FARMING PRACTICE
SOIL AMENDMENT WITH BIOCHAR

IMPACT: CROP YIELD

Reference 15

Zhang, Q; Xiao, J; Xue, JH; Zhang, L 2020 Quantifying the Effects of Biochar Application on Greenhouse Gas Emissions from Agricultural Soils: A Global Meta-Analysis Sustainability 12:3436. . 10.3390/su12083436

Background and objective

Agricultural disturbance has significantly boosted soil greenhouse gas (GHG) emissions such as methane (CH_4), carbon dioxide (CO_2), and nitrous oxide (N_2O). Biochar application is a potential option for regulating soil GHG emissions. However, the effects of biochar application on soil GHG emissions are variable among different environmental conditions. 1) quantify the response of soil GHG emissions to biochar application under different management strategies, biochar characteristics, and soil properties; 2) explore which environmental variables are the driving factors of the regulation of soil GHG emissions with biochar application; and 3) evaluate the response of soil global warming potential (GWP), greenhouse gas emission intensity (GHGI), and crop yield to biochar application under identical conditions.

Search strategy and selection criteria

These selected publications were obtained from the China Knowledge Resource Integrated Database (http://www.cnki.net) and the Web of Science (http://apps.webofknowledge.com). The keywords included "biochar", "methane", "carbon dioxide", "nitrous oxide" or "greenhouse gases", and "crop yield". 1) treatments and the control group must be included in the same independent trials; 2) either crop yield or soil GHG emissions must be present in both treatments and control groups; 3) the data of soil GHG emissions must come from topsoil (0–20 cm); 4) the means, standard deviation (or standard error), and number of replicates must be presented or calculated from the reported data; 5) the number of trial design iterations must be higher than two.

Data and analysis

One-way ANOVA was used to examine whether soil greenhouse gas emissions and crop yield differed significantly between biochar application and nonbiochar application. The software MetaWin 2.1 was applied to calculate the effect sizes of management, biochar characteristics, and soil properties on soil GHG emissions. All the graphs were obtained by using the software Origin 8.5. Eight variables (biochar application rate and time, biochar characteristics (type, pyrolysis temperature, carbon-to-nitrogen [C:N] ratio, and pH), and soil properties (soil texture and soil pH)) were retained to calculate the relative influence (%) of biochar application on soil GHG emissions on the basis of a boosted regression tree (BRT) model. Boosted trees were constructed by using the recommended parameter values: learning rate (0.01), bag fraction (0.50), cross-validation (10), and tree-complexity (5) [28]. Because there were continuous numerical variables, the Gaussian distribution of errors was used for all BRT fittings. All BRT analyses were performed with the gradient boost machinet (GBM) package in R version 3.3.3.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
129	Biochar obtained from crop residues or straw	Soil amendment with biochar	No amendment	Metric: Crop yield; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	0.625

Results

- Crop yield was increased with biochar application in several independent experiments under identical conditions, with an average weighted response ratio of +21%.

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

With biochar application, the overall crop yield significantly increased.