FARMING PRACTICE
SOIL AMENDMENT WITH BIOCHAR

IMPACT: GHG EMISSIONS

Reference 19

Liu, X; Mao, PN; Li, LH; Ma, J 2019 Impact of biochar application on yield-scaled greenhouse gas intensity: A meta-analysis Sci. Total Environ. p. 969–76. 10.1016/j.scitotenv.2018.11.396

Background and objective

The application of biochar to agricultural ecosystems is a potential solution to mitigate climate change and guarantee food security. However, the impacts of biochar on greenhouse gas emissions and crop yield are usually evaluated separately and the results are contradictory in individual studies. Quantitatively examine the impact of biochar application on yield-scaled GHGI in agricultural ecosystems using meta-analysis procedures. Potential factors regulating the impact of biochar on yield-scaled GHGI were also explored.

Search strategy and selection criteria

A literature search was conducted through ISI Web of Science and Google Scholar using the keywords "biochar" OR "charcoal" AND "greenhouse gas intensity" OR "greenhouse gas" OR "nitrous oxide" OR "methane" OR "N_2O" OR "CH_4" AND "crop yield" OR "crop productivity" (cut-off data: 18th September 2018). 1) data of yield-scaled GHGI must be reported or could be calculated through GWP and crop yield for control and biochar treatment; 2) sample size must be given for each treatment with a minimum of three replications. It should be noted that the only difference between control and biochar treatment was the application of biochar.

Data and analysis

Mean effect sizes and 95% confidence intervals (CIs) were generated through bootstrapping (4999 interactions) using MetaWin 2.1. Although a mixed-effects model or a fixed-effects model was technically not applicable for non-parametric meta-analytic procedure based on weighting by replication, a fixed-effects model must be selected when performing a correct bootstrapping using MetaWin.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
28	Not specified	Soil amendment with biochar	No amendment	Metric: Yield-scaled global warming potential; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	0.75

Results

- Overall, biochar application significantly reduced yield-scaled GHGI by 29%.
- No difference in reduction in GHGI was detected after applying biochar with different pyrolysis temperatures, although biochar produced at low pyrolysis temperatures (≤400 °C) led to a higher reduction in GHGI (−49%) than those produced at moderate (>400, ≤500 °C) (−19%) and high (>500°C) (−32%) pyrolysis temperatures.

Factors influencing effect sizes

- Cropping system : The reduction in dry lands (−41%) was significantly higher compared to that in paddy fields (−17%) .
- N fertilisation : When no N fertilizer was applied, biochar application had no effect on GHGI. In contrast, GHGI was significantly reduced by 23–54% as a result of biochar application when N fertilizer was applied, and the reductions decreased in the order: high application rate (>300 kg N ha−1) > low application rate (>0, ≤150 kg N ha−1) > moderate application rate (>150, ≤300 kg N ha−1). However, the differences in reductions in GHGI among the three application rates were not significant.
- Biochar application rate : Biochar significantly reduced GHGI by 21% when the application rate of biochar did not exceed 5 t ha−1. The reductions in GHGI varied in a range of 26–50% when the application rate of biochar was higher than 5 t ha−1, but the differences among different treatments were also not significant.
- Soil pH : Significant reductions (−31%) in yield-scaled GHGI were observed when incorporating biochar into acidic and alkaline soils. In contrast, applying biochar to neutral soils had no effect on GHGI. Although the reductions in GHGI in acidic and alkaline soils were 3.4 times greater than that in neutral soils after biochar application, the differences among them were not significant.
- Soil texture : The reduction in soils with fine texture was almost twice as large as those in soils with medium and coarse textures. Nevertheless, the differences did not differ significantly among the three soil textures.

Conclusion

Biochar application significantly reduced yield-scaled GHG intensity by 29%.