Seasonal dynamics of mobile carbohydrates and stem growth in Scots pine (*Pinus sylvestris*) exposed to drought

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Background/Aims

In dry inner Alpine valleys several studies revealed that drought has a strong impact on radial stem growth and tree mortality of *Pinus sylvestris*[1]. Therefore, we compared seasonal development of stem water deficit (ΔW) with intra-annual course of mobile carbohydrate pools (NSC) to improve our knowledge about the physiological mechanisms driving decline of *P. sylvestris* exposed to drought.

Methods

We monitored temporal dynamics of NSC (soluble carbohydrates and starch) in stem sapwood and key phenological dates of aboveground growth in *P. sylvestris* within a dry inner Alpine environment (750 m a.s.l., Tyrol, Austria). Determination of NSC was performed using specific enzymatic assays. Daily radial stem growth and tree water deficit (ΔW) were extracted from dendrometer records (n = 6).

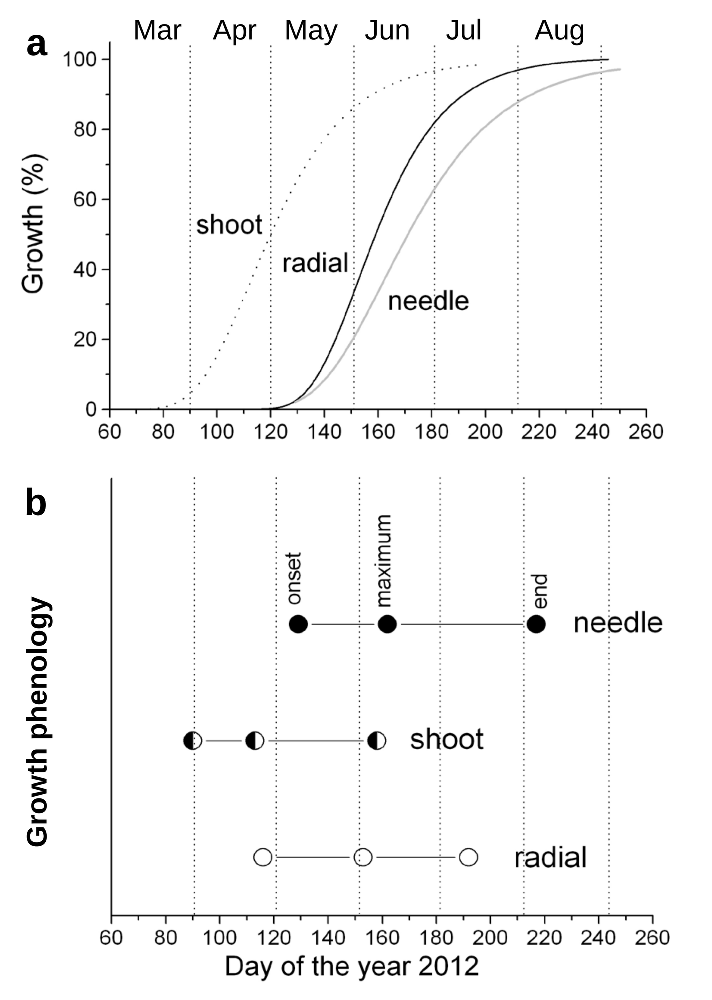

Fig. 1 Gompertz-modelled intra-annual dynamics of shoot (dotted line), needle (grey line) and radial growth (black line) (**a**) and phenological dates (**b**) in 2012. Inflection points are doy 113 for shoot growth, doy 153 and 162 for radial and needle growth, respectively[2].

