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Biochar reduces N2O emissions from soils: A meta-analysis

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Global efforts to mitigate climate change and to increase food security are challenging. Technologies that reduce greenhouse gas emissions from agriculture while increasing crop yields simultaneously are not well characterized for their efficiency. For instance, biochar used to sequester carbon and to increase crop yields also alters the soil nitrogen cycle. This in turn affects N2O emissions from soil, where N2O has a higher global warming potential than emitted CO_2. However, the mechanisms of biochar regarding the N2O emission process are not well understood due to complex interactions between soil organic and inorganic materials and their impact on the physical soil structure. To further understand the complex relationship, a single experimental study may not provide critical answers.
Therefore, we conducted a meta-analysis by reviewing literature published between 2010 and 2016 that focused on N2O emission from soils amended with biochars. A meta-analysis is a quantitative technique that allows estimating an overall treatment effect from many divergent research experiments. In our case, we included 92 publications that contained a total of 437 comparisons between biochar treated soils and biochar non-treated soils. We used a random effects model and bootstrapping with 1000 intervals to estimate the general percentage increase or decrease of N2O emission through biochar amendment. Our results showed that biochar treatment leads to a significant decrease of N2O emissions between 33% and 45%. This promising result highlights the need to increase investigations to more fully assess (i) the multitude of mechanisms involved in the observed N2O emission reductions such as soil pH changes, alterations in the soil microbial community and soil N cycling, a shift in the ratio of denitrifier end products (N2O/(N2O+N2) ratio) or nitrate capture by biochar particles, and (ii) the impact of biochar characteristics, soil properties and land use types on the multiple mechanisms controlling N2O emissions.