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研究论文

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凤眼莲对富营养化水体硝化、反硝化脱氮释放N_2O的影响

Effect of water hyacinth on N_2O emission through nitrification and denitrification reactions in eutrophic water

关键词：富营养化水体 凤眼莲 植物修复 硝化,反硝化脱氮 N_2O释放

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摘要：以往有关大型水生漂浮植物消减富营养化水体氮(N)的研究主要侧重于植物对N的吸收效果,而忽略了硝化、反硝化反应途径对水体脱氮的贡献.基于此,本研究中借助具创新性的收集凤眼莲种植水体释放N_2O的装置和方法,通过模拟实验研究了凤眼莲对富营养化水体硝化、反硝化脱氮中间产物N_2O的影响.结果表明,凤眼莲可以促进富营养化水体的硝化、反硝化、成对硝化-反硝化反应过程,在本实验条件下凤眼莲种植水体在整个培养期内释放的N_2O气体浓度累积升高幅度较大,为453~4055 nL·L^{-1}(未加硝化抑制剂处理),通过释放N_2O而脱除氮素的量占整个水体N消减量的1.36%,为相应未种植凤眼莲水体的4.31倍.种植凤眼莲水体试验期间释放N_2O-N的量与水体氨态氮或硝态氮浓度的变化量均存在显著相关关系(p<0.05),说明N_2O释放量受到水体中NH_4^+、NO_3^-浓度变化的影响.种植凤眼莲在实验中后期可以增加水体中硝化、反硝化细菌的数量,但其数量远低于凤眼莲根系附着的硝化反硝化细菌.水体中反硝化细菌数量与水体释放N_2O浓度之间并无显著相关性,说明种植凤眼莲水体反硝化脱氮释放N_2O过程可能主要是由根系共生微生物驱动的.

Abstract: Direct uptake of nitrogen (N) by floating macrophytes was widely studied with the aim of removing nitrogen from eutrophic water, while the contribution of nitrification and denitrification process was ignored in the past studies. In this study, an innovative method of collecting N_2O released from water cultivated with the floating macrophyte, water hyacinth (*Eichhonia crassipes*), was developed to study the effect of *Eichhonia crassipes* on N_2O emission through the nitrification and denitrification reactions in eutrophic water. It was found that cultivation of *Eichhonia crassipes* stimulated the nitrification, denitrification and coupled nitrification-denitrification reactions. Under the conditions of this experiment, concentrations of N_2O released from water with cultivation of *Eichhonia crassipes* ranged 453~4055 nL·L^{-1}, and the N_2O-N loss accounted for 1.36% of the total N removal (in treatment without addition of nitrification inhibitor). This proportion was 4.31 times higher than that in water without cultivation of *Eichhonia crassipes*. During the experiment, the amount of N_2O-N loss was significantly (p<0.05) correlated with the changes of NH_4^+ or NO_3^- concentration in water with cultivation of *Eichhonia crassipes*, indicating that N_2O emission was influenced by the change of NH_4^+ or NO_3^- concentration. The quantity of nitrifying and denitrifying bacteria in water was increased by cultivation of *Eichhonia crassipes*, but was still much lower than that attached to *Eichhonia crassipes* roots. However, there was no significant correlation between quantity of nitrifying or denitrifying bacteria in water and concentration of N_2O released from water. This may indicate that bacteria attached to *Eichhonia crassipes* roots were the major contributor to stimulate N_2O emission through nitrification and denitrification reactions in water.

Key words: eutrophic water water hyacinth phytoremediation nitrification and denitrification N_2O emission

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