PLOS ONE

RESEARCH ARTICLE

Response of soil organic carbon fractions, microbial community composition and carbon mineralization to high-input fertilizer practices under an intensive agricultural system

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Citation: Li J, Wu X, Gebremikael MT, Wu H, Cai D, Wang B, et al. (2018) Response of soil organic carbon fractions, microbial community composition and carbon mineralization to high-input fertilizer practices under an intensive agricultural system. PLoS ONE 13(4): e0195144. https://doi.org/10.1371/journal.pone.0195144

Editor: Xiujun Wang, Beijing Normal University, CHINA

Received: October 18, 2017

Accepted: March 16, 2018

Published: April 18, 2018

Data Availability Statement: All data files are available from Figshare under the following DOIs: DOI: https://doi.org/10.6084/m9.figshare.5771433.v1 DOI: https://doi.org/10.6084/m9.figshare.5771436.v1 DOI: https://doi.org/10.6084/m9.figshare.5771430.v1 DOI: https://doi.org/10.6084/m9.figshare.5771442.v1 DOI: https://doi.org/10.6084/m9.figshare.5771445.v1 DOI: https://doi.org/10.6084/m9.figshare.5771448.v1.

Abstract

Microbial mechanisms associated with soil organic carbon (SOC) decomposition are poorly understood. We aim to determine the effects of inorganic and organic fertilizers on soil labile carbon (C) pools, microbial community structure and C mineralization rate under an intensive wheat-maize double cropping system in Northern China. Soil samples in 0–10 cm layer were collected from a nine-year field trial involved four treatments: no fertilizer, CK; nitrogen (N) and phosphorus (P) fertilizers, NP; maize straw combined with NP fertilizers, NPS; and manure plus straw and NP fertilizers, NPSM. Soil samples were analyzed to determine labile C pools (including dissolved organic C, DOC; light free organic C, LFOC; and microbial biomass C, MBC), microbial community composition (using phospholipid fatty acid (PLFA) profiles) and SOC mineralization rate (from a 124-day incubation experiment). This study demonstrated that the application of chemical fertilizers (NP) alone did not alter labile C fractions, soil microbial communities and SOC mineralization rate from those observed in the CK treatment. Whereas the use of straw in conjunction with chemical fertilizers (NPS) became an additional labile substrate supply that decreased C limitation, stimulated growth of all PLFA-related microbial communities, and resulted in 53% higher cumulative mineralization of C compared to that of CK. The SOC and its labile fractions explained 78.7% of the variance of microbial community structure. Further addition of manure on the top of straw in the NPSM treatment did not significantly increase microbial community abundances, but it did alter microbial community structure by increasing G+/G- ratio compared to that of NPS. The cumulative mineralization of C was 85% higher under NPSM fertilization compared to that of CK. Particularly, the NPSM treatment increased the mineralization rate of the resistant pool. This has to be carefully taken into account when setting realistic and effective goals for long-term soil C stabilization.