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Individual versus combined effects of elevated CO_2, warming and drought on grassland productivity and stoichiometry

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In a future world, ecosystems will be affected by a concomitant increase in atmospheric CO_2 concentrations, temperature and drought events. While the individual effects of elevated CO_2, warming and drought on plant and ecosystem productivity are comparatively well understood, there is a major lack of experimental studies testing for their interactive effects. In a multifactor experiment (ClimGrass) established in 2013 on a managed montane grassland in Central Austria we tested how elevated CO_2 (eCO_2), warming (eT) and drought individually and interactively affect productivity and tissue stoichiometry.

Treatment effects varied and amplified across the eight treatment years, partly related to shifts in species composition. Above-ground net primary productivity (ANPP) was generally increased when eT and eCO_2 were combined, while it was not consistently affected by the individual treatments. Drought and drought recovery effects on ANPP, gross primary productivity (GPP) and belowground carbon allocation were amplified when drought was combined with eT and eCO_2. Both under current and future (eT, eCO_2) scenarios drought altered tissue stoichiometry by decreasing phosphorus concentrations during drought and increasing nitrogen and potassium concentrations post-drought. Overall, our study suggests that in the temperate grassland studied drought had an overriding effect on productivity and tissue stoichiometry, which was amplified by warming, but only weakly altered by elevated CO_2.

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