A019 LPSC

How much is soil nitrous oxide emission reduced with biochar application? An evaluation of meta-analyses

Abstract

Nitrous oxide (N_2O) is the third important long-lived greenhouse gas (GHG) next to carbon dioxide and methane and croplands are considered biogeochemical hotspots of soil N_2O emission. To reduce soil N_2O and other GHG emissions, climate-smart agricultural practices including biochar application have been applied. Many studies have been conducted with biochar application but results from these studies are not conclusive. To address this issue, meta-analysis, a quantitative review that synthesizes results from multiple independent studies, has been widely used. One major purpose of meta-analysis is to provide a more reliable result based on multiple studies. However, results from different meta-analyses also differ, but are seldomly evaluated. In this study, we evaluated meta-analyses on the effects of biochar on soil GHG emissions, particularly soil N_2O emission. We found more than 100 meta-analyses have been conducted on biochar application, about 28 with its impacts on GHGs, and 16 with soil N_2O emission. These 16 papers were published between 2014 and 2021. Sample size (publications or experiments) varied from 28 to more than 200. Response ratio was calculated in all studies except one.

Different croplands were included in most studies but some only considered paddy fields. While two meta-analyses did not find a significant effect of biochar application on soil N_2O emission, all others reported reductions of soil N_2O emission, but the magnitude ranged from -14% to -54%. While meta-analysis provides a more comprehensive and better estimation, it may not be able to resolve the inconsistence among studies. A grand mean response ratio was proposed to estimate an overall reduction based on those meta-analyses. Large sample size and more consideration on the impacts of other covariates are needed to conduct a better meta-analysis.

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