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Effects of dynamic factors of erosion on soil nitrogen and phosphorus loss under freeze-thaw conditions

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Soil erosion is one of the primary environmental problems in China, and it can lead to serious water, soil, and nutrient losses. However, the mechanism of action of the dynamic factors of erosion on nitrogen (N) and phosphorus (P) loss remains unclear. In this study, a series of laboratory experiments were carried out to characterize the N and P loss and its influencing factors under freeze–thaw conditions. Two slope treatments (i.e. LS: loess and FTS: freeze–thaw soil) and five soil water content (SWC) (i.e. 10%, 15%, 20%, 25% and 30%) were considered. The results showed that the total runoff was higher under 30% SWC and lower under 20% SWC for the LS and FTS treatments. The freeze–thaw action caused higher sediment loss under low water content (10% and 15%). The runoff-associated total nitrogen (RTN), runoff-associated total phosphorus (RTP), and sediment-associated total phosphorus (STP) loss rate showed a larger fluctuation for FTS than for LS. The freeze–thaw action not only caused the instability of the nitrogen and phosphorus loss behavior but also caused increased diversity among individual samples. The soil erodibility, runoff energy, and runoff power were important dynamic factors associated with erosion, and the freeze–thaw action has a very large impact on these factors. For the LS treatments, the SWC could explain 60% of the variation in RTN loss and 63% of the variation in RTP; the runoff and infiltration both explained 90% of the variation in STN loss and the runoff time explained 97% of the variation in STP. For the FTS treatments, the runoff time explained 63% of the variation in STN and 53% of the variation in STP. The results enable us to understand further the relationship between dynamic factors of rainfall erosion and nitrogen and phosphorus loss under freeze–thaw conditions.