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Effect of temperature on the decomposition of labile and recalcitrant organic matter in Chernozem

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We tested the hypothesis that the recalcitrant pool of soil organic matter (SOM) is more temperature sensitive to decomposition than the labile one. The hypothesis was verified for Chernozem soil sampled from the control (unfertilized) and fertilized with NPK experimental plots of the 50 year field experiment with maize monoculture in Voronezh Region, Russia (51o41'N, 39o15'E). The labile and recalcitrant SOM pools at 2, 12, and 22°C in a long-term (430 d) incubation experiment were traced using the method of 13C natural abundance by C3–C4 transition. Based on decomposition rate constants, the SOM pools followed the order plant residues < new (C4) SOM < old (C3) SOM, with plant residues as the most labile C pool. The hypothesis was valid only for the temperature interval of 12–22°C, where Q10 values increased in the recalcitrance order from 1.2 (plant residues) to 4.3 (C3 SOM). At low temperatures (2–12°C), the values of Q10 varied in the narrow range of 2.2–2.8 irrespective of a SOM pool. In the soil under maize monoculture fertilized with NPK, the increased decomposition of C3 SOM was observed compared to the unfertilized control. The input of new C4 carbon decreased the rate of CO_2 emission during the decomposition of the old C3 SOM, i.e. induced negative priming effect (PE). To the contrast, the fertilization increased the positive PE for the C3 SOM. Along with the SOM decomposition rate constants, the magnitude of PE was also temperature dependent. The maximal negative PE in control treatment was found at the lowest temperature of 2oC, while the highest positive PE in NPK fertilized soil was observed at the highest temperature of 22oC.