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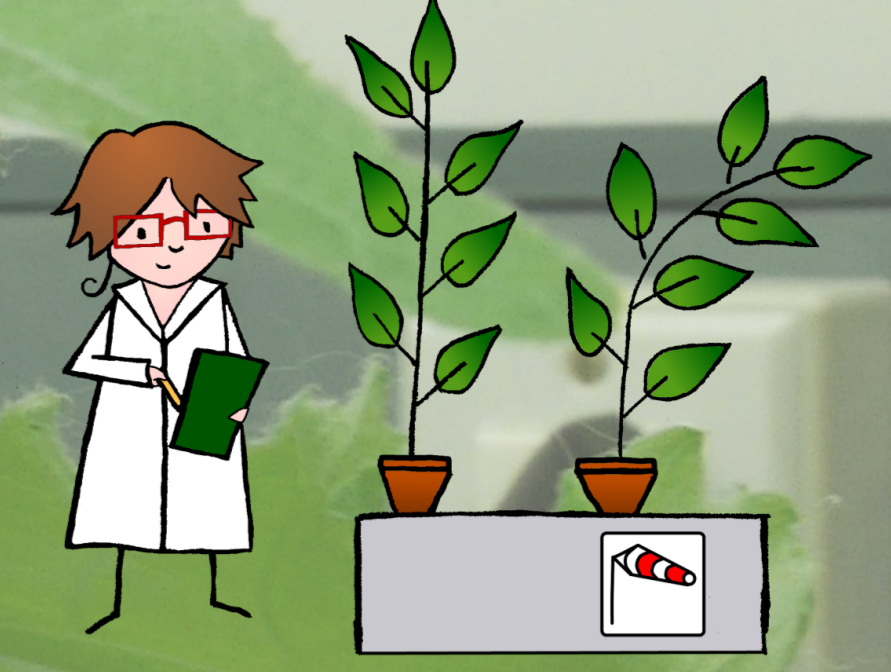
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# Acclimation of *Populus* to wind: kinetic of the transcriptomic response to single or repeated stem bending.

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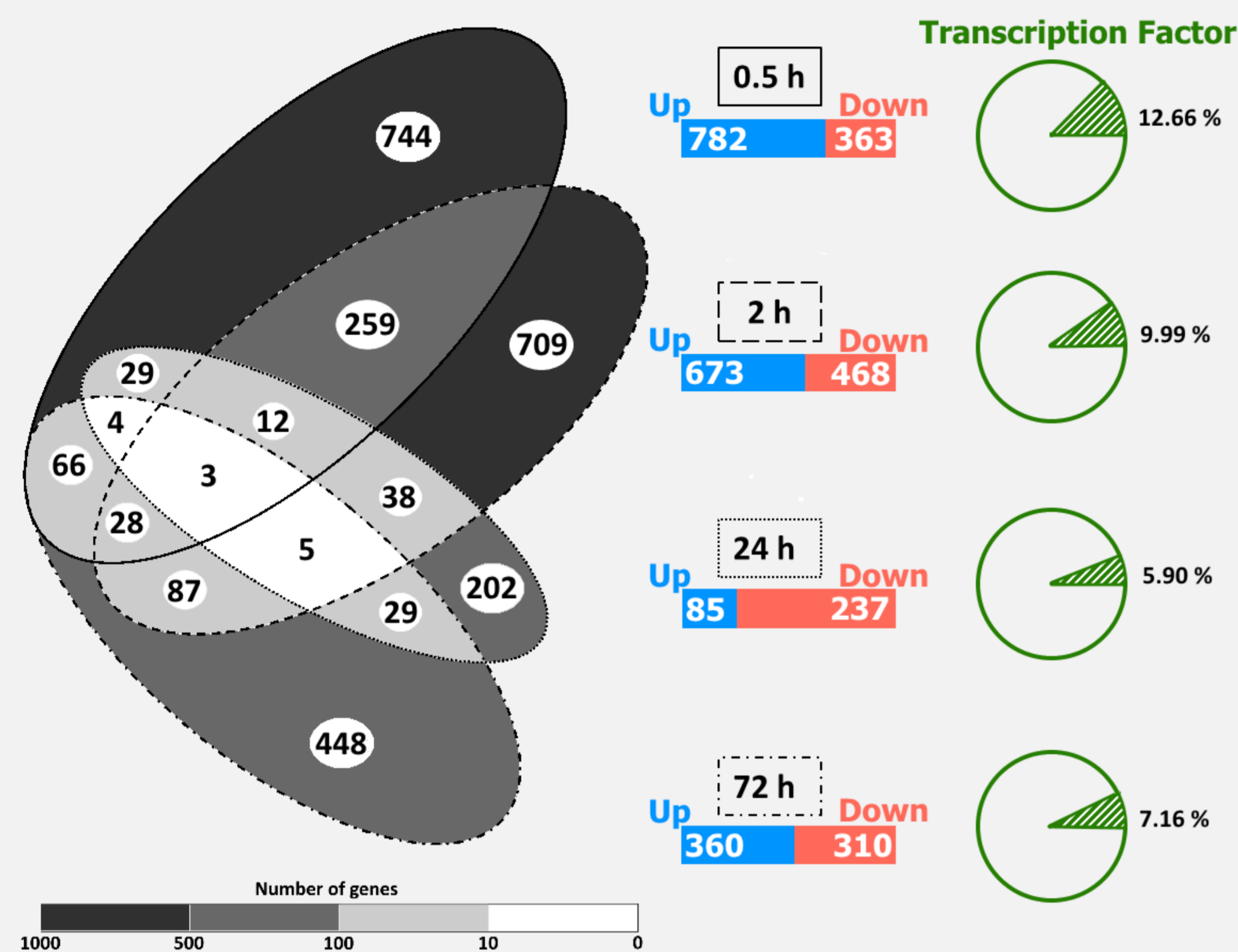
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Storms are the 1<sup>st</sup> cause of damages to European forests. Trees are sensitive to stem bending due to chronic wind. After 1 bending, they respond by modifying their growth during several days [1]. However, repeated stem bending induce a reduction in tree responsiveness, a phenomenon called accommodation [2][3]. Due to climate changes, strong wind may be more frequent [4]. **How will trees acclimate or not to such new wind regimes?**

