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Can rising CO₂ concentrations in the atmosphere mitigate the impact of drought years on tree growth?

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Atmospheric CO₂ concentrations and nitrogen deposition rates have increased substantially over the last century and are expected to continue unabated. As a result, terrestrial ecosystems will experience warmer temperatures and some may even experience droughts of a more intense and frequent nature that could lead to widespread forest mortality. Thus there is mounting pressure to understand and predict how forest growth will be affected by such environmental interactions in the future. In this study we used annual tree growth data from the Duke Free Air CO₂ Enrichment (FACE) experiment to determine the effects of elevated atmospheric CO₂ concentration (+200 ppm) and Nitrogen fertilisation (11.2 g of N m⁻² yr⁻¹) on the stem biomass increments of mature loblolly pine (*Pinus taeda* L.) trees from 1996 to 2010. A non-linear mixed-effects model was developed to provide estimates of annual ring specific gravity in all trees using cambial age and annual ring width as explanatory variables. Elevated CO₂ did not have a significant effect on annual ring specific gravity, but N fertilisation caused a slight decrease of approximately 2% compared to the non-fertilised in both the ambient and CO₂-elevated plots. When basal area increments were multiplied by wood specific gravity predictions to provide estimates of stem biomass, there was a 40% increase in the CO₂-elevated plots compared to those in ambient conditions. This difference remained relatively stable until the application of the fertilisation treatment, which caused a further increase in biomass increments that peaked after three years. Unexpectedly the magnitude of this second response was similar in the CO₂-elevated and ambient plots (about 25% in each after 3 years), suggesting that there was no interaction between the concentration of CO₂ and the availability of soil N on biomass increments. Importantly, during drier years when annual precipitation was less than 1000 mm we observed a significant decrease in annual increments across all treatments. However, the relative difference in growth between CO₂-elevated and ambient plots was greater during drought years, providing evidence that tree growth in the future might become less sensitive to water shortages under elevated CO₂ conditions.