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Blocking phloem transport triggers bimodal radial growth in *Pinus sylvestris* at a xeric site

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A bimodal radial grow pattern, i.e. growth peaks in spring and autumn, was repeatedly found in trees in Mediterranean regions, where summer drought causes reduction or cessation of cambial activity. In a dry inner Alpine valley of the Eastern Alps (Tyrol, Austria, *c*. 750 m asl), which is characterized by drought periods at the start of the growing season in spring and more favorable conditions during summer, *Pinus sylvestris* shows an unimodal growth pattern with onset and cessation of cambial activity in early April and late June, respectively. Although xylem cell differentiation (cell wall thickening) may last until end of August, a resumption of cambial activity after intense summer rainfall was not observed in this region. In a field experiment we therefore tested the hypothesis that early cessation of cambial activity under drought is an adaptation to limited water availability during the growing season (April through June), leading to an early and irreversible switch of carbon (C) allocation to belowground. To accomplish this, the C status of *c*. 20 year old *Pinus sylvestris* saplings (mean stem height 1.5 m) was manipulated at a xeric site by physical blockage of phloem transport (girdling) in mid-July (doy 199), i.e. *c*. four weeks after cessation of cambial cell division. The influence of manipulated C availability on radial growth was continuously recorded by stem dendrometers, which were mounted 5 cm above girdling. In response to blockage of phloem flow, resumption of radial growth was detected above the girdling zone after about 2 weeks, i.e., bimodal growth could be triggered above girdling by increasing C availability. Although the experimentally induced second growth surge lasted for the same period as in spring (i.e., *c*. 2 months), the increment was more than twice as large. Below girdling radial growth was not affected (i.e., no reactivation of cambial activity occurred), but cell wall thickness of last latewood cells was significantly reduced indicating lack of C after girdling. Intense radial growth resumption in *Pinus sylvestris* saplings after girdling indicates that cessation of stem cambial activity can be reversed by manipulating the C status of the stem suggesting a high belowground C demand on the drought-prone, nutrient deficient site. This work highlights the need of in-depth experimental studies in order to understand the impact of endogenous and exogenous factors on cambial activity more clearly.

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