## First global and kinetic picture of molecular responses to stem bending

### Long-term time series expression profiling



Gene expression modifications were assessed at 0.5 h, 2 h, 24 h and 72 h after a **transitory controlled bending** (with Affymetrix microarray).

→ **2,633 differentially expressed genes (DEG)**

→ 75.6% of DEG are detected at 0.5 h and 2 h after the bending

→ Many DEG are **detected at several time points.**

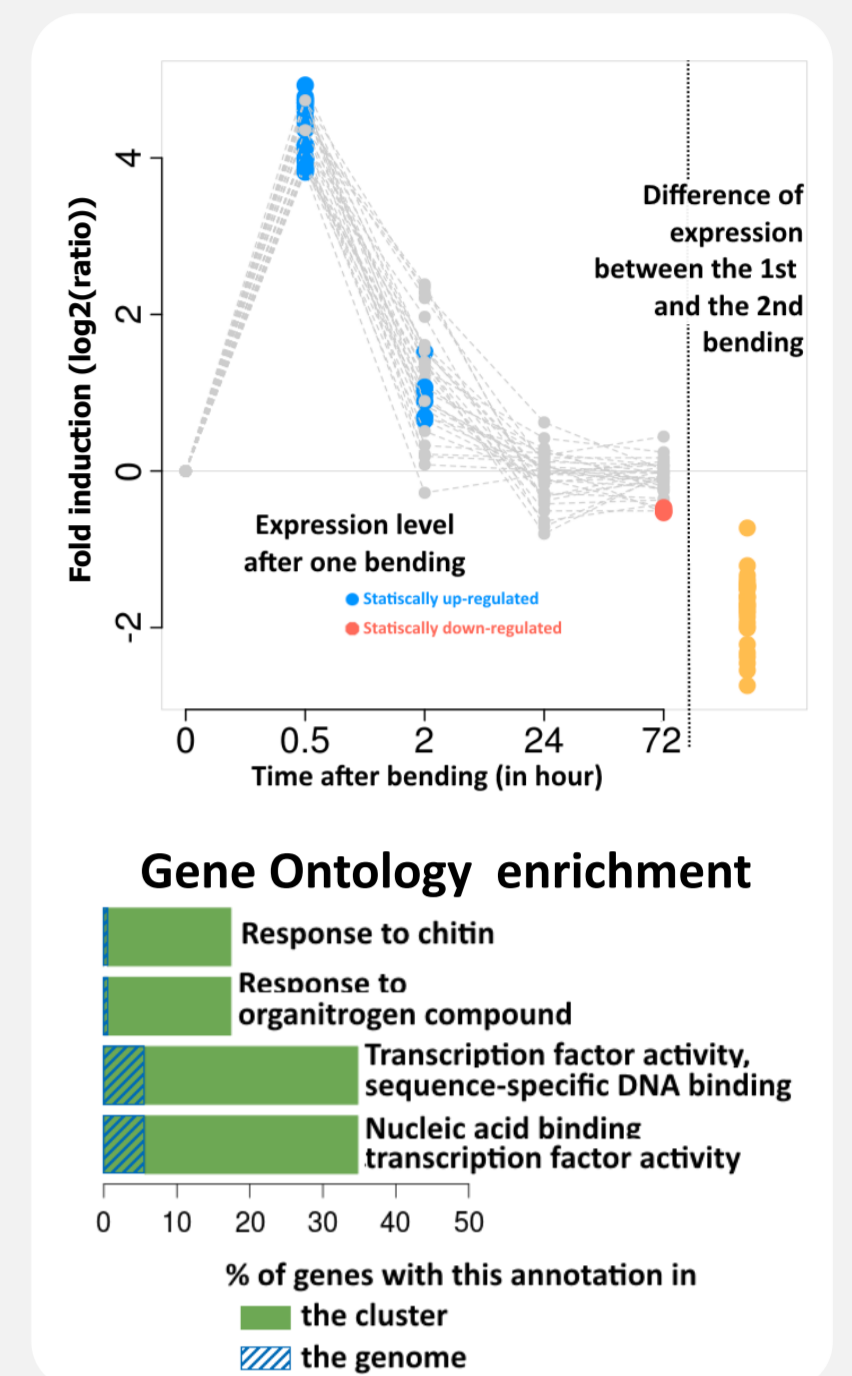
### Identification & characterization of temporal patterns in gene expression

#### k-means clustering

⇒ **40 different temporal patterns (clusters)**

**Gene Ontology (GO) enrichment** in each cluster

⇒ Temporal patterns are assigned a biological function



*Example: Cluster 4*  
