Coupling of microbial nitrogen transformations and climate in sclerophyll forest soils from the Mediterranean Region of central Chile

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Abstract

The Mediterranean region of central Chile is experiencing extensive "mega-droughts" with detrimental effects for the environment and economy of the region. In the northern hemisphere, nitrogen (N) limitation of Mediterranean ecosystems has been explained by the decoupling between N inputs and plant uptake during the dormant season. In central Chile, soils have often been considered N-rich in comparison to other Mediterranean ecosystems of the world, yet the impacts of expected intensification of seasonal drought remain unknown. In this work, we seek to disentangle patterns of microbial N transformations and their seasonal coupling with climate in the Chilean sclerophyll forest-type. We aim to assess how water limitation affects microbial N transformations, thus addressing the impact of ongoing regional climate trends on soil N status. We studied four stands of the sclerophyll forest-type in Chile. Field measurements in surface soils showed a 67% decline of free-living diazotrophic activity (DA) and 59% decrease of net N mineralization rates during the summer rainless and dormant season, accompanied by a stimulation of in-situ denitrification rates to values 70% higher than in wetter winter. Higher rates of both free-living DA and net N mineralization found during spring, provided evidence for strong coupling of these two processes during the growing season. Overall, the experimental addition of water in the field to litter samples almost doubled DA but had no effect on denitrification rates. We conclude that coupling of microbial mediated soil N transformations during the wetter growing season explains the N enrichment of sclerophyll forest soils. Expected increases in the length and intensity of the dry period, according to climate change models, reflected in the current mega-droughts may drastically reduce biological N fixation and net N mineralization, increasing at the same time denitrification rates, thereby potentially reducing long-term soil N capital.

KEYWORDS:

Denitrification; Diazotrophic activity; Net N mineralization; Summer drought; Water limitation