Ecophysiology and Carbon Allocation of Aspen and Balsam Poplar Seedling in Response to Drought

David A.G. Alcaraz

Abstract

Drought-induced forest mortality has been recorded in every forested continent. Although the effect of drought on plant growth, physiology and ecology have been extensively studied in the past, the physiological mechanism leading to plant mortality under drought conditions are far from being resolved. These mechanisms interact in very complex feedbacks between gas exchange, water relations and carbon reserves. Additionally, drought is theorized to increase plant susceptibility to other biotic stressors, such as herbivory. Questions on these issues were addressed through a series of experiments under greenhouse and outside conditions at the University of Alberta, Edmonton. Seedlings of trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*) were artificially droughted and defoliated under controlled conditions to evaluated the effects of drought and herbivory on growth, gas exchange, water relations and carbon reserve accumulation dynamics across tissues during different time lengths.

In two separated experiments mild and severe drought treatments were imposed on aspen and balsam poplar seedlings after controlled desiccation protocols and drought targets were identified. Mild drought stress had no effect on many of the measured variables in balsam poplar seedlings and, although the impact of mild drought increased over time, results suggested that under mild drought conditions balsam poplar seedlings prioritized growth over hydraulic safety. In aspen, accumulation of carbon reserves took place under drought conditions, which is contrary

to the original predictions of the current leading theory on mechanisms of plant mortality under drought conditions, the carbon starvation hypothesis (CSH).

Based on the previous results, two additional experiments were implemented to explore the effect of drought and defoliation on physiological and growth variables of both species over an extended period of time including a full growing season and a dormant period. Although both treatments affect carbon reserve dynamics, the underlying mechanisms were different. Results from these two experiments are, to our knowledge, the first experimental evidence describing some of the feedbacks between gas exchange, water relation and carbon reserve accumulation dynamics that may lead to plant mortality, and highlighted additional roles of carbohydrates, such as frost protection to roots, currently overlooked by the CSH