31 genes up-regulated 0,5h after 1 bending with a transcription factor activity GO affiliation.

### Refinement of the early time course analysis for the biological processes involved

Refined time course analysis using **Q-PCR** → 6 extra time points between 0,5 h and 24 h for representative genes of each cluster

Chosen **genes represent the temporal patterns and the GO annotations** of the cluster.

**BP annotation of clusters of up-regulated genes**

- Protein phosphorylation
- Regulation of jasmonic acid mediated pathway
- Jasmonic acid mediated pathway
- Response to hormone
- Response to chitine
- Regulation of nucleic acid templated transcription
- Regulation of cellular process
- Regulation of defense response
- Defense response

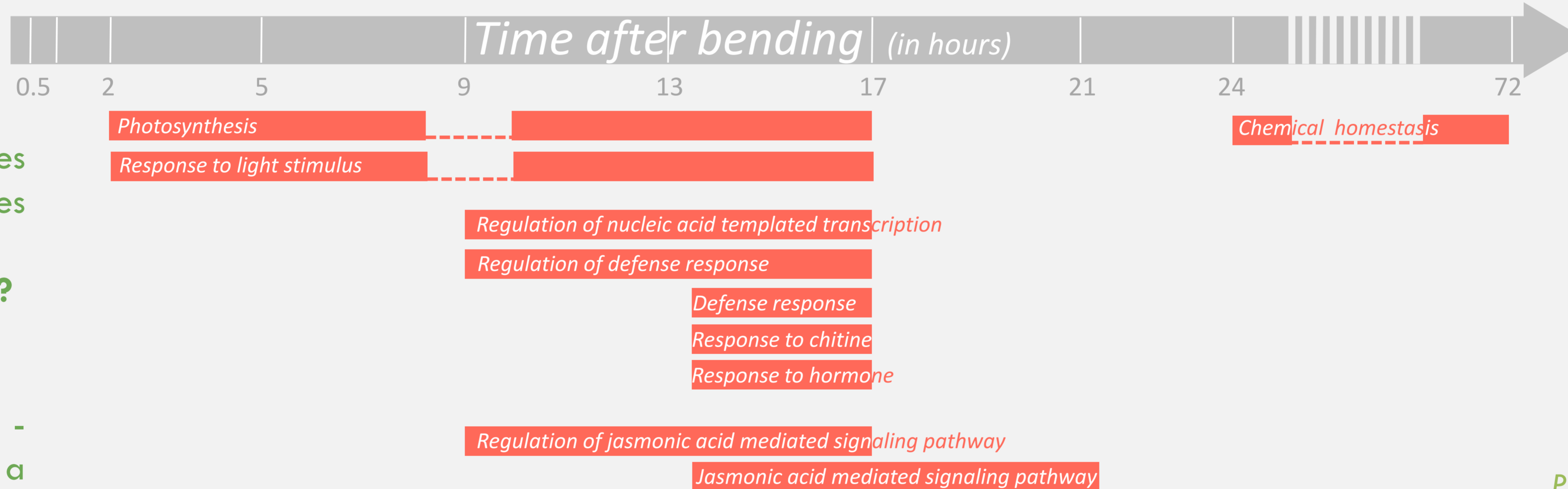
**BP annotation of clusters of down-regulated genes**

