Assessment of two contrasting French Douglas-fir (Pseudotsuga menziesii) seed orchards: potential for adaptation to climate change

Baptiste Antoine, Nathan Fornes, Rémy Gobin, Yves Rousselle, Gwenaël Philippe, Jean-Charles Bastien, Stéphane Matz, Sabine Girard, Didier Bier, Sylvia Theodoridis, et al.

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Introduction

Douglas-fir = 2nd most planted species in France: 12M of seedlings sold in 2022-2023

8 French seed orchards (SO) installed between 1978 and 1986 ⇨ 99 % of the nowadays French seedlings market.

Aim of the study: Compare two SO of contrasted origins and with a presumed different drought behaviours.

We tried to address a better understanding of mechanisms underlying the difference in drought behaviour using data from automatic point dendrometers in a comparative plantation of progenies of two SO.

Material

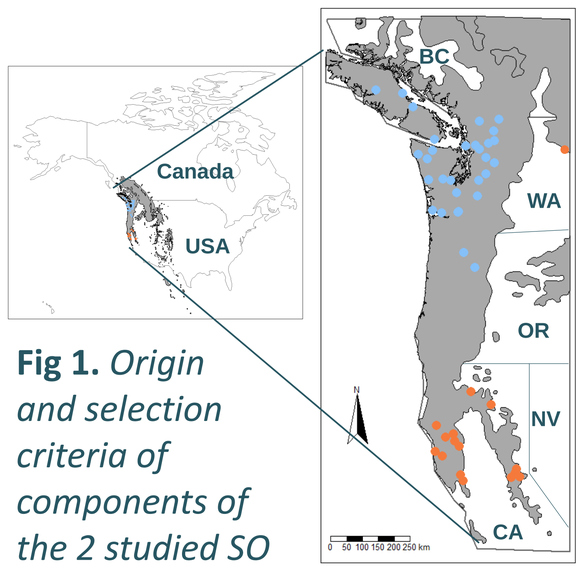

Fig 1. *Origin and selection criteria of components of the 2 studied SO*

***Luzette* LUZ (=northern SO)**

- Late budburst
- Shape
- Growth rate
- 226 clones

***Californie* CAL (=southern SO)**

- Survival in dry conditions
- Shape
- Growth rate
- 108 clones

Methods

Fig 2. *Automatic point dendrometer*
X 1 data / hour
X 4 years (2020-2023)
X 18 trees per SO

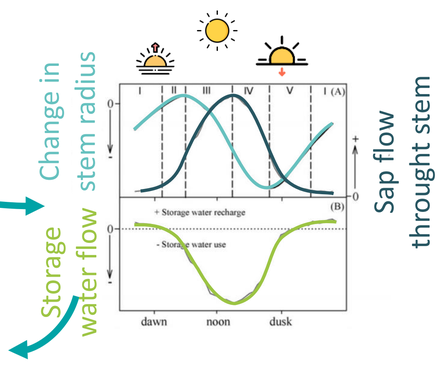

Fig 3. *Daily variation in trunk radius (adapted from Fernandez et al., 2010)*

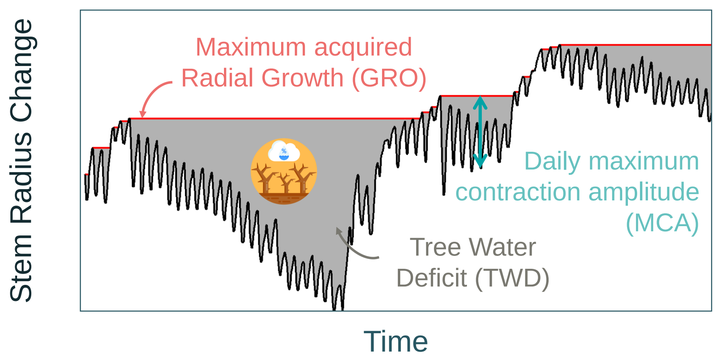

Fig 4. *Variation of stem radius over time (Adapted from Zweifel et al., 2021)*

Fig 5. *Weather station with hourly temperature and daily rainfall measurements*

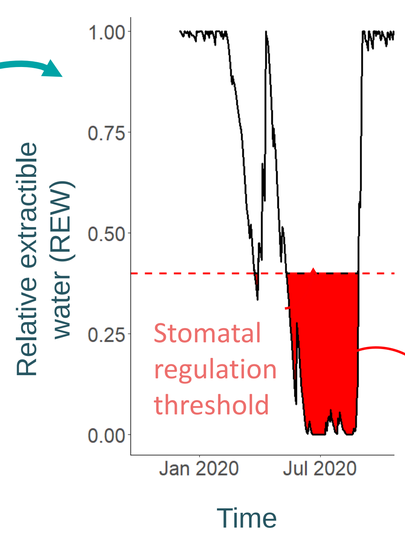

Fig 6. *Variation over time of Relative Extractible Water (REW) in the soil depending on weather (temperature and rainfall) and soil properties* (Black, 1979; Granier, 1987)

