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Plant feedbacks on soil respiration in a poplar plantation under elevated CO2 and nitrogen fertilization

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FACE experiments offered a unique occasion to investigate plant-soil relationship in terrestrial ecosystems. Changes in plant productivity and carbon (C) allocation under elevated CO2 have the potential to alter soil processes mediated by microorganisms. Also, fertilization can strongly affect plant-soil relationships through both direct and indirect effects. A fast growing poplar plantation was treated for six consecutive years with elevated CO2 at two nitrogen (N) levels. In the frame of plant responses to these environmental factors, our intent is to investigate plant-soil relationships and their impact on soil CO2 emissions. In particular, feedbacks of root productivity on soil respiration and heterotrophic community have been assessed in the last two years of the field experiment. In the POP-EUROFACE fast growing poplar plantation, the enhancement of atmospheric CO2 concentration induced an increase of fine root biomass and productivity, and consequently rhizodeposition. Concurrently, N addition reduced total root biomass but did not affect productivity. Soil respiration was deeply impacted by elevated CO2, with increases up to 95%, independent of N availability. The increase involved both auto and rhizomicrobial components of soil respiration. Indeed, the root-rhizosphere continuum stimulated the rhizomicrobial respiration, with the prompt loss of part of the extra C fixed through photosynthesis in elevated CO2. In fact, whereas the basal soil respiration was significantly dependent on fine root standing biomass, total soil respiration and the rhizomicrobial component during the growing season were significantly dependent on fine root productivity. This mechanism was also evident in the year following the end of CO2 enrichment, when no “residual” effects of elevated CO2 on soil respiration were observed, in unfertilized soil. The relationship between root productivity and heterotrophic respiration was mediated by the pattern of labile C availability in soil, which includes rhizodeposition and was significantly increased under elevated CO2. Our results demonstrate how the manipulation of environmental factors, directly affecting plant productivity and allocation, provide a comprehensive approach in the study of plant-soil relationships. Moreover, the importance of plant activity and labile C availability as regulator of soil responses indicates the necessity to include these factors in models predicting soil activity. Because of its potential impact on C losses and thus C sequestration potential of soil, the activity and functions of the rhizomicrobial community merit to have full consideration in the next generation of FACE experiments.