Soil Water Stress Overrides the Boosting Effect of iWUE from Rising CO2 and temperature in Determining Plantation Mortality in Semi-arid Cold Area

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Abstract

The counteractive influence of atmospheric CO2 enrichment and drought stress on tree growth results in great uncertainty in growth patterns of planted forests in cold semi-arid regions. We used tree-ring chronology and carbon isotope analysis to track ecophysiological processes in reaction to environmental factors over the past four decades of Populus simonii plantations in cold semi-arid areas in northern China. Our results showed that the boosting effect of the rising atmospheric CO2 concentration (Ca) on iWUE and stem growth was more significant in declined stands. However, the increased iWUE did not negate tree dieback when water stress was present. Therefore, the BAI and iWUE deviation of different health status trees started from a very early age. Climatic factors showed limited influences on the stem growth of the poplar plantations. The inaccessibility of deep soil water due to site-specific soil conditions rendered the trees exposed to chronic soil water stress and constrained stomatal conductance and reduced the CO2 fertilization effect. Consequently, these stands experienced a lower stem growth rate. In summary, we suggest that soil moisture conditions the iWUE and growth sensitivity to global warming and thus portrays site-specific decline episodes of different degrees in drought-prone areas.

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