

Quantitative review of the effects of biochar application on soil available inorganic nitrogen using meta-analysis

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Biochar has been evaluated to be a promising mean to improve soil bio-chemical properties including nitrogen (N). Multiple studies have reported influences of biochar on soil inorganic N (SIN) including ammonium (NH₄⁺-N) and nitrate (NO₃⁻-N); however, the influences vary and have not yet been synthesised. We aimed to investigate how biochar properties and the interaction among biochar, soil and fertilisation affect SIN using a meta-analysis. This quantitative systematic review used 56 studies with 1080 experimental cases which were published between 2010 and 2015. Our main finding was approximately 10% reduction of total SIN by biochar regardless of experimental conditions; however, 95% of cases were observed within one year after biochar application. Woody biochar accounted for 45.9% of studied biochars, but it did not decrease SIN as much as other plant-derived biochars. The combination of biochar and NH₄-based fertiliser significantly decreased SIN compared with biochar alone. However, the increase of SIN was observed when biochar was combined with organic fertiliser. Biochar volatile organic compounds (VOCs) and soil texture did not influence soil NO₃⁻-N significantly. Biochar surface area and VOCs did not influence soil NH₄⁺-N significantly. By exploring that SIN clearly reduced after one month of biochar application, we suggest biochar should be applied at least one month prior to planting to the soil so plant does not suffer decreased N. Due to the lack of data, the long term effects of biochar on SIN (>1 year) remained unanswered.