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Degradation increase responses of priming effects to temperature in Tibetan alpine grasslands

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Kobresia grassland in Tibet plateau, with a rich storage of soil organic carbon (SOC), is very important to both ecosystem function and the livelihoods of local pastoral communities. But its intensive degradation in recent decades has led to unclear consequences for SOC stocks and dynamics. Kobresia grassland acts as a critical "first response region" to climate change, where the SOC decomposition is highly sensitive to temperature, and can produce positive C climate feedback. Priming effects, induced by inputs of labile organic carbon (LOC), can also affect SOC dynamic. Therefore, knowledge about how the priming effects response to temperature, and how their interactions affect SOC decomposition are central to understanding the carbon cycle of Tibet plateau under global warming.

To this ends, we conducted a laboratory incubation experiment with the non-degraded soil collected from intact Kobresia patches, and degraded soil collected from crust patches, labeled with 14C-glucose in high/low level and incubated under 0 °C, 10 °C and 20 °C for 80 days. Cumulated CO_2 emission increased significantly with temperature. Degraded soil showed lower CO_2 emission at 0 °C, but significant higher CO_2 emission at higher temperature compared to that of non-degraded soil. Priming positively responded to increasing temperature, with 78.9% increment in degraded soil and 12.9% in non-degraded soil on average, and at 20 °C, it was significant higher in degraded soil than non-degraded soil. Low-level glucose input led to the positive priming effects, while high-level glucose induced the negative priming. Higher temperature led to higher microbial activity (i.e. qCO_2) and enzyme activity (i.e. β-glucosidases, chitinase, cellobiohydrolase and Xylosidase). Vmax of enzyme was significantly higher in degraded soil than in non-degraded soil, exhibiting a positive linear regression with priming effects. In conclusion, increase in temperature improved priming effects via higher microbe and enzyme activity it caused, and in turn strongly accelerated SOC decomposition in Kobresia grassland, which is particularly significant in degraded pasture. Therefore future global warming and grassland degradation in Tibetan Plateau may lead to positive C climate feedback to atmospheric CO_2.

Key words: Kobresia grassland, grassland degradation, priming effect, temperature sensitivity, enzyme kinetics