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Intra-specific variations of embolism resistance and water loss regulation in response to drought: A Case study on the Cordilleran cypress

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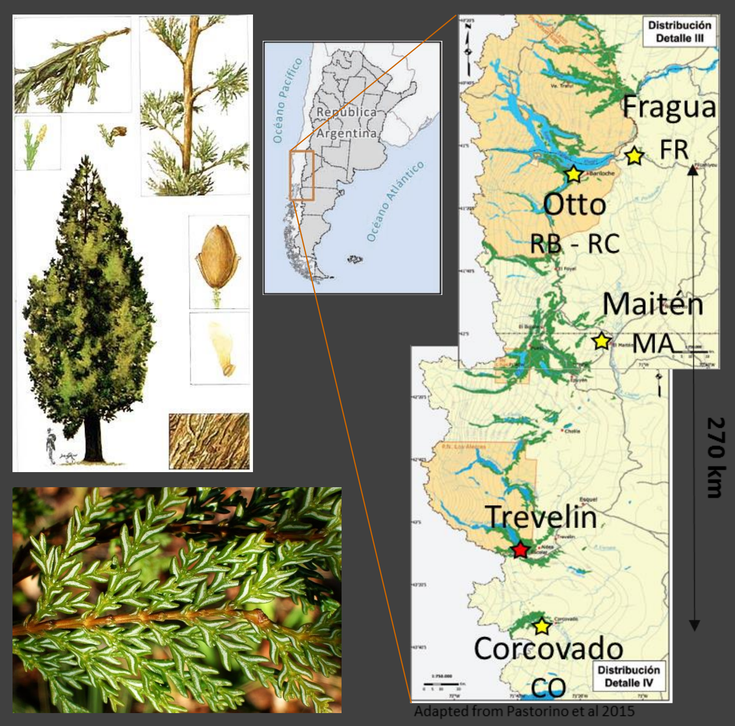


Adapted from Pastorino et al 2015

Introduction

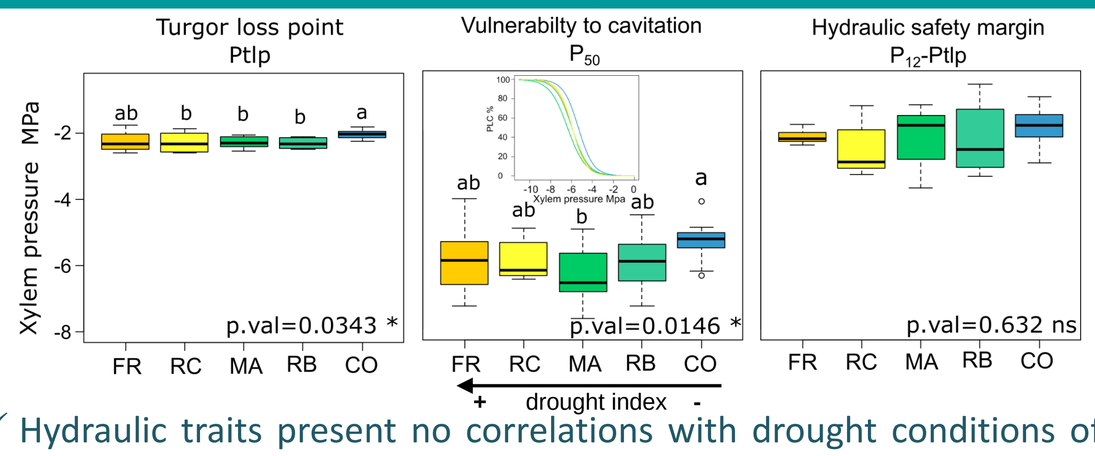
- ✓ Drought intensity is expected to increase in the southernmost regions of America (i.e Patagonia), potentially leading to forest die back and decrease in forest productivity.
- ✓ Embolism resistance and water loss regulation traits define spectrum of drought resistance[1] but it is still not clear how these traits vary among populations of the same species respect to the level of drought they experienced.
- ✓ Cordilleran cypress - *Austrocedrus chilensis* – a native cupressacea from Patagonia - has a large geographical distribution: (1200 km from north to south) presenting a strong west to east precipitation gradient (from 3000 to 300 mm of annual precipitation) showing high adaptation to contrasted climatic conditions. Over the last decade, significant mortality events related to drought were evidenced[2] .

