Abstract

Future climate scenarios indicate increasing CO_2 levels in combination with more frequent drought spells. Recent studies suggest that elevated CO_2 reduces the effect of drought stress, but the mechanisms underlying the reduced stress effects remain unclear. Therefore we investigated the growth, physiological, biochemical and genome-wide transcriptional responses of *Arabidopsis thaliana* to mild (MD) and severe drought (SD) under ambient (aCO_2) and elevated CO_2 (eCO_2), 360 and 620 ppm respectively. Kinematic analysis showed that drought reduced leaf growth by inhibiting cell division and expansion. High CO_2 and drought showed opposite and interactive effects on growth. Where, eCO_2 reduced the impact of MD on growth by limiting the effect on both cell number and size, and the impact of SD by reducing the effect on cell size only. Genome-wide transcriptional analysis showed that growth, photosynthesis and defense processes are more strongly affected by SD as compared to MD. These results were mirrored at the growth, physiological and biochemical levels, where SD inhibited photosynthesis and stomatal conductance and induced defense related parameters. Accumulation of antioxidants and osmolytes were not sufficient to completely recover the SD damage impact. In contrast, in SD conditions in particular, eCO_2 significantly mitigated the detrimental effects of drought stress. The transcriptome and metabolic analyses did not implicate the antioxidant defense metabolism in protective effect of eCO_2, with down regulation or no significant impact on most of measured antioxidant parameters. On the other hand, we found that eCO_2 alleviated photorespiration; a stress-induced H_2O_2 generation process thus, the relaxation in antioxidant system could be a consequence of less oxidative pressure. Further induction of osmolytes was also observed and that could be associated with improved leaf relative water content under the drought and eCO_2. We therefore concluded that elevated CO_2 mitigates the effects of drought by maintaining plant turgor and reduced hydrogen peroxide production.

Keywords

Climate Change
Drought
Elevated CO_2
Oxidative stress
Redox network
Gene expression
Arabidopsis thaliana