Effects of elevated CO2, warming and drought episodes on plant carbon uptake in a temperate heath ecosystem are controlled by soil water status

The impact of elevated CO2, periodic drought and warming on photosynthesis and leaf characteristics of the evergreen dwarf shrub Calluna vulgaris in a temperate heath ecosystem was investigated. Photosynthesis was reduced by drought in midsummer and increased by elevated CO2 throughout the growing season, whereas warming only stimulated photosynthesis early in the year. At the beginning and end of the growing season, a T × CO2 interaction synergistically stimulated plant carbon uptake in the combination of warming and elevated CO2. At peak drought, the D × CO2 interaction antagonistically down-regulated photosynthesis, suggesting a limited ability of elevated CO2 to counteract the negative effect of drought. The response of photosynthesis in the full factorial combination (TDCO2) could be explained by the main effect of experimental treatments (T, D, CO2) and the two-factor interactions (D × CO2, T × CO2). The interactive responses in the experimental treatments including elevated CO2 seemed to be linked to the realized range of treatment variability, for example with negative effects following experimental drought or positive effects following the relatively higher impact of night-time warming during cold periods early and late in the year. Longer-term experiments are needed to evaluate whether photosynthetic down-regulation will dampen the stimulation of photosynthesis under prolonged exposure to elevated CO2.

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