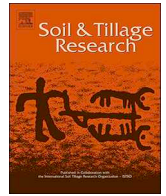




ELSEVIER

Contents lists available at ScienceDirect

Soil & Tillage Research

journal homepage: www.elsevier.com/locate/still

Partial substitution of chemical fertilizer with organic amendments affects soil organic carbon composition and stability in a greenhouse vegetable production system

Haoan Luan^{a,b,1}, Wei Gao^{c,1}, Shaowen Huang^{a,*}, Jiwei Tang^a, Mingyue Li^c, Huaizhi Zhang^a, Xinping Chen^b

^a Key Laboratory of Plant Nutrition and Fertilizer, Ministry of Agriculture/Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, China

^b Center for Resources, Environment and Food Security, China Agricultural University, Beijing 100193, China

^c Tianjin Institute of Agricultural Resources and Environment, Tianjin 300192, China

ARTICLE INFO

Keywords:

Fertilization
Soil organic carbon stability
Greenhouse vegetable production

ABSTRACT

Understanding soil organic carbon (SOC) composition and stability is necessary for long-term carbon (C) sequestration. Fertilization is known to modify SOC stability and composition; however, inconsistent results have been reported. Here, we evaluated the changes in SOC composition and stability through multiple methods in an 8-year fertilization experiment under greenhouse vegetable production (GVP) systems in Tianjin, China. This experiment was designed to supply an equivalent amount of nutrients (N, P₂O₅ and K₂O) but variable amount of C through different exogenous organic resources (ORs) input. Five treatments were included based on substitution of chemical fertilizer nitrogen (N) with different exogenous ORs: no N (no nitrogen inputs), 4/4CN (CN, nitrogen in chemical fertilizer), 2/4CN + 2/4 MN (MN, nitrogen in pig manure, high-quality ORs), 2/4CN + 2/4SN (SN, nitrogen in corn straw, low-quality ORs) and 2/4CN + 1/4 MN + 1/4SN. Organic fertilization strategies promoted SOC accumulation and reduced SOC stability by increasing labile C fractions, whereas chemical fertilizer alone had a negative effect on SOC accumulation by consuming labile C fractions but enhanced SOC stability. Notably, the characteristics of high temperature, nutrient availability and C inputs in organically managed soils in GVP systems weaken the influence of ORs quality on SOC stability. Consequently, high doses of C inputs (11.5 and 18.5 Mg ha⁻¹ year⁻¹ in 2/4CN + 1/4 MN + 1/4SN and 2/4CN + 2/4SN treatments) induced lower SOC stability than low doses of C inputs (4.5 Mg ha⁻¹ year⁻¹ in the 2/4CN + 2/4 MN treatment), irrespective of ORs quality. In addition, strong correlations were found between SOC thermal characteristics and SOC chemical and ¹³C NMR spectral properties, indicating that thermal analysis techniques can characterize SOC stability effectively.

1. Introduction

The stability and composition of soil organic carbon (SOC) has received an increasing amount of research attention in recent years as a result of its key role in carbon (C) cycling in terrestrial ecosystems (Grandy and Neff, 2008; Schmidt et al., 2011). In general, SOC stability can be defined as its resistance to microbial decomposition (i.e., the opposite to SOC decomposability). The SOC stability, in the broadest sense, includes the following three major mechanisms: (1) biochemical recalcitrance (i.e., its inherent biochemical ‘resistance’ to decomposition); (2) spatial inaccessibility to microorganisms or enzymes (i.e.,

physical protection (soil aggregate) of SOC from microbial attack); and (3) interactions of SOC with minerals (i.e., SOC is protected by mineral surfaces and Fe- and Al-hydroxides) (Kögel-Knabner et al., 2008; Schmidt et al., 2011). An increasing number of studies have emphasized Mechanisms (2) and (3) in driving soil C cycle and SOC stability (Dungait et al., 2012; Medina et al., 2015), but Mechanism (1) still plays a vital role in SOC stability.

Understanding how addition of exogenous organic resources (ORs) affects SOC stability is critical to predicting the response of soil C dynamics to ORs application (Tian et al., 2013). Increasing evidence indicates that ORs can be used as agricultural amendments and for

* Corresponding author.

E-mail addresses: luanhaoan@163.com (H. Luan), vivigao2002@163.com (W. Gao), huangshaowen@caas.cn (S. Huang).

¹ These authors contributed equally to this study.

<https://doi.org/10.1016/j.still.2019.04.009>

Received 25 July 2018; Received in revised form 4 April 2019; Accepted 9 April 2019

Available online 15 April 2019

0167-1987/ © 2019 Elsevier B.V. All rights reserved.