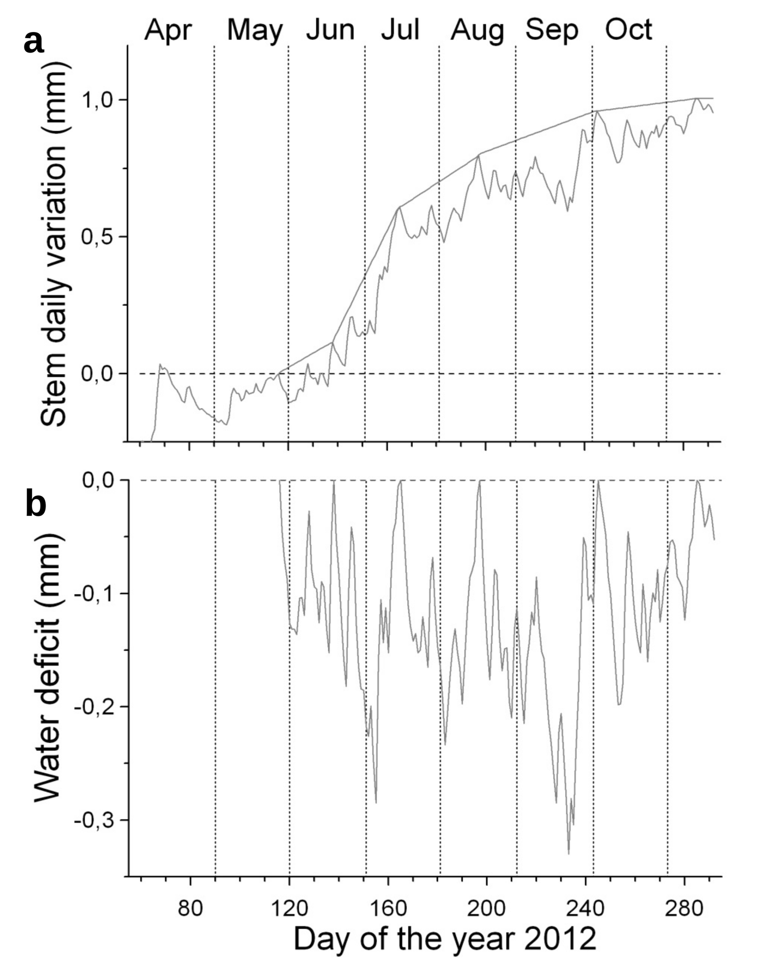

Fig. 2 Time series of mean daily dendrometer records and growth-trend lines over-bark (**a**) and mean daily extracted stem water deficit (**b**) .

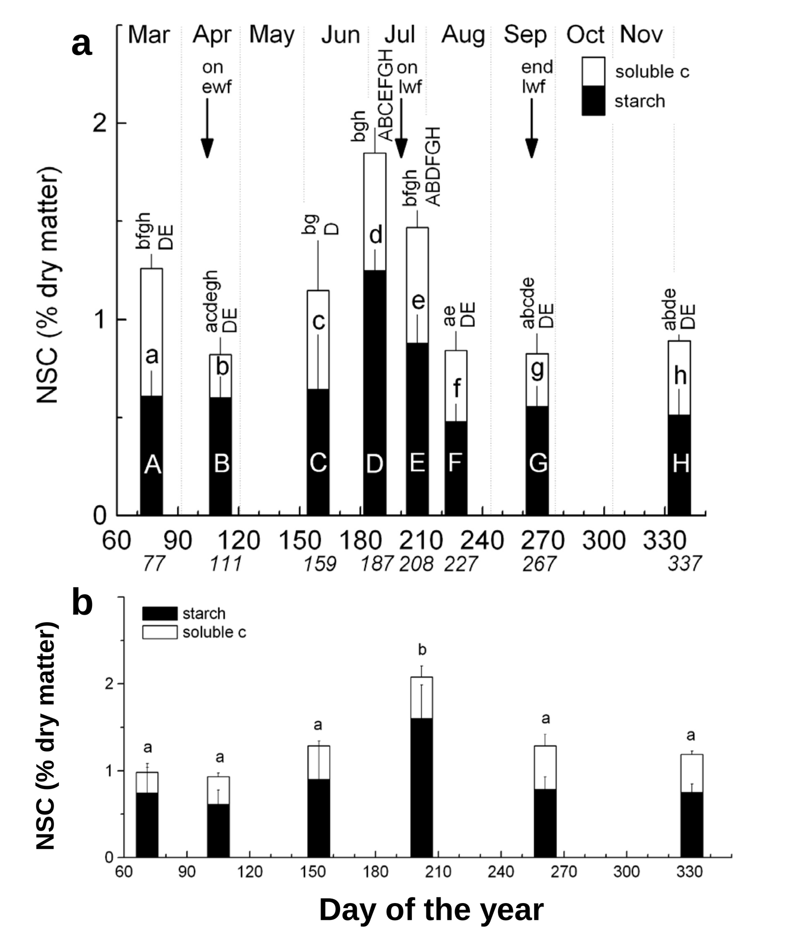

Fig. 3 Dynamics of starch (filled bars) and soluble carbohydrates (open bars) in stem sapwood (**a**) and coarse roots (**b**). Ewf and lwf indicate time of onset/end of earlywood and latewood formation, respectively. Lowercase and uppercase lettering above bars denote significant differences (P<0.05) among sampling dates for soluble carbohydrate (a-h) and starch (A-H) (**a**) and for NSC (**b**)[3,4].

Major findings of our study were:

- aboveground growth peaked between late April (shoot growth) and mid-June (needle and radial growth) **(Fig. 1)**[2],
- highest ΔW was found in summer concurrently with end of latewood formation **(Figs. 2, 3)**, and
- seasonal dynamics of NSC indicate a strong sink competition for carbon to the mycorrhizal root system at the time of decreasing growth aboveground **(Fig. 3)**[3,4].

We conclude that

- carbon was not a limiting resource in *P. sylvestris* exposed to drought, indicating that photosynthesis was less affected by moisture shortage than aboveground growth, and
- as a response to seasonal development of stem water deficit a shift in carbon allocation from aboveground to the root system might occur to ensure adequate resource acquisition on the drought-prone substrate.

References

[1]Oberhuber et al. (2014) Eur For Res 133:467-79; [2]Swidrak et al. (2013) Flora 208:609-17;
[3]Oberhuber et al. (2011) Can J For Res 41:1590-97; [4]Gruber et al. (2012) Plant Biol 14:142-48.

Acknowledgements

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