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Temperature sensitivity of soil organic matter mineralization depends on N fertilization: Comparison of four Q10 estimation approaches

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Global warming and increasing anthropogenic nitrogen (N) loads are two major worldwide issues that arose with industrialization, and both factors permanently impact carbon (C) cycling. For the first time, we compared four independent approaches to evaluate the temperature sensitivity (Q10) of soil organic matter (SOM) mineralization: Equal time, Equal C, 1-C pool model and 2-C pool model. With this goal, soil was sampled from a wheat-maize double cropping system, after 23-year of no N (control), low N (organic and mineral N), high organic N (manuring), or high mineral N fertilization. Four Q10 estimation approaches were compared based on the CO_2 released from long-term N fertilized soil at 10, 20 and 30 ºC during one-year incubation. All four approaches clearly showed large Q10 decrease for all SOM pools by N fertilization compared to unfertilized control (Q10 = 0.8-2.3 vs. 2.7-3.7) at low temperature. N fertilization decreased the activation energy (from 85 to 56 kJ mol-1) and led to lower Q10 according to Arrhenius formalism. The lower Q10 under long-term N fertilization resulted also in the decreased C:N ratio, accelerated C turnover and increased microbial C use efficiency. All Q10 estimation approaches captured the decomposition of different SOM pools (from labile to recalcitrant) at various time scales. The '1-C pool model' is not adequate for Q10 estimation because it ignores the response of various C pools to soil warming. The '2-C pool model' fit data very well but the fitted decomposition rates strongly depend on incubation duration. The 'Equal C' approach was more dynamic in separating various SOM to provide a mechanistic understanding of soil C sequestration and cycling under increasing temperature. However, 'Equal C' approach was largely C quality dependent and disregards the incubation duration. The advantages and shortcomings of the four Q10 estimation approaches were intensively discussed. Long-term incubation and continuous measurement of SOM mineralization is always needed to separate various C pools, especially very recalcitrant C. N fertilization lead to added benefit in protecting SOM under warming by decreasing Q10 of SOM. Such reduction of temperature sensitivity caused by N fertilization is large enough to be considered in predictions of the magnitude of global SOM stocks under warming and increasing anthropogenic N loads.