World Scientific Research Journal Volume 10 Issue 1, 2024
ISSN: 2472-3703 DOI: 10.6911/WSRJ.202401_10(1).0010

Research Progress on The Stability of Soil Organic Carbon Pool

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Abstract

Soil organic carbon pool is the main component of terrestrial carbon pool, which is dynamically changed under the influence of climate change and human activities. It is estimated that the global terrestrial soil carbon pool is about 1300 ~ 2000 Pg C, which is 2 ~ 3 times that of the terrestrial vegetation carbon pool of 500 ~ 600 Pg C and more than twice that of the global atmospheric carbon pool of 750 Pg C. Therefore, the soil carbon pool plays an important role in the global carbon balance, especially the soil organic carbon pool. The components, main components and stability mechanism of soil organic carbon pool were discussed. Based on the theory of stability mechanism, some suggestions were given for the study of soil organic carbon pool.

Keywords

Soil organic carbon pool; POC; MAOC; Stability mechanism of soil organic carbon.

1. SOIL ORGANIC CARBON

Soil organic carbon (SOC), as one of the important components of soil, plays a very important role in maintaining soil fertility and soil health. At present, the lack of understanding of soil carbon cycle is an important reason for the structural differences among models. In addition, soil carbon pools in many models cannot be separated by experimental means, thus many parameters of traditional models cannot be quantified by tests [1]. The classical Century model divides organic carbon into active carbon pool, slow carbon pool and passive carbon pool based on the chemical stubbornness of soil organic carbon pool) [2], which is also the carbon pool division method adopted by most terrestrial ecosystem models at present.

2. CLASSIFICATION OF SOIL ORGANIC CARBON POOL

Active carbon pool is the organic carbon with high activity in soil, which is easily decomposed and assimilated by soil microorganisms and directly supplies plant nutrients. Active organic carbon pool has a high bioavailability and loss rate, while inert organic carbon pool has a high residual rate, generally accounting for 60% to 80% of soil organic matter [3]. Soil inert organic carbon mainly exists in soil clay and fine powder produced by soil formation process during the Quaternary glacial period. Inert organic carbon forms a very close bond with soil clay and fine powder particles, which makes it difficult to be decomposed and mineralized by microorganisms in the soil, and can remain stable in the soil for hundreds to tens of thousands of years [4].

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Compared with soil inert components, activated carbon is more sensitive to environmental changes [5-7]. Activated carbon pool includes soil microorganisms and their derivatives, which are the main sources of soil nutrients and greatly affect soil quality and productivity [8]. However, due to its short average residence time, its contribution to soil carbon sink is relatively small [9]. In addition to improving soil quality and productivity, inert organic carbon mainly contributes to the increase of soil total organic carbon, which can be used as a reliable indicator of soil organic carbon sequestration potential [10]. Most of the stable organic carbon in soil is directly derived from microorganisms, because metabolically dead microorganisms contribute organic carbon to the soil carbon pool [11]. Soil bacteria and fungi promote the degradation, utilization, synthesis and stability of different carbon compounds in different ways, and help to transform stable organic carbon into active organic carbon by secreting extracellular enzymes [12-13].

3. SOIL ORGANIC CARBON GROUPING

At present, there is no uniform grouping system for soil organic carbon, which is probably one of the important factors limiting the development of this research field. Usually researchers are grouped according to the needs of their own research. In the last 20 years, scientists have mainly grouped organic carbon according to its turnover rate, degradation rate, sensitivity to external factors and physical density. The establishment of a scientific and reasonable soil organic carbon grouping (carbon pool division) method is of great significance for both soil carbon cycle test and model research [14-15]. Existing studies have shown that plant-derived organic carbon and microbial organic carbon mainly contribute to the accumulation process of SOC. SOC is considered to be a complex and heterogeneous mixed component composed of organic carbon from plant or microbial sources with different decomposition degrees and times, sizes and chemical compositions. Due to the differences in the formation, turnover time and function of plant-derived organic carbon and microbial organic carbon, In recent years, more and more scholars have suggested that soil organic carbon should be separated into Particulate organic carbon (POC) and mineral-associated organic carbon (mineral-associated organic carbon) according to the formation and stabilization mechanism of soil organic carbon. MAOC) [16-17].

POC refers to organic carbon with a particle size greater than 53μm, mainly from plant residues and fungal mycelia of high molecular weight organic carbon, mainly plant macromolecular substances, with high C:N ratio and fast turnover rate, is an intermediate product with high activity of plant and animal residues to soil humus transformation. POC is a component defined by physical classification and particle size, including any > 53 μm identifiable organic debris and light groups, mainly including plant and animal remains from above-ground vegetation litter and roots undecomposed, with known structure, such as recognizable lignin, plant particles, cell structures, and other plant debris, plant root hair, fine roots, animal excreta, etc. The stability of particulate organic carbon mainly depends on the biochemical indecomposability and aggregate protection, which is of great significance in maintaining soil carbon pool content, stability and improving soil physical and chemical indexes.

MAOC with a particle size of less than 53 μm is mainly derived from small molecular organic carbon after depolymerization of plant and microbial residues. Compared with granular organic carbon, mineral-bound organic carbon has higher density, lower temperature sensitivity, longer turnover time, lower C:N and slower turnover rate. It is the organic carbon adsorbed by fine particles (clay particles) in soil through hydrogen bonding, ligand exchange and hydrophobic bonding. Some researchers believe that MAOC is mainly derived from grassland microbial organic carbon. The small molecular compounds produced by biodegradation can be combined with soil minerals to form mineral-bound organic carbon, and the life of microbial compounds

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(polysaccharides, proteins, etc.) in soil is longer than that of structural compounds (cellulose compounds, lignin compounds, etc.) in plants, and microorganisms are the main producers of long-term stable organic compounds (relative to plants). The stability of mineral binding organic carbon mainly depends on mineral protection and aggregate protection

4. STABILITY MECHANISM OF SOIL ORGANIC CARBON

Soil organic carbon stability refers to the ability of the soil to avoid carbon loss, and soils with high stability are less likely to release carbon through mineralization (gaseous form of CO2 and CH4) and leaching (liquid form of dissolved organic carbon). At present, the main soil stability mechanisms are physical stability, chemical stability and biochemical stability. Its stability is mainly affected by the non-degradability of organic matter itself, soil physicochemical properties, external environmental conditions and soil microbial community.

5. CONCLUSION AND SUGGESTION

At present, researches on the stability of soil organic carbon mainly focus on grassland and forest land, and few studies on agroecosystems that are greatly affected by human activities. Due to the scarcity of existing researches, although soil stability research in agroecosystems is a difficult and challenging work, However, this work is of great significance to the sequestration and carbon neutrality of soil organic carbon in agroecosystems, and future studies on the stability of soil organic carbon can be carried out in agroecosystems.

ACKNOWLEDGMENTS

This work was jointly supported by the Scientific Research Item of Shaanxi Provincial Land Engineering Construction Group (2020-NBYY-39) and Shaanxi Provincial Land Engineering Construction Group fund (DJNY-2022-21).

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