FARMING PRACTICE
SOIL AMENDMENT WITH BIOCHAR

IMPACT: CARBON SEQUESTRATION

Reference 35

Wang, JY; Xiong, ZQ; Kuzyakov, Y 2016 Biochar stability in soil: meta-analysis of decomposition and priming effects NA 10.1111/gcbb.12266

Background and objective

The stability and decomposition of biochar are fundamental to understand its persistence in soil, its contribution to carbon (C) sequestration, and thus its role in the global C cycle. Our current knowledge about the degradability of biochar, however, is limited. The extent of biochar decomposition and its mean residence time (MRT) in soils means its stability remains nearly unknown. The overall objective of this meta-analysis is therefore to synthesize those biochar decomposition studies in which 13C or 14C isotopes were used.

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
21	Column, pot and field experiments on rice (paddy soils)	Soil amendment with biochar	No amendment	Metric: Native soil organic matter, Total soil organic carbon; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	0.5625

Results

- Averaged across all studies, biochar addition induced a negative priming effect on native soil organic matter, but this effect was not statistically significant (overall mean = −3.8%, 95% CI = −8.1–0.8%).
- The labile and recalcitrant pools represent 3% and 97% of biochar C, respectively. The mean residence time (MRT) of carbon in soil varied greatly among studies, ranging from less than three up to 891 years, with an average of 107 years. Similar to other organic materials added into soils, biochar decomposition can be approximated well by biphasic patterns. The commonly used double first-order exponential decay model yielded rates for labile and recalcitrant biochar pools of 0.0093% day−1 and 0.0018% year−1, respectively. This corresponds to MRTs of 108 days and 556 years, respectively.

Factors influencing effect sizes

- Time scale : Approximately half of the studies shorter than 0.5 year showed a significantly negative priming effect (−8.6%) following biochar addition, whereas no significant effect was found in studies longer than 0.5 year.
- Bioachar feedstock : The crop-derived biochar addition induced the highest negative priming (−20.3%) compared to other feedstocks.
- Biochar pyrolysis temperature : Biochar produced either by fast pyrolysis or at the lowest pyrolysis temperature (200–375 °C) induced significant negative priming compared to other groups for each categorical variable.
- Biochar application rate : Small application amount (0.1–1%) induced significant negative priming compared to other groups for each categorical variable.

Conclusion

The authors conclude that priming on native soil organic matter induced by biochar addition is slightly negative, because of the preferential utilization of easily available substrates from incomplete pyrolysis. For all studies, the authors definitely conclude that biochar application has a positive C balance at least within 10 years.