Organic matter decomposition is more sensitive to temperature than the mineral associated organic matter

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ABSTRACT

Temperature sensitivity of soil organic matter decomposition is important in determining the role of soils in future climate change. We isolated coarse and fine particulate organic matter (*c*POM and *f*POM) and mineral associated organic matter (MinOM) to represent labile, relatively less labile and stable pools of soil organic matter (SOM), respectively and incubated each at four different temperatures to determine temperature sensitivity of decomposition. The coarse particulate organic C, which comprised the smallest pool of soil organic C (SOC) was most decomposable and the mineral associated organic C that accounted for more than half of the SOC was least decomposable. At all the temperatures, the C mineralization rate followed the order *c*POM ≥ *f*POM > whole soil > MinOM. The disparity in the mineralization rates between *c*POM and the other two SOM fractions and the whole soil widened with increase in temperature from 15° to 45 °C indicating that the labile pools of SOM were more sensitive to temperature than the stable pool. The Arrhenius, the Llyod and Taylor and the Gaussian models well-described the temperature dependence of organic matter decomposition, but the shape of the temperature response curve for different models varied considerably. Gaussian model yielded the highest decomposition Q_{10} and the Arrhenius model the lowest Q_{10} for different SOM fractions and whole soil. The decomposition temperature response of isolated SOM fractions mainly differed at temperatures below 25 °C beyond which the response tended to converge suggesting that the differential response of labile and stable pools to temperature will be foremost at temperatures below 25 °C beyond which the effect will be small and similar for SOM pools of different lability. The decomposition of cPOM fraction is likely to be influenced to the greatest extent and the MinOM at the least as a result of global warming. The transformation and movement of materials within soil organic matter pools is a dynamic process influenced by climate, soil type, vegetation and soil organisms. All these factors operate within a hierarchical spatial scale. Soil organisms are responsible for the decay and cycling of both macronutrients and micronutrients, and their activity affects the structure, tilth and productivity of the soil. In natural humid and subhumid forest ecosystems without human disturbance, the living and non-living components are in dynamic equilibrium with each other. The litter on the soil surface beneath different canopy layers and high biomass production generally result in high biological activity in the soil and on the soil surface. This equilibrium creates almost closed-cycle transfers of nutrients between soil and the vegetation adapted to such site conditions, resulting in almost perfect physical and hydric conditions for plant growth, i.e. a cool microclimate, increased evapotranspiration, good rooting conditions with good porosity and sufficient soil moisture. This facilitates water infiltration and prevents erosion and runoff. Thus, it results in clean water in the streams emanating from the area, a relatively smooth variation in streamflow during the year, and recharge of groundwater.

Keywords: Mineralization; Temperature sensitivity; Particulate organic matter; Mineral associated organic matter; Temperature response models; Global warming