Tree ring analysis indicates genetic component in drought response of Douglas fir

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Conclusions

Two provenances from Oregon and a local source exhibited milder growth depression in response to drought, as well as faster recovery in the following years. Two provenances from Vancouver Island and Washington, characterized by high summer precipitation showed comparatively stronger drops in increment and sustainable growth reductions.

Introduction

Douglas fir is among the most ecologically and economically important conifer species in western North America. These functions may, however, be jeopardized by recent and projected climate warming. The expected increase in the frequency and severity of drought events may exceed the adaptive capacity of local populations. To mitigate the negative effects of an expected increase in drought, the transfer of tolerant seed sources has been proposed. We used a dendro-ecological approach to identify drought tolerant genotypes using samples from a provenance trial in British Columbia.

Materials & Methods

The study site, located approximately 60 km east of Vancouver, was affected by a drought event in the summer of 1985 (Fig. 1). We selected two provenances from British Columbia, one provenance from Washington, and two provenances from Oregon according to latitudinal, altitudinal and summer drought gradients. A total of 304 increment cores on 76 trees were sampled from a completely randomized block design with four replications. As a measure of drought tolerance, we used growth depression and subsequent post-drought recovery. For statistical evaluation, we performed ANOVAs in the R-programming environment.

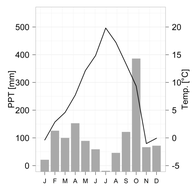

Fig. 1: Precipitation and Temp. in 1985

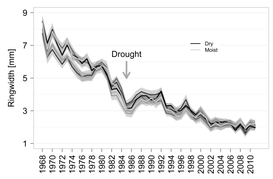

Fig. 2: Tree ring series colored according to the precipitation gradient

Growth response to drought

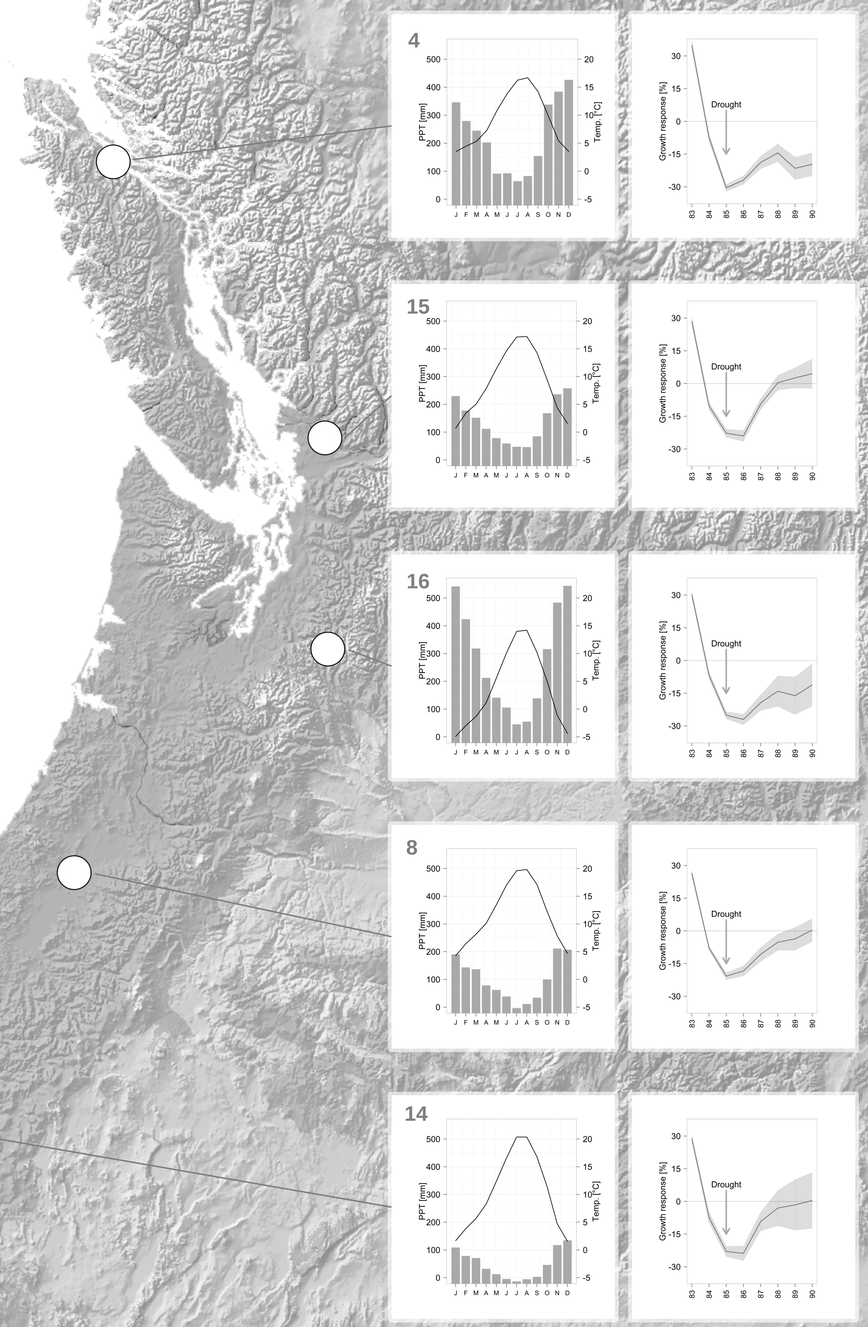

Fig.3: Climate normals (left) and growth response of provenances to drought (right)

Is there a genetic component in drought tolerance?

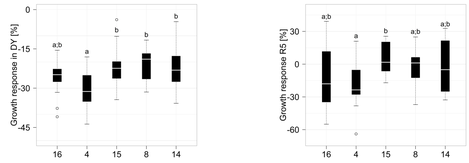

Fig. 4: Growth response in drought year (left) and five years after the event (right), ordered from wet to dry

The two wet provenances (16 & 4) had the deepest drops in increment (Fig. 4). The tree ring widths of the local source (15) and the provenances from Oregon (8 & 14) were relatively less affected. In addition, these three sources had fully recovered to their pre-drought growth rate after five years. In contrast, the two wet provenances still had reduced growth rates in 1990.

Can climate change impacts be mitigated by planting drought tolerant provenances?

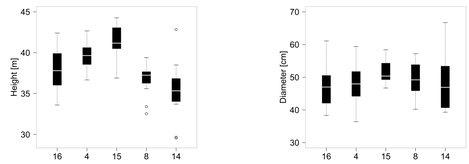

Fig. 5: Height (left) and diameter (right) at age 53 (2012)

Our results indicate that provenances from warmer and drier regions are indeed more drought tolerant than provenances from wetter and colder sites. However, foresters must consider the trade-off between productivity and drought resistance, as provenances from the south have lower height and diameter growth (Fig. 5). Interestingly, we found that a local source was as drought tolerant as the southern provenances, but also showed superior height and diameter growth. The adaptation to local conditions may have reduced stress and therefore prevented a strong reduction of increment and facilitated faster recovery. The indication of this result is that local seed sources could remain a practical option under warming climates.

Acknowledgements

We are very thankful to Ionut Aron of the Malcolm Knapp Research Forest and Bruce Larson of the University of British Columbia for support with research logistics. We are also very grateful for Anja Litka's field assistance and for helpful discussions with Miriam Isaac-Renton. DM is supported by scholarship funds from the State Graduate Funding Program of Baden-Württemberg.