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Effects of nitrogen fertilization on soil N2O emissions and soil respiration in temperate grassland in Inner Mongolia, China

Y. Dong, Y. Qi, and Q. Peng
Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences,Beijing 100101, China (dongys@igsnrr.ac.cn)

Nitrogen addition to soil can play a vital role in influencing nitrogen balance and the losses of soil carbon by respiration in N-deficient terrestrial ecosystems. The aim of this study was to clarify the effects of different levels of nitrogen fertilization (HN:200 kg N ha-1y-1, MN:100 kg N ha-1y-1 and LN:50 kg N ha-1y-1) on soil N2O emissions and soil respiration compared with non-fertilization(CK, 0 kg N ha-1y-1), from July 2007 to September 2008, in temperate grassland in Inner Mongolia, China.

Several N fertilizer forms were included(CAN:calcium ammonium nitrate, AS:ammonium sulphate and NS:sodium nitrate) and a static closed chamber method was used as gas fluxes measurement. Our data showed that peak N2O fluxes induced by N treatments were concentrated in short periods (2 to 3 weeks) after fertilization in summer and in soil thawing periods in early spring; there were similarly low N2O fluxes from all treatments in the remaining seasons of the year. The three N levels increased annual N2O emissions significantly(P<0.05) in the order of MN>HN>LN compared with the CK(control) treatment in year 1; in year 2, the elevation of annual N2O emissions was significant (P<0.05) by HN and MN treatments but was insignificant by LN treatments (P>0.05). The three N forms also had strong effects on N2O emissions. Significantly (P<0.05) higher annual N2O emissions were observed in the soils of CAN and AS fertilizer treatments than in the soils of NS fertilizer treatments in both measured years, but the difference between CAN and AS was not significant (P>0.05). Annual N2O emission factors (EF) ranged from 0.060 to 0.298% for different N fertilizer treatments in the two observed years, with an overall EF value of 0.125%. The EF values were by far less than the mean default EF proposed by the Intergovernmental Panel on Climate Change(IPCC).

Our results also showed that N fertilization did not change the seasonal patterns of soil respiration, which were mainly controlled by soil heat-water conditions. However, N fertilization could change the relationships between soil respiration and soil temperature, and water regimes. Soil respiration dependence on soil moisture was increased by N fertilization, and the soil temperature sensitivity was similar in the treatments of HN, LN, and CK treatments (Q10 varied within 1.70–1.74) but was slightly reduced in MN treatment(Q10=1.63). N fertilization increased soil CO_2 emission in the order MN>HN>LN compared with the CK treatment. The positive effects reached a significant level for HN and MN (P<0.05) and reached a marginally significant level for LN (P=0.059<0.1) based on the cumulative soil respiration during the 2007 growing season after fertilization (July–September 2007). Furthermore, the differences between the three fertilization treatments and CK reached the very significant level of 0.01 on the basis of the data during the first entire year after fertilization (July 2007–June 2008). The annual total soil respiration was 53, 57, and 24% higher than in the CK plots (465 g m-2y-1). However, the positive effects did not reach the significant level for any treatment in the 2008 growing season after the second year fertilization (July–September 2008, P>0.05). The pairwise differences between the three N-level treatments were not significant in either year(P>0.05).