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Increasing Soil Organic Carbon (SOC) Content through Tillage Systems Management to Improve Soil Structure

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Editorial

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Editorial

Organic carbon loss from agricultural soils is one of the biggest environmental problems and challenges on a global scale which is considered in the United Nations Environment Program. Managing soil organic carbon (SOC) through optimized agricultural practices is a strategy to improve soil ecosystem services and it has an essential role in enhancing soil functions. Increasing the SOC storage level not only affects the atmospheric carbon content but it also ameliorates the soil physical, chemical, and biological functions and properties. However, low amounts of SOC causes soil structural degradation and decreases the water infiltration rate and aggregate stability, especially in arid and semi-arid regions of the world, which also increases soil erosion and soil loss Blanco-Canqui H, et al. [1].

Keywords: Soil Organic Matter; Soil Structural Stability; Conservation Tillage Systems; Arid/Semi-Arid Regions.

Abbreviations

SOC: Soil Organic Carbon.

Tillage practices lead to strong changes in soil structure, especially the practice of primary tillage (e.g., moldboard or chisel ploughing), but the extent of changes varies depending on soil type, tillage system, and soil water content Veiga MD, et al. [2]. The effects of tillage systems on soil organic carbon stocks may be related to the movement of organic carbon to deeper layers due to tillage practices, which can promote stabilization process Wertebach TM, et al. [3]. Also, excessive tillage systems may increase organic carbon decomposition and creates soil degradation, which is leading to reduced soil quality Chenu C, et al. [4] Marinari S, et al. [5]. However, conservation tillage systems increase organic carbon content Bhattacharyya R, et al. [6], improve soil aggregation Martinez E, et al. [7] Pagliai M, et al. [8] and can increase total porosity Bhattacharyya R, et al. [9] and water retention McGarry D, et al. [10]. Conservation tillage includes reduced tillage, no-till, mulch tillage, strip tillage, ridge tillage, and line tillage Holland JM [11]. Conservation tillage can also reduce crop yields in the first years after adoption, but it protects the soil from degradation and improves soil quality in the long-term Lampurlanes J, et al. [12]. Around the world, the economic and environmental benefits of reduced tillage and no-till are driving the rapid adoption of conservation tillage Fowler R, et al. [13] Liu K, et al. [14].

Highlights of Some Studies

No-tillage systems have a tendency to conserve soil organic carbon storage and increase carbon sequestration from the atmosphere into carbon stocks. Organic carbon encourages soil microbial activity and produces polysaccharides and carbohydrates, which stabilize soil aggregates, create macropores and improve soil structure Caravaca F, et al. [15].

The application of a no-tillage system increased soil aggregate stability under wheat-corn and wheat-legume rotations in a semi-arid Mediterranean region of Turkey Celik I, et al. [16].

Reduced tillage also increased the accumulation of SOC, and could create greater values of aggregate stability indices (MWD and WSA) in temperate region of Denmark Abdollahi L, et al. [17].

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More aggregate stability in no-till as compared with conventional systems may be attributed to the higher organic matter content in no-till and the development of inter- and intra-aggregate cohesion forces due to the absence of tillage, which is known to stabilize aggregates Mamedov AI, et al. [18].

The advantages of conservation tillage compared to conventional system were better SOC storage and more stable soil structure. Most of the changes in soil physical and structural properties were related to SOC variations in the treatments and no-till system had a profound effect on soil properties such as SOC quantity, aggregate stability, and the soil pore space in arid/semi-arid region of Iran Farahani E, et al. [19].

Under a no-till system, soil organic matter increased by 28% and 52% at two sites of a study in Morocco. Also, most of the physical properties of the soil were improved and structural stability showed a significant increase in both sites under no-till. It demonstrated that conservation agriculture, especially no-till, improves the soil physical quality in both medium and long terms, confirming its suitability for the climatic conditions of semi-arid areas in Morocco El Mekkaoui A, et al. [20].

Contrarily, in a study in Denmark after 20 years of conservation agriculture experiment, tillage systems did not affect soil organic carbon content. However, no-till system improved soil structural and aggregate stability and plant available water capacity in surface soil (0–10 cm depth) because of positive effects ascribed to absence of soil disturbance Rocco S, et al. [21].

Conclusion

It can be concluded that the effects of tillage systems on soil structure is not only depend on organic carbon content but also may influence by intensity of soil disturbance. Mostly, application of no tillage systems in agricultural fields could increase soil organic carbon content due to reduction of organic decomposition by soil microbial community. Therefore, soil structural stability increased and aggregate formation encouraged by more organic carbon content. On the other hand, sometimes conservation tillage systems, especially no tillage, affect soil stability due to lack of soil disturbance. The latter could be considered as a physical phenomenon, neither chemical nor microbial effects of tillage systems on soil properties and functions. As a result, the soil structural responses to tillage systems must be analyzed in terms of origin, which may be physical, chemical or both. It could also be suggested to evaluate the climatic and regional effects on the impact of tillage systems and management on soil structure in the future.

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