- Carbohydrate derivative metabolic process
- Cell wall organization or biogenesis

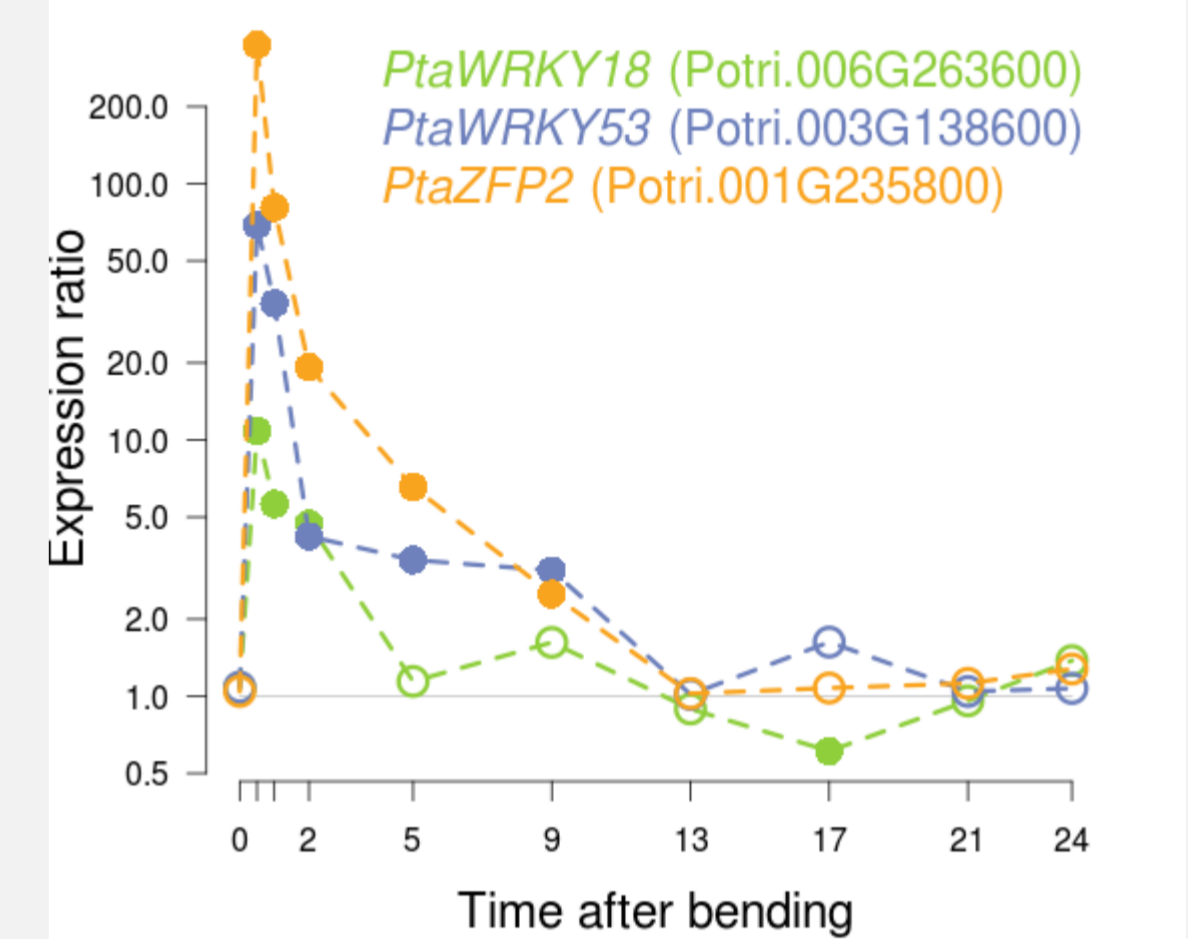
• **Early regulated genes** are related to “stress response”:  
- Transcription factors families (e.g. fig. A);  
- Jasmonic acid and ethylene signaling (e.g. fig. B).

