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Effects of Global Warming on Decomposition of Soil Organic Matter: A Simulation Study

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Higher temperatures could increase the rate of microbial decomposition of organic matter, adversely affecting soil fertility and increasing erosion in the long run. However, information about the intensity of these effects on organic systems, especially in semi-arid climate of Iran is scarce. In this study the effect of increased temperature on decomposition of organic matter is predicted using a simple simulation model.

A first order (mono-component model) equation (Equation 1) was applied to the entire quantity of organic matter (Ajwa and Tabatabai, 1994): $dY/dt = -K * Y$

after integration: $Y_t = Y_0 * \exp(-K * t)$ (1)

where t is time, K (> 0) is the relative decomposition rate (t^{-1}) and Y_0 and Y_t are the quantity of organic matter at t=0 and t, respectively.

The effect of temperature rise was described by the use of Q_{10}, being the ratio of relative decomposition rates at two temperatures differing by 10 °C (Kirschbaum, 1995). Equation 2 was developed by using this concept: $K_2 = K_1 * Q_{10}^{10/(T2-T1)}$ (2)

where T_1 and T_2 are temperatures, and K_1 and K_2 are the relative decomposition rates at T_1 and T_2, respectively. If Q_{10} is 1, there is no effect of a raised temperature. Above and below 1, positive and negative effects of temperature on K are expected, respectively. The values of Q_{10} for commonly used organic material could vary from 1.5 to 8 within the temperature range of 0 to 35 °C (Kirschbaum, 1995).

Using this simple approach decomposition of barley straw was simulated under different temperatures assuming a K-value of 0.05 (y^{-1}) and Q_{10} = 1.5 at t = 0 °C (Kirschbaum, 1995).

Simulation results show a drastic increase in decomposition rate of organic material with raising temperature (Fig.1) with halving time (ln2/K) of 6.16, 2.74, 2.09 and 1.39 years at 5, 10, 25 and 35 °C, respectively. In this study soil moisture was assumed as 50% field capacity. However, higher decomposition rate in regions with increased rainfall could lead to increased leaching of minerals, especially nitrates. Further studies on the combination effects of soil moisture content, temperature and C:N ratio of organic matter on their decomposition rate based on climate change scenarios are required.

Key words: Organic matter, decomposition rate, global warming.

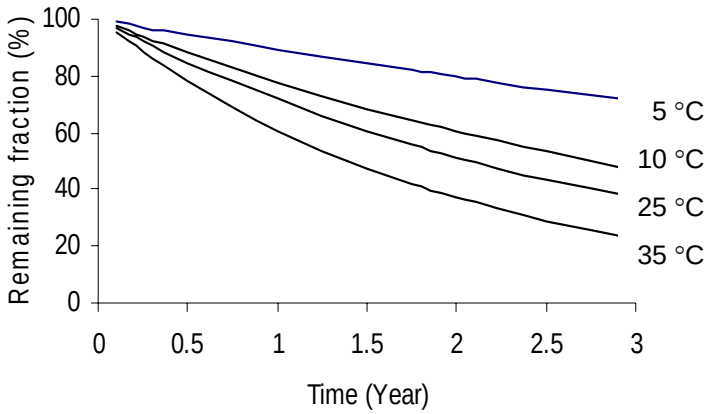

Fig1. Decrease of remaining quantity of barley straw over time at different temperatures.

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