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Organic amendment regulates soil microbial biomass and activity in wheat-maize and wheat-soybean rotation systems

Dali Song[a,b], Xianglin Dai[c], Tengfei Guo[d], Jiwen Cui[a], Wei Zhou[a,*], Shaomin Huang[d,*], Jianbo Shen[b], Guoqing Liang[a], Ping He[a], Xiubin Wang[a], Shuiqing Zhang[d]

[a] *Ministry of Agriculture Key Laboratory of Plant Nutrition and Fertilizer, Institute of Agricultural Resource and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, China*
[b] *College of Resources and Environmental Sciences, China Agricultural University, Beijing 100193, China*
[c] *Institute of Coastal Agriculture, Hebei Academy of Agriculture and Forestry Sciences, Tangshan 063299, China*
[d] *Institute of Plant Nutrition and Environmental Resources Science, Henan Academy of Agricultural Sciences, Zhengzhou 450002, China*

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A B S T R A C T

Long-term heavy application of inorganic fertilizers is associated with a decrease in soil quality and biodiversity. Organic amendments have been reported to positively affect soil quality; however, relatively little is known regarding soil carbon (C) cycle enzyme kinetic parameters (V_{max} and K_m), community-level physiological profiles (CLPP), and the interactions between these factors and soil microbes and physicochemical properties under sustained organic amendment. Therefore, this study aimed to evaluate the effect of organic amendments on crop yield, soil chemical properties, microbial activity, enzyme kinetic parameters of five extracellular C cycle-related hydrolase enzymes, and soil microbial functional diversity in wheat-maize (WM) and wheat-soybean (WS) rotation crop systems. The results of the study showed that combined application of organic and inorganic fertilizers increased crop yield (6.81–17.47%), soil total organic C (TOC, 29.44–39.54%), total nitrogen (TN, 24.22–50.79%), available potassium (AK, 39.47–59.62%), total dissolved nitrogen (TDN, 19.68–33.75%), dissolved organic C (DOC, 14.54–55.10%), available phosphorus (AP, 34.81–243.90%), and microbial biomass C and nitrogen (MBC, 17.65–40.86% and MBN, 18.63–50.76%) concentration. The combined application also enhanced microbial growth when compared with an inorganic amendments regime. Additionally, the combined application of organic and inorganic fertilizers increased soil microbial activity and catabolic diversity and maintained a high substrate-induced respiration (SIR) value. Furthermore, the conversion from a WM rotation to a WS rotation increased both soil pH and microbial biomass, and the resultant soil exhibited lower potential activity and higher enzyme-substrate affinity. Overall, the findings of this study showed that an increase in soil microbial biomass is a key determinant of microbial catabolic activity and functional diversity.

1. Introduction

Long-term heavy application of inorganic fertilizers in agricultural production can lead to adverse environmental consequences (Harkes et al., 2019; Krauss et al., 2020), such as water eutrophication, soil erosion, and biodiversity loss (Foley et al., 2005; Harkes et al., 2019; Krauss et al., 2020). Therefore, it is essential to develop sustainable management practices to reduce the negative environmental impact of agriculture (Krauss et al., 2020; Tilman et al., 2002). Over the years, legume cultivation, crop rotation, and organic amendment have been adopted to reduce the environmental impacts of agricultural practices (Poulton et al., 2018). However, nitrogen (N)-based inorganic fertilizers are still widely used to increase crop productivity to meet high global food demand (Zhang et al., 2015). To minimize the negative effects of large-scale agriculture without negatively affecting food production, combined organic and inorganic fertilizers application have recently been developed (Dai et al., 2019; Harkes et al., 2019).

The combined application of organic and inorganic fertilizers can improve soil fertility and productivity and alter microbial community composition (Marschner et al., 2003; Poulton et al., 2018; Dai et al., 2019). Previous studies have suggested that the benefits of organic amendments application could be attributed to the maintenance of a

* Corresponding authors.
E-mail addresses: zhouwei02@caas.cn (W. Zhou), hsm503@126.com (S. Huang).

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