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Effects of elevated CO_2 on Populus tremula during severe drought stress: aggravation or mitigation?

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Widespread tree mortality and forest die-off due to climate-change-induced drought is increasing and is expected to continue in the future. Despite the need to better understand the effects of climate change on tree development and survival, many questions remain. Rising atmospheric CO_2 concentration ($[CO_2]$) has been suggested to mitigate drought stress via enhanced carbon gain, but our understanding on the interaction of these two climate-driven effects remain largely unresolved.

We performed a factorial experiment to evaluate the combined effect of drought stress and elevated $[CO_2]$ on the development and whole-tree water use of one-year-old *Populus tremula* seedlings over one growing season. Seedlings were grown in two treatment chambers set at ambient (400 ppm, aCO_2) and elevated (700 ppm, eCO_2) $[CO_2]$. Drought stress was imposed by shutting down irrigation for half of the seedlings growing under ambient and elevated $[CO_2]$ conditions. Seedlings were instrumented with plant sensors to continuously monitor sap flow, diel stem diameter variations and seasonal stem growth.

Results suggest a significant interaction between eCO_2 and drought stress on stem growth and whole-tree water use. As expected, eCO_2 resulted in increased radial stem growth. Diel stem diameter variations showed a reduced maximum daily shrinkage (difference between daily maximum and minimum) under eCO_2 in both well-watered and drought-stressed seedlings, likely due to a reduced cell elasticity. Sap flow measurements showed an increased water use per leaf area under aCO_2 conditions, posing questions towards stomatal regulation in future climate conditions. Our experiment and detailed mapping of plant hydraulic functioning and radial stem growth enabled advanced assessment of elevated $[CO_2]$ effects on trees during severe drought.