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The impact of climate change on the growth of tropical agroforestry tree seedlings

Shahira Esmail · Maren Oelbermann

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Abstract Several studies have been conducted on the response of crops to greater concentrations of atmospheric CO_2 (CO_2 fertilization) as a result of climate change, but only few studies have evaluated this effect on multipurpose agroforestry tree species in tropical environments. The objectives of this study were to quantify differences in growth parameters and in leaf carbon (C) and nitrogen (N) concentrations of *Cedrela odorata* L. and *Gliricidia sepium* (Jacq.) Walp. seedlings under current ambient temperature (32°C daytime, 22°C night time) and CO_2 (360 ppm) (AMB); CO_2 fertilization (800 ppm, 32°C daytime, 22°C night time) ($_fCO_2$); elevated ambient temperature (360 ppm, 34°C daytime, 25°C night time) (TEMP); and a combination of elevated temperature (32°C daytime, 22°C night time) and CO_2 fertilization (800 ppm) (TEMPx$_fCO_2$). Results showed significant differences ($P < 0.05$) in seedling growth parameters (seedling height, number of stem leaves, leaf area ratio, shoot and root biomass, and shoot/root ratio) between treatments for both tree species. The greatest increases in growth parameters occurred in the TEMP and TEMPx$_fCO_2$ treatments compared to the AMB treatment for both tree species. However, growth parameters were significantly lower ($P < 0.05$) in the $_fCO_2$ treatment compared to that of the AMB treatment. Leaf N concentration was 1.1 to 2.1 times lower ($P < 0.05$) in all treatments when compared to current ambient conditions (AMB) in both tree species, but no significant changes in leaf C concentrations were observed. Results from our study suggested that $_fCO_2$ had the greatest negative impact on tree growth parameters, and leaf N concentrations were affected negatively in all treatments compared to current ambient conditions. It is expected that such changes in growth parameters and plant N content may impact the long-term cycling of nutrients in agroforestry systems.

Keywords *Cedrela odorata* · CO_2 fertilization · Controlled environmental growth chambers · *Gliricidia sepium* · Global warming · Leaf nutrient concentrations · Seedling growth parameters

S. Esmail · M. Oelbermann (✉)
Department of Environment and Resource Studies, Faculty of Environment, University of Waterloo, Waterloo, ON N2L 3G1, Canada
e-mail: moelbermann@uwaterloo.ca

Introduction

The effects of climate change as a result of rising ambient temperatures and atmospheric CO_2 concentrations are currently observed in a range of ecosystems and species on a global level (Warren et al. 2011), including tropical central America (Walther et al. 2002) where temperatures are predicted to increase between 1.5 and 5.6°C compared to current conditions (IPCC 2007). The majority (95%) of