Atmospheric CO\textsubscript{2} enrichment reduces wheat nitrate utilization and enhances soil N\textsubscript{2}O emissions

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Abstract

Atmospheric carbon dioxide enrichment (eCO\textsubscript{2}) often increases soil nitrous oxide (N\textsubscript{2}O) emissions, but the underlying mechanisms are not fully understood. Emerging evidence suggests that eCO\textsubscript{2} alters plant N preference in favor of ammonium (NH\textsubscript{4}\textsuperscript{+}-N) over nitrate (NO\textsubscript{3}\textsuperscript{-}-N). Yet, whether and how this attributes to the enhancement of N\textsubscript{2}O emissions has not been investigated. We examined the effects of eCO\textsubscript{2} on soil N\textsubscript{2}O emissions in the presence of two N forms (NH\textsubscript{4}\textsuperscript{+}-N or NO\textsubscript{3}\textsuperscript{-}-N), using wheat (Triticum aestivum L.) as a model plant. Our results showed that N forms dominated eCO\textsubscript{2} effects on plant and microbial N utilization, and thus soil N\textsubscript{2}O emissions. Elevated CO\textsubscript{2} significantly increased the rate and the sum of N\textsubscript{2}O emissions by three to four folds when NO\textsubscript{3}\textsuperscript{-}-N, but not NH\textsubscript{4}\textsuperscript{+}-N, was supplied. Enhanced N\textsubscript{2}O emission was related to the reduced plant NO\textsubscript{3}\textsuperscript{-}-N uptake in wheat. We propose a new conceptual model in which eCO\textsubscript{2}-inhibition of plant NO\textsubscript{3}\textsuperscript{-}-N uptake and/or CO\textsubscript{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\textsubscript{2}O emissions. Together, these findings suggest that to enhance plant N use efficiency and reduce N\textsubscript{2}O emission, crop breeding and management need to consider altered plant preference of N sources under future CO\textsubscript{2} scenarios.

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