Objective: Assessing the intraspecific variation of traits involved in drought resistance particularly embolism resistance and water loss regulation

Materials and methods

- ✓ 4 populations from contrasted climatic conditions
  + one population in two sites with contrasted soil conditions
- ✓ In-Situ + Common garden (15 years old)
  - 15 trees / site - natural conditions
  - 6 trees / population - common garden
- ✓ Hydraulic and stomatal closure traits :
  - P_{12} and P_{50} – vulnerability curves by air injection
  - Turgor loss point (*Ptlp*) from pressure volume curves
  - Hydraulic safety margin as P_{12}-*Ptlp*
- ✓ Other traits related to drought responses :
  - cuticular conductance , leaf mass per area, leaf elasticity modulus, branch leaf to sapwood ratio, leaf area index
- ✓ Soil and climatic conditions - Pedo-climatic drought index
  = soil water content + precipitation of the driest quarter of the year

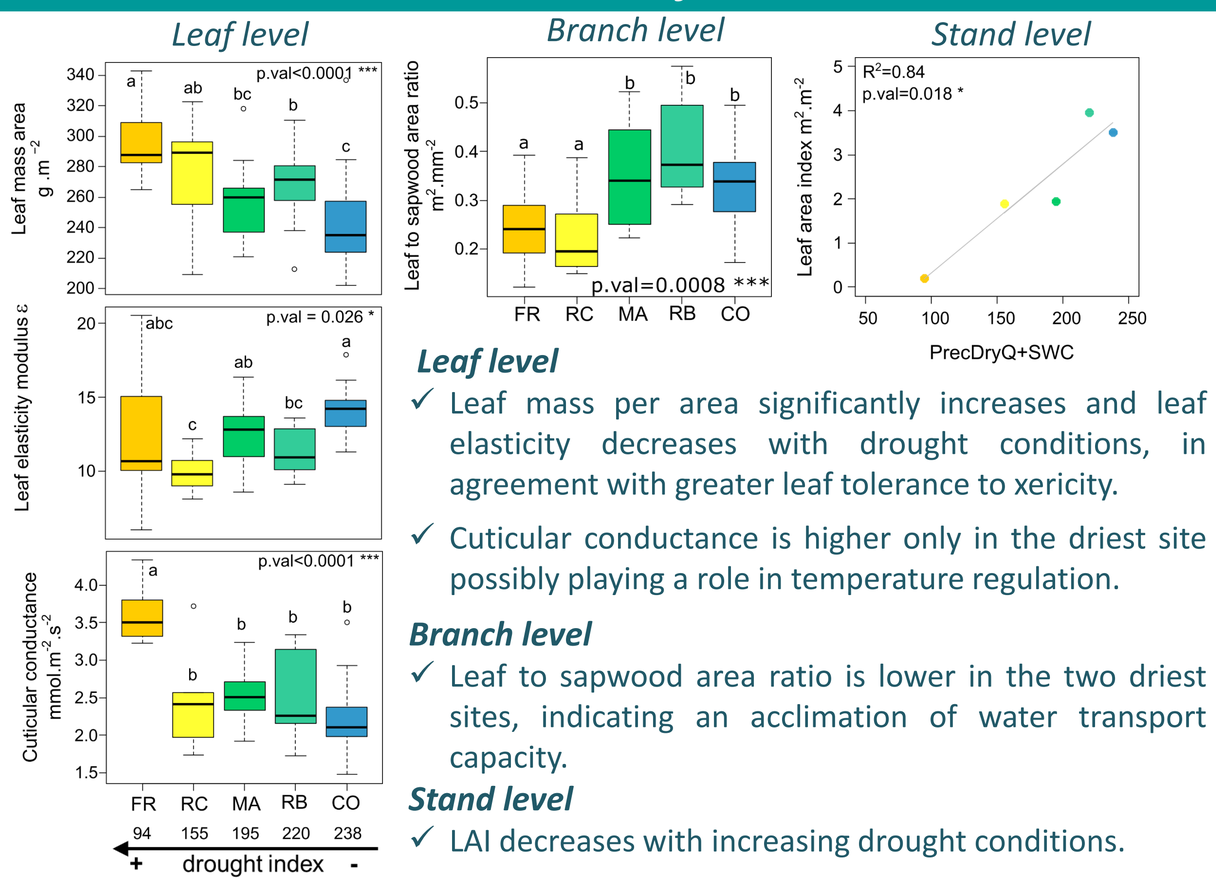
Results – stomatal and hydaulic traits – *in-situ*



