The role of soil organic matter in sustainable crop production in the Tropics

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Increasing crop yield is an important issue in the twenty first century to meet food demand of increasing world population and concern on environmental pollution. Crop yield can be increased by increasing cultivated land area, crop productivity per unit area and cropping intensity. Tropics offer all the three possibilities to increase world demand of food and fiber. However, most of the tropical soils are infertile and acidic in reaction. The relatively infertile Oxisols and Ultisos occupy about 43% of the tropics but only 7% of the temperate zone, while fertile Mollisols account for 2% of the tropics and 11% of temperate regions. Within the tropics, soils with chemical deficiencies or toxicities total about 47% of South America, 59% of Southeast Asia and 18% of Africa. Hence, use of adequate rate of chemical fertilizers and liming and maintaining adequate level of soil organic matter in the tropical soils is a prerequisite to improve crop productivity and maintaining sustainability of the cropping systems.

Soil organic matter (SOM) has long been recognized as important indicator of soil productivity. The SOM refers to the organic fraction of the soil exclusive of undecayed plant and animal residues. In addition, soil organic matter is a heterogeneous and dynamic soil component that varies in molecular structure, decomposition rate, and turnover time and exerts a major influence on soil quality and the global C cycle. Its role in improving crop productivity and sustainability of agricultural systems is enormously high. It plays a crucial role in maintaining sustainability of cropping systems by improving soil physical (texture, structure, bulk density and water holding capacity), chemical (nutrient availability, cation exchange capacity, reducing Al toxicity and allelopathy), and biological (nitrogen mineralization bacteria, dinitrogen fixation, mycorrhizae fungi and microbial biomass) properties.

Heavy metals are important environmental pollutants threatening the health of man, animal and agroecosystems. The fate of heavy metals in the soil-plant systems is largely controlled by sorption reactions with soil colloids. The SOM owing primarily to higher CEC and to form inner-sphere complexes through surface reactions groups, important sorbent of heavy metals. Thus, decreasing their toxicity to crop plants in heavy metal contaminated soils as well as inhibit their leaching to ground water. The SOM also adsorbs herbicides and prevent their leaching to ground water. In addition, SOM stores large amount of C in the soil (comprising >60% of the terrestrial C pool) and avoids CO_2 escape to atmosphere. Hence, organic matter plays an important role in reducing global warming, or greenhouse effect and environmental pollution. Substantial amount of N requirements of the plants is satisfied from the mineralization of soil organic matter. The pool sizes of soil organic matter are soil specific, while their mineralization rate constants vary with environmental conditions.

Soil organic matter formation and accumulation is dependent on management practices and the amount and placement of organic materials. The preservation of SOM is crucial to ensure long term sustainability of agricultural ecosystems. Improvement/preservation of soil organic matter can be achieved by adopting appropriate soil and crop management practices. These practices include conservation tillage, crop rotation, use of organic manures, increasing cropping intensity, use of adequate rate of chemical fertilizers, incorporation of crop residues, liming acid soils and keeping land under pasture.

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