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Carbon and Nitrogen Stocks of the Soils of different climatic regions of Golestan Province, Iran

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Abstract

Some biological soil quality indicators i.e. soil respiration, microbial biomass, biomass nitrogen, C:N, net mineralization, population of the microorganisms together with total carbon, organic carbon, inorganic carbon and total nitrogen were studied to investigate their variation in different climatic regions of Golestan province, northeast Iran. Fourteen soil profiles were dug and described on three climatic regions namely: Aridic-thermic, xeric-thermic and udic-mesic soil moisture and temperature regimes. All the studied soils formed on loess or loess-derived parent material. Natural vegetation varies from sparse rangelands in the northern arid parts to dense deciduous forest in the southern humid regions of north-facing slopes of the Alborz mountain ranges. The studied soils were classified as Aridisols and Entisols in the aridic moisture regimes, Inceptisols and Mollisols in the xeric moisture regimes and Alfisols in the udic moisture regime regions. The results revealed that organic carbon and total nitrogen increased while inorganic carbon decreased with increasing precipitation. Soil inorganic carbon and consequently pH decreased with increasing precipitation. Biological soil quality attributes such as soil respiration, biomass carbon and nitrogen increased sharply from aridic to xeric regions but decreased gradually in the udic regions. This trend was in accordance with the population of bacteria and actinomycetes. The xeric-thermic moisture and temperature regimes has provided favourable soil environment with regard to the available moisture and temperature both for the population of microorganisms and also the vegetative cover which both are responsible for the biomass production.

Introduction

Soil organic carbon (SOC) is a key component of any terrestrial ecosystem, and any variation in its quantity and composition has important effects on many of the processes that occur within the system. The size and dynamics of the carbon pool in the soils of the world are still poorly known (Batjes, 1996). Climate is one of the main factors controlling the SOC contents. Nichols (1984) showed that there was a significant relationship between SOC and clay content and precipitation. Bhattacharyya et al., (2006) estimated the carbon stocks in the red and black soils of some selected benchmark spots in semi-arid tropics of India and concluded that the level of management adopted in the black soils for the last 20-25 years helped these soils reach a new higher quasi-equilibrium value in terms of SOC. The soil carbon pool is composed of organic and inorganic parts. The SIC pool consists of mainly primary inorganic carbonates or lithogenic inorganic carbonates and secondary or pedogenic carbonates. Secondary carbonates are formed through dissolution of primary carbonates and re-precipitation of weathering products. The reaction of atmospheric carbon dioxide (CO_2) with water and calcium and magnesium in the upper horizons of the soil leaching into the subsoil and subsequent re-precipitation results in formation of secondary carbonates and in the sequestration of atmospheric CO_2 (Sahrawat, 2003). It has been postulated that aridity in the climate is responsible for the formation of pedogenic calcium bicarbonate and this is a reverse process to the enhancement of SOC.

Materials and methods

A south-north transect forming a climo-toposequence with fourteen soil profile observations starting from 150mm precipitation in the northeast to over 900mm in the heights of Alborz Mountain Ranges in southwest were selected to study the soil carbon and nitrogen pools in different climatic regions. The soil moisture and regime vary from aridic to xeric and finally to udic from north to south. The soil temperature regime also varies from thermic in the northern parts to mesic in southern parts where the elevation reaches to 2500 m. The parent material of all the soils is loess deposits. Soils were classified according to Soil Taxonomy (Soil Survey Staff, 2006). Some physico-chemical analysis such as soil texture, bulk density, pH, EC, SP, $CaCO_3$, CEC, available P and K was carried out with standard techniques. Organic, inorganic and total carbon was measured by TOC analyzer. Total N was analyzed using TNS equipment of the soil chemistry lab. Inorganic N, soil respiration, microbial biomass C and N, net N mineralization, and population of bacteria, actinomycetes and fungi were determined in the ICRISAT, India.

Results and discussion

The studied soils were classified as Aridisols and Entisols in the aridic moisture regimes, Inceptisols and Mollisols in the xeric moisture regimes and Alfisols in the udic moisture regime regions. The results revealed that organic carbon and total nitrogen increased while inorganic carbon decreased with increasing precipitation. Total carbon did not show any significant variation with climate (Fig. 1). Biological soil quality attributes such as soil respiration, biomass carbon and nitrogen increased sharply from aridic to xeric regions but decreased gradually in the udic regions. This trend was in accordance with the population of bacteria and actinomycetes. The xeric-thermic moisture and temperature regimes has provided favourable soil environment with regard to the available moisture and temperature both for the population of microorganisms and also the vegetative cover which both are responsible for the biomass production.

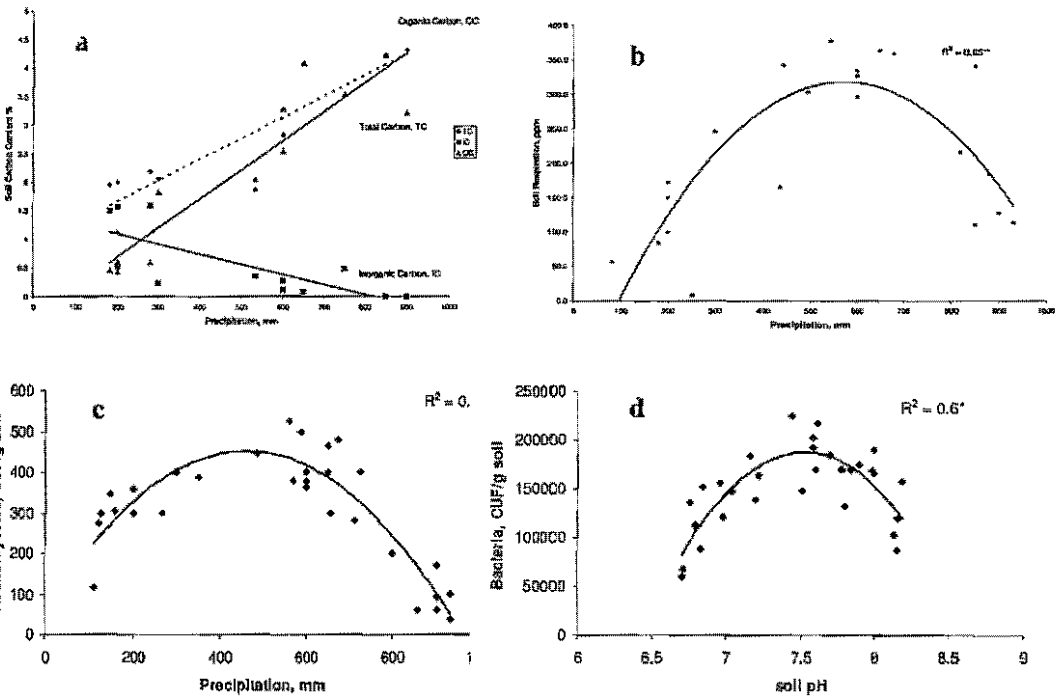

Fig. 1. Variation of soil carbon (a), soil microbial respiration (b) population of actinomycetes (c) with precipitation and bacterial population with soil pH (d) in the topsoil. The variation of TC was shown as average for the top 1m soil.

The organic carbon content of the soils varied from 0.5% in the arid regions to at least 5% in the top layer of the soils of humid regions.

Conclusions

The xeric-thermic moisture and temperature regimes has provided favourable soil environment with regard to the available moisture and temperature both for the population of microorganisms and also the vegetative cover which both are responsible for the biomass production

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