Low temperature limits for root growth in alpine species are set by cell differentiation

ID 4189864
Author(s) Nagelmüller, Sebastian; Hiltbrunner, Erika; Körner, Christian
Author(s) at UniBasel Hiltbrunner, Erika ; Körner, Christian ;
Year 2017
Title Low temperature limits for root growth in alpine species are set by cell differentiation
Journal AoB Plants
Volume 9
Number 6
Pages / Article-Number plx054

Plant growth in cold climates is not limited by carbon assimilation (source activity) but rather by reduced carbon investment into new tissues (sink limitation). It has been hypothesized that all cold-adapted plants face similar growth constraints at low temperature mainly associated with the formation of new tissues. To explore the thermal limitation of plant tissue formation, we studied root growth and anatomical root tissue characteristics in four cold-adapted alpine species (Ranunculus glacialis, Rumex alpinus, Tussilago farfara, Poa alpina), grown in thermostated soils with a vertical temperature gradient approaching 1 řC. Above-ground plant organs were exposed to typical alpine climate conditions (high solar radiation and cool nights) at 2440 m a.s.l. in the Swiss Alps to assure continuous source activity. Image-based measurements of root growth (root elongation rates at 12-h intervals, RERs) were combined with anatomical examinations in thermally constrained root tips as well as with a functional growth analysis of entire plants. Temperatures in the range 0.8 to 1.4 řC were denoted as critically low temperature thresholds for root formation across the four species. The RERs per 12 h revealed that roots kept extending at low rates at 0.7-1.2 řC but cell elongation and xylem lignification were clearly inhibited in the terminal zones of root tips. Roots exposed to temperatures between 1 and 5 řC showed strongly reduced elongation rates so that these roots contributed very little to the entire root system compared to control roots grown at 10 řC. Hardly any secondary roots were formed at temperatures below 5 řC and total root mass was substantially lower (74 % reduction in comparison to control), also the above-ground biomass was reduced by 23 %. Cell elongation and differentiation rather than cell division control length and shape of root cells at the low temperature limit of growth. Lignification of root xylem is clearly constrained at temperatures below 3 řC.

Publisher Oxford University Press
ISSN/ISBN 2041-2851
edoc-URL http://edoc.unibas.ch/58690/
Full Text on edoc Available;
Digital Object Identifier DOI 10.1093/aobpla/plx054
PubMed ID http://www.ncbi.nlm.nih.gov/pubmed/29218137
ISI-Number WOS:000419628500003
Document type (ISI) Journal Article