission was measured following the application of wood BC, compared to the control. The BCs derived from rice husk and maize straw significantly reduced cumulative CH_4 emission (-0.331 to -8.017 CI95%). Other than maize straw and rice husk BCs, a feedstock type of BC led to insignificant changes in cumulative CH_4 emission with a negative medium N_2O emission by an average of26.1% with E? values of?0.692 to ?0.863 effect size <0.39 E-. A feedstock type ofBC decreased cumulative N_2O emission by an average of 26.1% with E- values of -0.692 to -0.863.
- Biochar pyrolysis temperature : NA
- Biochar application rate : NA

Conclusion

Biochar application significantly reduces CO_2 and N_2O emissions in paddy soils, while having no significant effect on CH_4 emissions.