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## 冻融对土壤氮素转化和 $N_2O$ 排放的影响研究进展

### Effects of freeze-thaw on soil nitrogen transformation and $N_2O$ emission: A review

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中文摘要:

在中、高纬度及高海拔地区,土壤冻融现象常有发生。冻融作用通过影响土壤理化性质和生物学性状进而影响土壤氮素转化过程及 $N_2O$ 的产生和释放,但迄今关于冻融对土壤氮素转化过程影响的研究结果还不尽一致,正效应或负效应均存在,土壤冻融期间 $N_2O$ 排放对全年 $N_2O$ 排放总量的贡献程度也存在着较大差异。本文重点论述了土壤冻结或冻融循环过程对土壤氮矿化、固持、硝化和反硝化等主要氮素转化过程的影响机制,同时分析了可引起冻融期间 $N_2O$ 排放强度变化的四种可能机理(禁锢-释放、环境-底物诱导、 $N_2O$ 还原酶抑制和化学反硝化增强)。指出在全球变暖背景下研究土壤冻融格局改变影响土壤氮素转化过程及 $N_2O$ 排放的必要性,并简要提出了若干理论问题及研究方向。

Abstract:

As a natural phenomenon, soil freeze-thaw processes often occur in the regions of mid- and high latitudes and high altitude. Freeze-thaw can alter the soil physicochemical and biological properties, which thereby results in changes in soil nitrogen transformation and  $N_2O$  production and hence emission. Up to now, the impacts of freeze-thaw processes on soil nitrogen transformation found in previous studies remain inconsistent and large discrepancies have been found in the data on the contributions of  $N_2O$  losses during freeze-thaw period to annual emissions. In addition, this review also addresses the effects of freezing or a freeze-thaw cycle on major soil nitrogen transformation processes, including mineralization, immobilization, nitrification and denitrification, and possible explanations are discussed. Meanwhile, four potential mechanisms relating to  $N_2O$  emission intensity during the freeze-thaw period, such as  $N_2O$  trapped in and below the frozen layer and released from thawed soil,  $N_2O$  induced by circumstance and substrates,  $N_2O$  inhibited by  $N_2O$  reductase and  $N_2O$  enhanced by chemodenitrification, are systematically analyzed. The implications of global warming for soil freeze-thaw patterns are addressed, as well as the need to investigate alteration of soil nitrogen transformation and  $N_2O$  emission as affected by these circumstances. At last, some theoretical problems and perspectives of the study are brought forward.

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