• Some early up-regulated genes are down-regulated in later stages (see *PtaJAZ2* fig. B)  
→ **negative feedback mechanism?**

• **Late up-regulated genes** (21 h - 72 h), seem to be linked to a remodeling of cell wall-related processes.

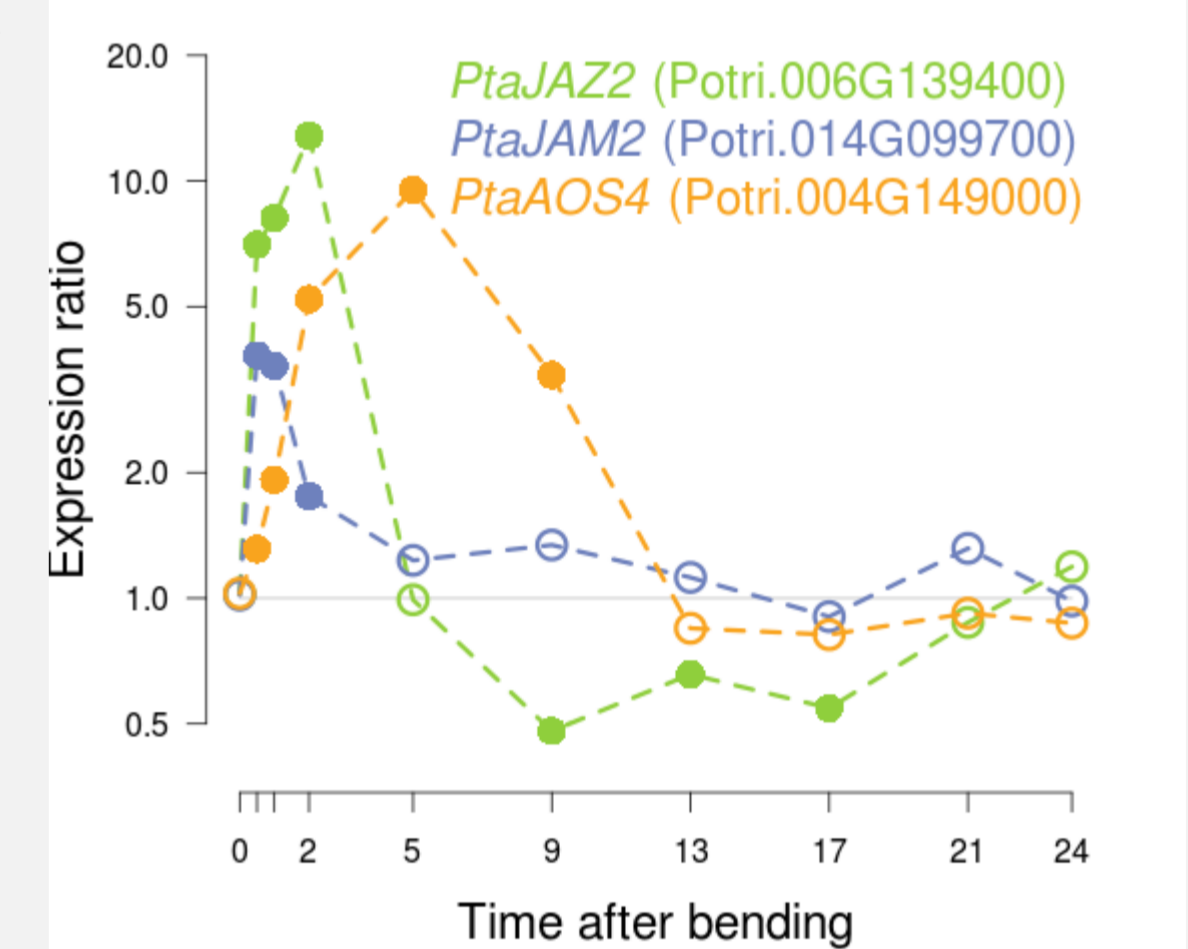


### A - Transcription Factor



*PtaWRKY18*, *PtaWRKY53*, *PtaZFP2* (**C2H2**): transcription factors

### B - Jasmonic Acid (JA)



*PtaJAZ2*, *PtaJAM2* JA-induced transcription factors, negative regulator of JA responses  
*PtaAOS4*, allene oxide synthase, JA biosynthetic pathway

