Geophysical Research Abstracts
Vol. 19, EGU2017-6572, 2017
EGU General Assembly 2017

Drought stress release increased growth rate but did not affect levels of storage carbohydrates in Scots pine trees

Leonie Schönbeck, Arthur Gessler, Andreas Rigling, Marcus Schaub, and Mai-He Li
Swiss Federal Research Institute WSL, Birmensdorf, Switzerland (leonie.schoenbeck@wsl.ch)

For trees, energy storage in the form of non-structural carbohydrates (NSCs) plays an important role for survival and growth, especially during stress events such as drought. It is hypothesized, that tree individuals that experience long-term drought stress use up larger amounts of NSCs than trees that do not experience drought. Consequently, such drought-induced depletion might lead to a decrease in tree vigor and carbon starvation, a mechanism that is subject of intensive debates in recent literature. Hence, if carbon starvation is occurring during drought, drought stress release should again increase NSC concentrations.

A long-term (13 years) irrigation experiment is being conducted in the Pfyn forest, the largest Pinus sylvestris dominated forest in Switzerland, located in the dry inner-Alpine Swiss Rhone valley (average precipitation ∼600 mm/year, with frequent dry spells). Water addition (∼600 mm/year) is executed every year during the growing season between April and October. Tree height, stem diameter and crown transparency are being measured since 2003. In February, July and October 2015, roots, stem sapwood and needles were harvested from 30 irrigated and 30 control trees and 5 different crown transparency classes. Shoot length, needle morphology, soluble sugars, starch concentrations, needle δ13C and δ15N were measured.

Shoot and stem growth were higher in irrigated trees than in control trees. Growth decreased with increasing crown transparency in both treatments. Only in July, needle starch levels were higher in irrigated trees than in control trees but there was no treatment effect for wood and root starch concentrations. Tissue starch and sugar levels were negatively correlated with crown transparency, particularly in the roots ($p<0.001$), independent of the treatment. Needle δ13C values were higher in the control trees than in the irrigated trees, where needle δ13C values were positively correlated with increasing transparency ($p<0.01$). Annual shoot growth was positively correlated with starch levels in the roots.

The results show that 13 years of irrigation did lead to increased growth but not to increased NSC levels hence not confirming our initial hypothesis. δ13C levels indicate that control trees experienced more drought stress than irrigated trees. However, we found irrigated trees from high crown transparency classes with similar δ13C levels as for non-irrigated control trees. The release of drought stress has benefited the initially vital trees, whereas the initially inferior trees still show signs of drought stress. The results point to a 'winner takes it all principle', where differences between individuals increase when environment conditions improve. This caused the irrigation treatment not being effective in generally releasing drought stress and NSC depletion in all trees. As increasing crown transparency over both treatments is correlated with decreasing growth and decreasing NSC levels, there are still indications that reduced NSC is related to reduced tree vigor under drought.