Drought stress index

Results

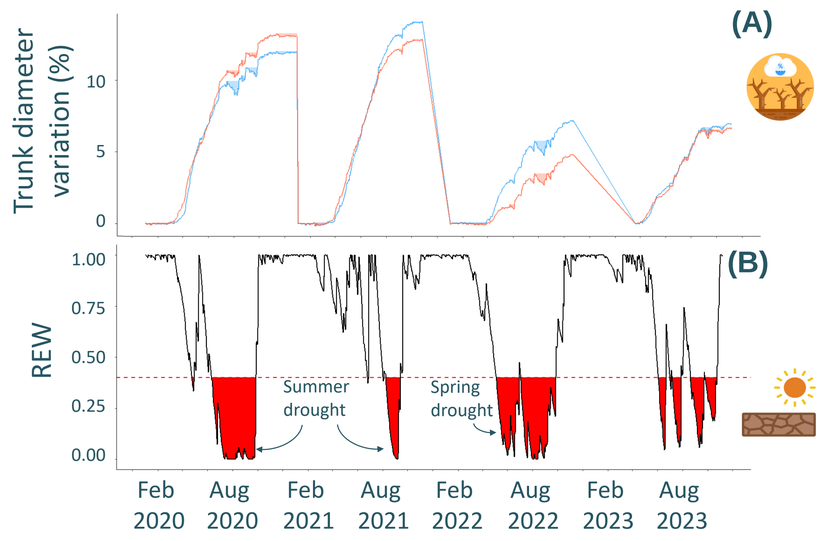

Fig 7. Comparison:
(A) *Variation in trunk diameter*
(B) *Variation in soil relative extractible water content (REW)*

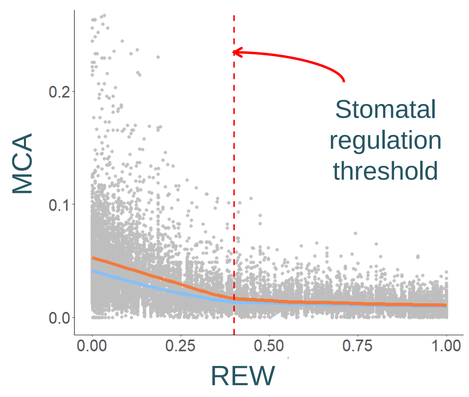

Fig 8. *Daily comparison between relative extractible water (REW) and maximum contraction amplitude (MCA)*

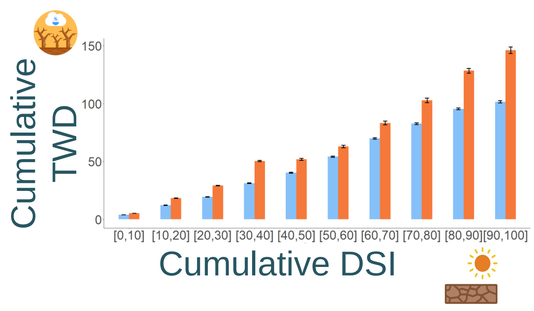

Fig 9. *Cumulative tree stress index (TWD) & Cumulative drought stress index (DSI)*

⇨ CAL's progenies seem to lowlier regulate their water loss (=water spender) than LUZ's progenies (=water saver).

Conclusion

⇨ **Contrasted behaviours for drought** tolerance and reaction of the progenies of "*Californie*" and "*Luzette*" SO.

⇨ **Stomatal regulation strategy** (water spender VS water saver) seems to be different between the two provenances.

We suggest to be precocious in the use of the "*Californie*" SO for adaptation to climate change, always look at the local conditions and be careful in case of spring droughts. These results have to be strengthened by longer studies and will be used to improve advices of the use of Douglas-fir seed orchards.

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