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Organic amendment increases soil respiration in a greenhouse vegetable production system through decreasing soil organic carbon recalcitrance and increasing carbon-degrading microbial activity

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Abstract

Purpose Recent works have shown that fertilization has an important influence on soil respiration (Rs); however, the underlying mechanisms involved in regulating Rs in greenhouse vegetable production (GVP) systems remain unclear.

Materials and methods Samples from six kinds of soils that were amended with different fertilization patterns (8 years) were incubated for 36 days to determine soil microbial community (PLFA), enzyme activities, soil organic C (SOC) quality (^{13}C NMR), and Rs in a GVP system in Tianjin, China. Treatments included 100% chemical N (CN) and different substitution rates of CN with manure-N and/or straw-N.

Results and discussion Compared with 100%CN treatment, organic amendment strongly promoted microbial (e.g., fungi, bacteria, and actinomycetes) growth, enhanced the majority of C-degrading enzyme activities, affected SOC chemical composition with increasing O-alkyl (labile) C and reducing aromatic (stable) C, decreased SOC recalcitrance, and enhanced Rs. Redundancy analysis indicated that variations in microbial community and SOC chemical composition were closely linked to light fraction organic C (LFC) and readily oxidizable C (ROC), respectively. Further, structural equation modeling and linear regression analysis revealed that SOC recalcitrance (negative effects) and C-degrading enzyme activities (positive effects) together mediate Rs rates; meanwhile, microbial community can indirect affect Rs rates through altering C-degrading enzyme activities.

Conclusions Agricultural soil abiotic properties (mainly labile C fractions, i.e., LFC and ROC) are altered by adding organic resources (i.e., manure and straw), the changes of which can promote soil microbial growth, enhance C-degrading microbial activity, and reduce SOC recalcitrance, and in turn accelerate Rs in GVP systems.

Keywords Soil respiration · Soil organic C quality · Microbial community composition · C-degrading enzyme activity · Greenhouse vegetable production

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