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Phosphorus regulates ecosystem carbon dynamics after permafrost thaw

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The ecosystem carbon (C) dynamics after permafrost thaw depends on more than just climate change since soil nutrient status may also impact ecosystem C balance. It has been advocated that the potential nitrogen (N) release upon permafrost thaw could promote plant growth and thus offset soil C loss. However, compared with the widely accepted C-N interactions, little is known about the potential role of soil phosphorus (P) availability. Here we combined two-year field observations along a permafrost thaw sequence (constituted by four thaw stages, *i.e.*, non-collapse and 5, 14, and 22 years since collapse) with an in-situ fertilization experiment (included N and P additions at the level of 10 g N m^{-2} yr^{-1} and 10 g P m^{-2} yr^{-1}, respectively) in a Tibetan swamp meadow to evaluate ecosystem C-nutrient interactions upon permafrost thaw. Our results showed that changes in soil P availability rather than N availability played an important role in regulating the increases in gross primary productivity and the decreases in net ecosystem exchange along the thaw sequence. The fertilization experiment further confirmed that P addition had stronger effects on plant growth than N addition in this permafrost ecosystem. These two lines of evidence highlight the crucial role of soil P availability in altering the trajectory of permafrost C cycle under climate warming.