Atmospheric CO_2 enrichment reduces wheat nitrate utilization and enhances soil N_2O emissions

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Abstract

Atmospheric carbon dioxide enrichment (eCO_2) often increases soil nitrous oxide (N_2O) emissions, but the underlying mechanisms are not fully understood. Emerging evidence suggests that eCO_2 alters plant N preference in favor of ammonium (NH_4^+-N) over nitrate (NO_3^--N). Yet, whether and how this attributes to the enhancement of N_2O emissions has not been investigated. We examined the effects of eCO_2 on soil N_2O emissions in the presence of two N forms (NH_4^+-N or NO_3^--N), using wheat (*Triticum aestivum* L.) as a model plant. Our results showed that N forms dominated eCO_2 effects on plant and microbial N utilization, and thus soil N_2O emissions. Elevated CO_2 significantly increased the rate and the sum of N_2O emissions by three to four folds when NO_3^--N, but not NH_4^+-N, was supplied. Enhanced N_2O emission was related to the reduced plant NO_3^--N uptake in wheat. We propose a new conceptual model in which eCO_2-inhibition of plant NO_3^--N uptake and/or CO_2-enhancement of soil labile C enhances the N and/or C availability for denitrifiers and increases the intensity and/or the duration of N_2O emissions. Together, these findings suggest that to enhance plant N use efficiency and reduce N_2O emission, crop breeding and management need to consider altered plant preference of N sources under future CO_2 scenarios.

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