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# Adjustements of mechanical and hydraulic properties of wood formed under environmental stresses

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## Wood: a complex material acclimating to environmental changes

Trees create wood, a complex heterogeneous material, that ensures the mechanical support of the tree in fluctuant environments. Climatic conditions will be significantly modified during the 21st century: on one hand, the intensity and frequency of outstanding events (wind and drought) will increase and on the other hand, chronic wind events will be lower. These climatic changes will modify the biological process of wood formation and the resulting properties of the stem and the wood.



## Environmental stresses impact wood formation

**Tests: From April to the end of September**  
**Controlled mechanical stresses:** 3 successive bending, 3 times / day, 5 days / week  
**Controlled water stress:** automated plant irrigation, stabilised to 40% of full field capacity

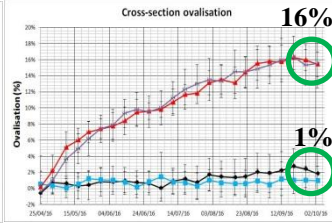
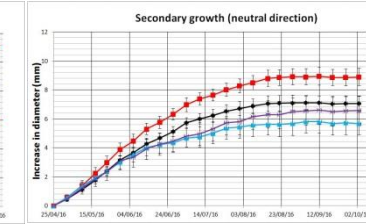
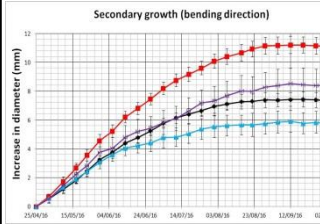
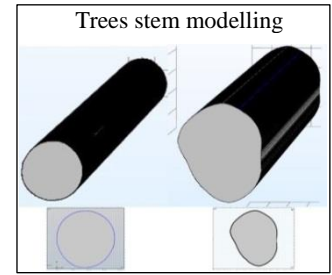
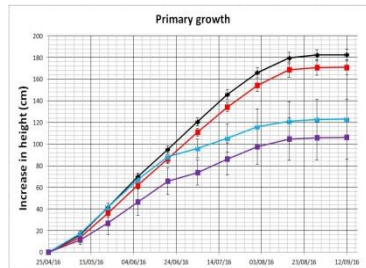
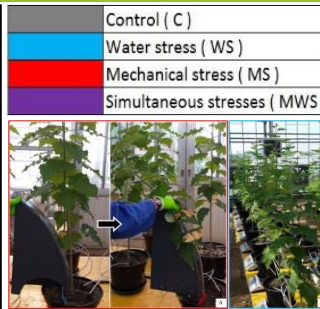
**Results on growth: stem dimensions**  
**Mechanical stresses impact on well-watered plants:**

Diameter (+53%), Height (-6%), Ovalisation of the stem (16%)

**Mechanical stress impact on water stressed plants:**  
 Diameter (+47%), Height (-14%), Ovalisation of the stem (16%)

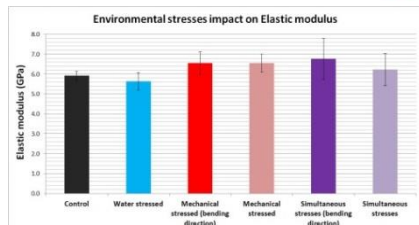
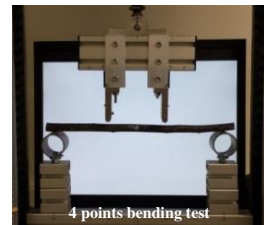
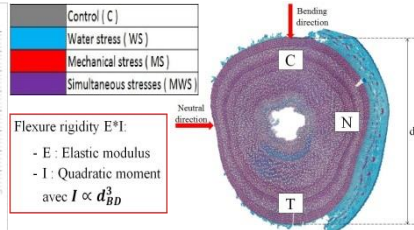
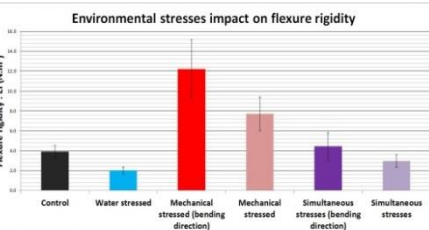
**Water stress impact (without mechanical stress):**  
 Diameter (-21%), Height (-33%)

**Water stress impact on plants under mechanical stress:**  
 Diameter (-24%), Height (-38%)



⇒ **Thigmomorphogenetic response is independent of hyric state of plants**

## Adjustments of properties to environmental stresses



### Global measurements: on stems

*Flexure rigidity EI: structure aptitude to prevent its bending*  
*Elastic modulus E: material rigidity to traction or compression*

**Mechanical stress impact on well-watered plants: (C=>MS)**

- ⇒ Flexure rigidity multiplied by 3
- ⇒ Increase of Elastic modulus of 10%

**Mechanical stress impact on water stressed plants: (WS=>MWS)**

- ⇒ Flexure rigidity multiplied by 2
- ⇒ Increase of elastic modulus of 20%

**Water stress impact on Control plants: (C=>WS)**

- ⇒ Flexure rigidity divided by 2
- ⇒ No significant impact on the elastic modulus

**Water stress impact on plants under mechanical stress: (MS=>MWS)**

- ⇒ Flexure rigidity divided by 3
- ⇒ No modification of the elastic modulus

*N.B: Treatment of results on hydraulic properties is still in progress*

### Local measurements: on matches of local wood

*Mechanical resilience  $Q_R$ : ratio of rupture energy by cross-section area*

**Mechanical stress impact on well-watered plants: (C=>MS)**

- ⇒ Increase of mechanical resilience (Cp: 17%, Ts: 19%)

**Mechanical stress impact on water stressed plants: (WS=>MWS)**

- ⇒ No significant impact

**Water stress impact on Control plants: (C=>WS)**

- ⇒ No significant impact

**Water stress impact on plants under mechanical stress: (MS=>MWS)**

- ⇒ Decrease of mechanical resilience (Cp: 30%, Ts: 41%)

*Prospect: treatment of micro-bending tests*

