European Commission

FARMING PRACTICE
SOIL AMENDMENT WITH BIOCHAR

IMPACT: AIR POLLUTANTS EMISSIONS

Reference 27

Liu, Q; Zhang, YH; Liu, BJ; Amonette, JE; Lin, ZB; Liu, G; Ambus, P; Xie, ZB 2018 How does biochar influence soil N cycle? A meta-analysis Plant Soil 426:211–25 10.1007/s11104-018-3619-4

Background and objective

The amendment of soils with biochar has been suggested as a promising solution to regulate the soil N cycle and reduce N effluxes. However, a comprehensive and quantitative understanding of biochar impacts on soil N cycle remains elusive. 1) identify how and why the response of soil N cycle to biochar application varies across different biochar and soil properties; and 2) explore whether biochar production process entails hidden risk of extra pollutant N emissions. The study is expected to develop constructive biochar management for decreasing soil N losses without incurring negative side effects.

Search strategy and selection criteria

A literature search was performed through Web of Science, Google Scholar, Springer Link, Wiley Blackwell, and China Knowledge Resource Integrated (CNKI) databases using the keywords 'biochar', 'black carbon', 'soil', 'nitrogen'. 1) the research was on soil N cycle in response to biochar addition; 2) biochar was produced by pyrolyzing organic materials anaerobically (technology levels range from highly advanced facilities to simply equipped stoves); and 3) control and biochar treatments were subjected to the same management (e.g. same tillage, watering, fertilization, or residue addition).

Data and analysis

Mean effect sizes and the 95% bootstrapped confidence intervals (CIs) based on 9999 iterations for each grouping categories were generated based on a random-effect model. The total heterogeneity of effect sizes among studies (QT) was partitioned into within-group (QW) and between-group (QB) heterogeneity. A QB larger than a critical value suggests a significant difference between subgroups.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
208	Global dataset of 208 studies, 340 pairwise comparisons. Different types of soils, pedo-climate conditions, different types of biochars.	Soil amendment with biochar	No amendment	Metric: Ammonia emission; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	0.6875

Results

- Biochar significantly enhances soil NH_3 volatilization by 19% ($P = 0.034$) on average across different studies.
- Manure biochar and straw biochar stimulate soil NH_3 volatilization by an average of 43% and 27%, respectively, whereas wood biochar tends to decrease soil NH_3 volatilization by an average of 30%.

Factors influencing effect sizes

- Soil pH : Biochar stimulates soil NH_3 volatilization to a larger extent from acidic soils ($pH \leq 5$) than from moderately acidic soils ($5 < pH \leq 6.5$), while it shows little effect on neutral or alkaline soils.
- Soil texture : Soil NH_3 volatilization from clay textured soils are more prone to be increased by biochar than that from other types of soil.
- Soil organic carbon : Biochar addition to soils with less than 10 g SOC kg^{-1} induces a significant increase in soil NH_3 volatilization, while no significant response to biochar is observed in soils with SOC > 10 g kg^{-1}.
- Biochar pH : Biochar characterized by pH > 9 induces a significant increase in soil NH_3 volatilization, however, biochar with pH lower than 9 shows no significant effect.
- Biochar application rate : Biochar being applied at the rate > 40 t ha^{-1} induces a significant increase in soil NH_3 volatilization, however, biochar being applied at less than 40 t ha^{-1} shows no significant effect.

Conclusion

Biochar significantly enhances soil ammonia volatilization. However, wood biochar tends to decrease soil NH_3 volatilization.