- ✓ Hydraulic traits present no correlations with drought conditions of natural populations.
- ✓ Trees from the wettest site (Corcovado) had higher turgor loss point and P_{50}, possibly indicating a more sensible stomatal control associated to a higher vulnerability to cavitation.
- ✓ No significant variation in safety margin among populations was found.

In Situ adaptation to contrasted drought conditions is not related to changes in stomatal regulation or embolism resistance

Results – Leaf to stand adjustements – *in-situ*



Leaf level

- ✓ Leaf mass per area significantly increases and leaf elasticity decreases with drought conditions, in agreement with greater leaf tolerance to xericity.
- ✓ Cuticular conductance is higher only in the driest site possibly playing a role in temperature regulation.

Branch level

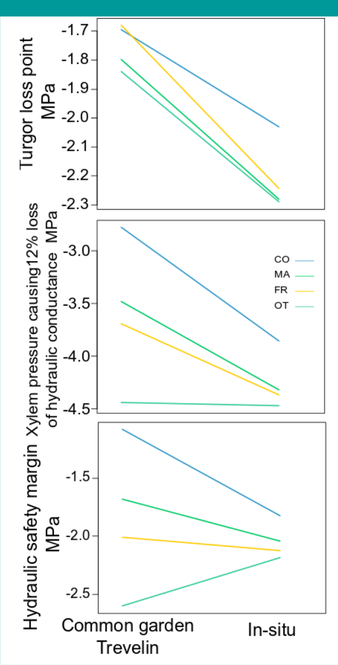
- ✓ Leaf to sapwood area ratio is lower in the two driest sites, indicating an acclimation of water transport capacity.

Stand level

- ✓ LAI decreases with increasing drought conditions.

Leaf area is highly responsive to pedo-climatic conditions suggesting that adjustments involve a regulation of water potential

Results – *in-situ* vs common garden



- ✓ In both settings hydraulic traits values are not related to drought conditions which is consistent with other studies on intra-specific variation of embolism resistance.
- ✓ The ranking of trait values in natural population and in the common garden is maintained among populations, indicating a genetic control.
- ✓ Variability in P_{12} and safety margins is lower in natural than in common garden conditions suggesting that plasticity may compensate genetic variation to reach a given value.

Variations (plastic or genetic) of stomatal regulation and hydraulic traits may not be directly involved in the intra specific adaptation to drought

Conclusion

- ✓ Few differences among populations of vulnerability to cavitation, turgor loss point and hydraulic safety margin. These traits are poorly related with in-situ pedo-climatic drought conditions.
- ✓ Genetic and environmental variation of stomatal regulation and embolism traits are not related to pedo-climatic drought conditions. Surprisingly the plasticity of P_{12} and safety margins compensate the genetic variation, leading to a reduction of variation between populations *in-situ*.
- ✓ In natural conditions, the adjustment of leaf area from branch to stand may play a dominant role in the local acclimation to drought conditions of the Cordilleran cypress.

Bibliography

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TOPWOOD