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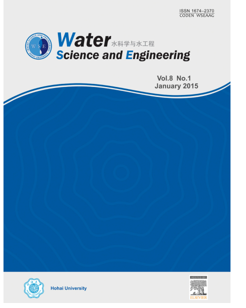

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Effects of elevated atmospheric CO_2 and nitrogen fertilization on nitrogen cycling in experimental riparian wetlands

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Abstract

Studies on the relationship between plant nitrogen content and soil nitrogen reduction under elevated CO_2 conditions and with different nitrogen additions in wetland ecosystems are lacking. This study was meant to assess the effects of elevated CO_2 concentrations and inorganic nitrogen additions on soil and plant nitrogen cycling. A cultured riparian wetland, alligator weeds, and two duplicated open top chambers (OTCs) with ambient (380 μmol/mol) and elevated (700 μmol/mol) CO_2 concentrations at low (4 mg/L) and high (6 mg/L) nitrogen fertilization levels were used. The total plant biomass increased by 30.77% and 31.37% at low and high nitrogen fertilization levels, respectively, under elevated CO_2 conditions. Plant nitrogen content decreased by 6.54% and 8.86% at low and high nitrogen fertilization levels, respectively. The coefficient of determination (R^2) of soil nitrogen contents ranged from 0.81 to 0.96. Under elevated CO_2 conditions, plants utilized the assimilated inorganic nitrogen (from the soil) for growth and other internal physiological transformations, which might explain the reduction in plant nitrogen content. A reduction in soil dissolved inorganic nitrogen (DIN) under elevated CO_2 conditions might have also caused the reduction in plant nitrogen content. Reduced plant and soil nitrogen contents are to be expected due to the potential exhaustive use of inorganic nitrogen by soil microorganisms even before it can be made available to the soil and plants. The results from this study provide important information to help policy makers make informed decisions on sustainable management of wetlands. Larger-scale field work is recommended in future research.

Keywords: Elevated CO_2 concentration; Invasive species; Plant growth; Climate change; Inorganic nitrogen; Nitrogen cycling

1. Introduction

The functions of wetlands, including flood control, water purification, and even production of fish, cannot be utterly overlooked. However, in some situations, the plants in wetlands tend to become invasive and, in some cases, they have the ability to alter nutrient cycling process, productivity, and food webs in the wetland. On the other hand, when plants are not present, shifts in soil microbial communities have also been found to be capable of altering the ecosystem's nutrient cycling process in a manner similar to that observed when plants are present (Balser and Firestone, 2005; Balser et al., 2001), since microorganisms play an important mediating role in biogeochemical cycles. Research by Koizumi et al. (1991) showed that these microbial activities often do not change at low atmospheric CO_2 concentrations while the activities at high CO_2 concentrations are still under study. On the contrary, both empirical and modeling studies have shown a possible increase in sensitivity of plant productivity to increasing CO_2 concentrations (Morgan et al., 2007). However, not all plant species respond in the same manner. Differences in photosynthetic pathways and the ability to fix nitrogen are important species traits in plants, which affect their response (Reich et al., 2001). Both elevated CO_2 and nitrogen additions have been found to increase plant biomass. However, the effect of the former has been found to be greater with high available nitrogen levels (Martín-Olmedo et al., 2002; Daepp et al., 2000). Both have also been found to alter the carbon-to-nitrogen ratio of plant tissues, which tends to modify the decomposability of plant residues (van Groenigen et al., 2006). In a spate of climatic changes, CO_2 concentrations have been rising and are expected to rise further.

Furthermore, elevated CO_2 can reduce soil nitrogen availability due to a possible increase in microbial growth (Gill et al., 2002; Díaz et al., 1993), leading to an increase in inorganic nitrogen. Plant nitrogen uptake can further reduce available soil nitrogen in the long term because of increasing storage of nitrogen in long-lived plant biomass and soil

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