World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:10, No:10, 2016

Microbial Activity and Greenhouse Gas (GHG) Emissions in Recovery Process in a Grassland of China

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Abstract : The nitrogen (N) is an important limiting factor of various ecosystems, and the N deposition rate is increasing unprecedentedly due to anthropogenic activities. The N deposition altered the microbial growth and activity, and microbial mediated N cycling through changing soil pH, the availability of N and carbon (C). The CO2, CH4 and N2O are important greenhouse gas which threaten the sustainability and function of the ecosystem. With the prolonged and increasing N enrichment, the soil acidification and C limitation will be aggravated, and the microbial biomass will be further declined. The soil acidification and lack of C induced by N addition are argued as two important factors regulating the microbial activity and growth, and the studies combined soil acidification with lack of C on microbial community are scarce. In order to restore the ecosystem affected by chronic N loading, we determined the responses of microbial activity and GHG emssions to lime and glucose (control, 1‰ lime, 2‰ lime, glucose, 1‰ lime×glucose and 2‰ lime×glucose) addition which was used to alleviate the soil acidification and supply C resource into soils with N addition rates 0-50 g N m–2yr–1. The results showed no significant responses of soil respiration and microbial biomass (MBC and MBN) to lime addition, however, the glucose substantially improved the soil respiration and microbial biomass (MBC and MBN); the cumulative CO2 emission and microbial biomass of lime×glucose treatments were not significantly higher than those of only glucose treatment. The glucose and lime×glucose treatments reduced the net mineralization and nitrification rate, due to inspired microbial growth via C supply incorporating more inorganic N to the biomass, and mineralization of organic N was relatively reduced. The glucose addition also increased the CH4 and N2O emissions, CH4 emissions was regulated mainly by C resource as a substrate for methanogen. However, the N2O emissions were regulated by both C resources and soil pH, the C was important energy and the increased soil pH could benefit the nitrifiers and denitrifiers which were primary producers of N2O. The soil respiration and N2O emissions increased with increasing N addition rates in all glucose treatments, as the external C resource improved microbial N utilization. Compared with alleviated soil acidification, the improved availability of C substantially increased microbial activity, therefore, the C should be the main limiting factor in long-term N loading soils. The most important, when we use the organic C fertilization to improve the production of the ecosystems, the GHG emissions and consequent warming potentials should be carefully considered.

Keywords : acidification and C limitation, greenhouse gas emission, microbial activity, N deposition
Conference Title : ICEEE 2016 : International Conference on Environmental and Ecological Engineering
Conference Location : London, United Kingdom
Conference Dates : October 17-18, 2016