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Role of biochar in low carbon sustainable crop production of China: a synthesizing analysis of field studies

Jufeng Zheng, Xiaoyu Liu, Afeng Zhang, Gang Wu, Bin Zhang, Kun Cheng, Lianqing Li, Yuming Liu, Jingjing Qu, Dengxiao Zhang, Grace Kubie , Siddie Muhanmud , and Genxing Pan

Nanjing agriculture university, Soil Science, China (zhengjufeng@njau.edu.cn)

Zheng Jufeng[1], Liu Xiaoyu[1¶], Zhang Afeng[1¶], Wu Gang[1¶], Zhang Bin[1¶], Cheng Kun[1¶],Li Lianqing [1¶], Liu Yuming[1¶], Qu Jingjing[1], Zhang Dengxiao[1], Kubie Grace [1], Muhanmud Siddie [1], Pan Genxing[1]

1,Center of Climate Change and Agriculture, and Institute of Resource, Ecosystem and Environment of Agriculture, Nanjing Agricultural University,1 Weigang, Nanjing 210095, China

¶These authors made equal contribution with either performing field studies for single sites or data collecting and analysis.

Corresponding author: Genxing Pan

Address: Institute of Resource, Ecosystem and Environment of Agriculture, Nanjing

Agricultural University, 1 Weigang, Nanjing 210095, China

Abbreviations: BSA, BSA; LCA, low carbon agriculture; RP, rice paddy(ies); DC: dry cropland(s); GHGs, greenhouse gases; GWP: global warming potential

Abstract

BSA (BSA) has been proposed as a measure to enhance soil organic C sequestration and mitigate greenhouse gas emission from world croplands. In this study, results of BSA field experiments with rice paddy and dry croplands in 7 sites over China were synthesized for addressing an overall role of biochar in low carbon sustainable crop production. Soil amendment at rates of 0, 20 t ha^{-1} and 40 t ha^{-1} of biochar via pyrolysis from wheat straw at 35o-550°was performed consistently across the sites with local conventional fertilization and crop managements. Soil emission monitoring of non-CO_2 greenhouse gases (CH_4 and N_2O) was conducted at 1 week interval during crop growing season in the year of BSA all sites and the subsequent year after BSA in some sites. Yield and properties, greenhouse gases (CH_4 and N_2O) and C intensity were assessed. The results from single experiments were synthesized for quantifying the relative changes in yield and GWP with BSA as well as changes in soil properties. BSA increased significantly soil pH, TN, SOC and decrease soil bulk density. On average, crop yield was significantly increased ($\sim$6% for rice and 10%$\sim$18% for maize) at an extent higher in croplands than in rice paddies. While BSA reduced slightly CH_4 uptake in dry cropland, increases in CH_4 emission showed a large uncertainty related to soil and climate condition as well as water regime from rice paddies. However,N_2O emission from treated croplands were significantly reduced with BSA by 37$\sim$48% across sites. As the integration effect, global warming potential (GWP) and C intensity were decreased averagely by over 30% agriculture production (38% $\sim$ 44% in dry cropland and 22% $\sim$ 42% in paddy soil) with BSA, which was a great contribution to mitigation of CO_2 in Chinese agriculture. The results further implicated BSA to cropland may to develop sustainable low carbon agriculture as a feasible measure.

Key words: Biochar soil application, soil properties, C sequestration, CH4 and N2O mitigation, C intensity, synthesizing analysis