Genetic variability of maritime pine radial growth in water stress conditions

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Maritime pine plantations will face climatic change

➤ **1 million hectares forest in southwestern France**

- maritime pine (*Pinus pinaster* Ait.): fast growing species (rotation = 35 years) adapted to the constrained environment of the Landes region forest (poor sandy soils, hydromorphic soils in winter, dry summers)
- 24% of French wood harvest (60% for saw timber, 40% for industrial wood)

➤ **An advanced breeding program**

- a three generation breeding population (G0, G1, G2) developed from a base population selected in the Landes forest (~600 G0 trees)
- improved varieties for growth and sweep (+30% for growth and +30% for stem straightness)

➤ **Climatic change in southwestern France**

- IPCC climate projections for 2050 in southwestern France (A1B-scenario): temperature +1.5℃ and rainfall -10%
- increasing frequency and intensity of droughts in summer

OBJECTIVES

Evaluate genetic variability of tree growth in water stress conditions for breeding applications

➤ **Tree response to water stress measured through radial growth**

➤ **Definition of key parameters to characterize radial growth curves in water stress conditions and evaluate their genetic variability**

➤ **Identification of proxies to simplify selection for drought adaptation**

Radial growth and environmental parameters recorded every hour

➤ **Genetic trial on two contrasted sites**

- Trial established in 1996 (density = 1,250 trees/ha) on 2 sites encountered similar climate: a dry heathland ("**DrySite**") and a humid heathland ("**HumidSite**"). Site differences mainly due to depth of water table (between -6m and -8m for DrySite vs. between 0m and -2m for HumidSite) and soil nutrients (less nitrogen and carbon contents in DrySite than HumidSite).
- On each site: the same 175 half-sib families (G1 mother tree crossed with a mix of 42 pollens) with 35 trees / family (randomized complete blocks) ➔ more than 6,000 trees / site

➤ **Real-time measurement of radial growth on 150 trees**

- Selection of 25 half-sib families representing a large range of growth variability
- Electronic dendrometers installed on 150 trees (i.e. 25 families x 3 trees/family x 2 sites) in 2014
- Radial growth data recorded every hour
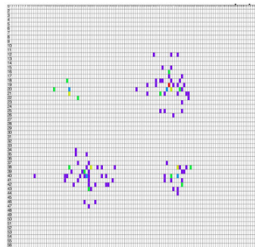
➤ **Climatic data and soil humidity measurement**

- One meteorological station close to each site
- Soil water content measured with TDR (Time Domain Reflectometry) sensors: 16 sensors at 45cm deep and 4 sensors at 70 cm deep in each site. Water table level measured in each site.

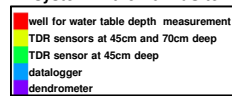Solar panel for recharging the battery of the datalogger

Well to measure water table depth with a TDR sensor

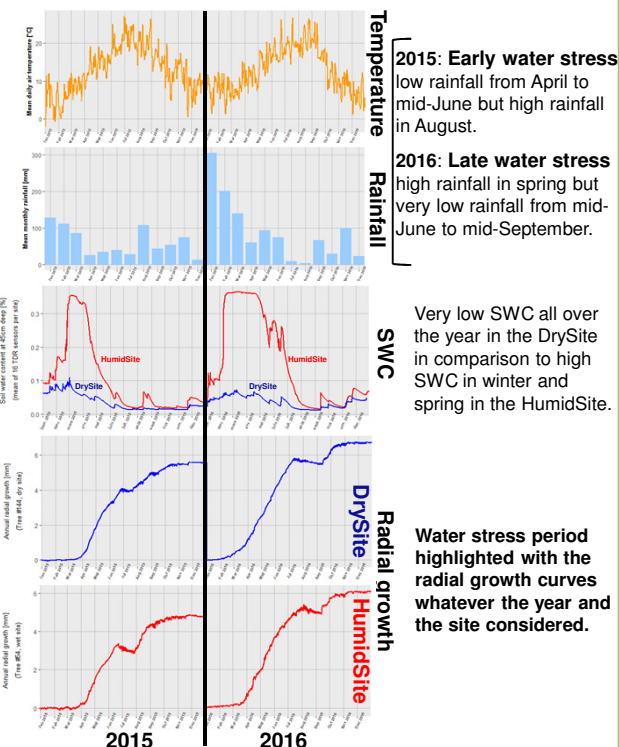Datalogger to connect TDR sensors and electronic dendrometers

Mapping of electronic instrument system in the HumidSite
- well for water table depth measurement
- TDR sensors at 45cm and 70cm deep
- TDR sensor at 45cm deep
- datalogger
- dendrometer

Electronic dendrometer at breast height

Records in 2015 and 2016

Temperature
Rainfall
SWC
Radial growth — DrySite — HumidSite

2015: **Early water stress** low rainfall from April to mid-June but high rainfall in August.

2016: **Late water stress** high rainfall in spring but very low rainfall from mid-June to mid-September.

Very low SWC all over the year in the DrySite in comparison to high SWC in winter and spring in the HumidSite.

Water stress period highlighted with the radial growth curves whatever the year and the site considered.

2015 and 2016 show similar annual radial growth pattern but differ for the position and the duration of the water stress period.

Variability of annual radial growth curve
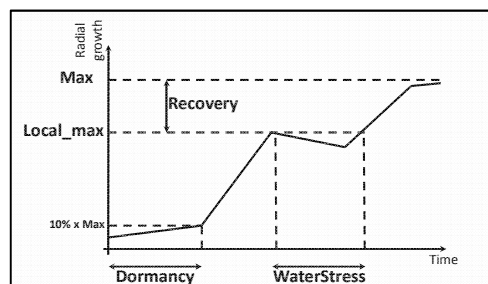
Parameters used to characterize the radial growth curve:

- « **Max** »: total annual growth (in mm)
- « **Dormancy** »: number of days to reach 10% of Max
- « **Recovery** »: radial growth realized after the water stress period (expressed in % of total annual growth)
- « **WaterStress** »: number of day with no growth during water stress period

✓ « **Year** » and « **Site** » effects significant for all parameters
✓ Moderate genetic variability for Max (annual radial growth): h²=0.39±0.20
✓ No genetic variability for « **Dormancy** », « **WaterStress** » and « **Recovery** »

Max [mm]
Dormancy [days]
WaterStress [days]
Recovery [%]
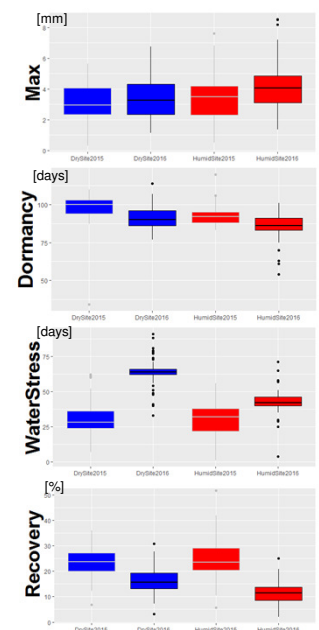
Conclusions and perspectives

➤ Radial growth can be used as tree response to water stress conditions.

➤ Only preliminary results are presented here. Analyses are in progress (integration of local environmental conditions, paternity recovery to better estimate genetic effects…) in particular to highlight genetic variability for growth curve parameters related to better adaptation for drought events.

➤ Next experimental step will be to sample increment cores to link radial growth curves with wood density profiles ➔ identify proxies to screen more easily breeding populations.