## Toward a better understanding of the accommodation process

**3 types of genes:**

**Objectives:** to investigate the extent of the molecular accommodation and to identify potential molecular actors.

Gene expression 0.5 h after 1 bending

**vs.**

Gene expression 0.5 h after 2 bending (24 h interval)

**96% of the early regulated genes** after a 1<sup>st</sup> bending are **less regulated** after a 2<sup>nd</sup> bending

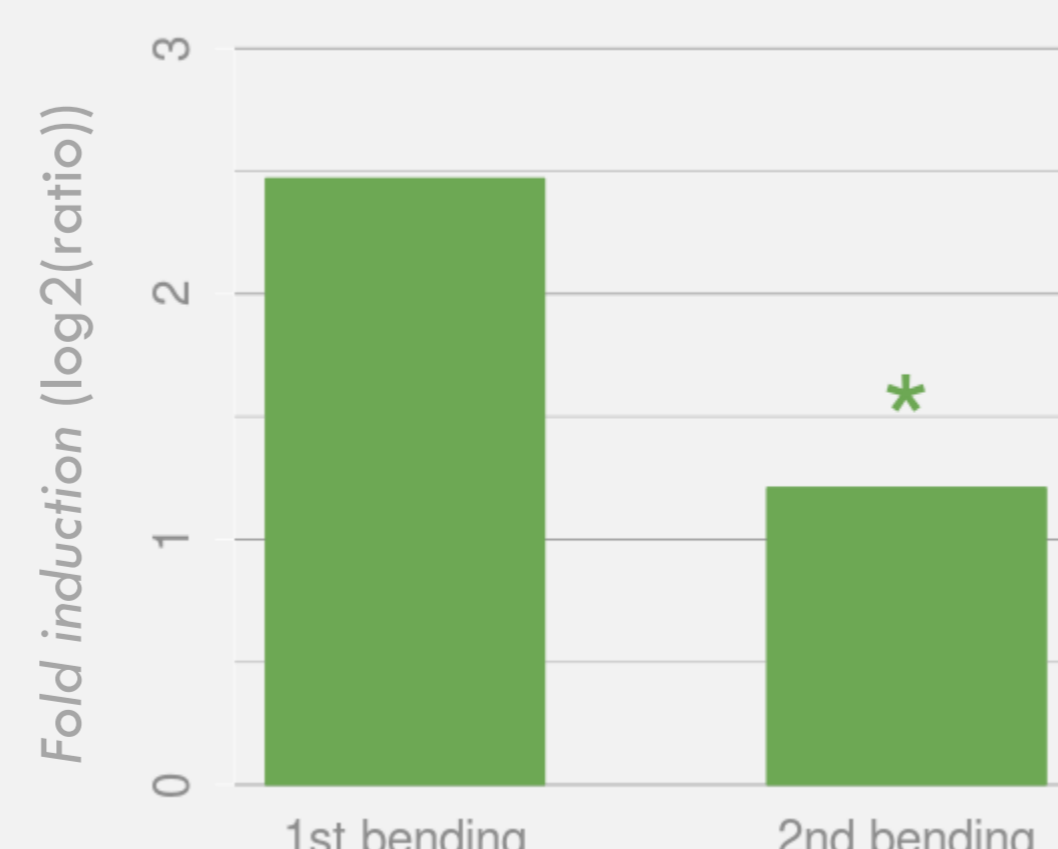
This mechanism may allow the plant to **avoid over-reaction** to successive bending.

#### Accommodated

Less regulated after the 2<sup>nd</sup> bending, than after the 1<sup>st</sup> one.

**1,098 genes**

Example : *PtaWRKY18* (Potri.006G63600)

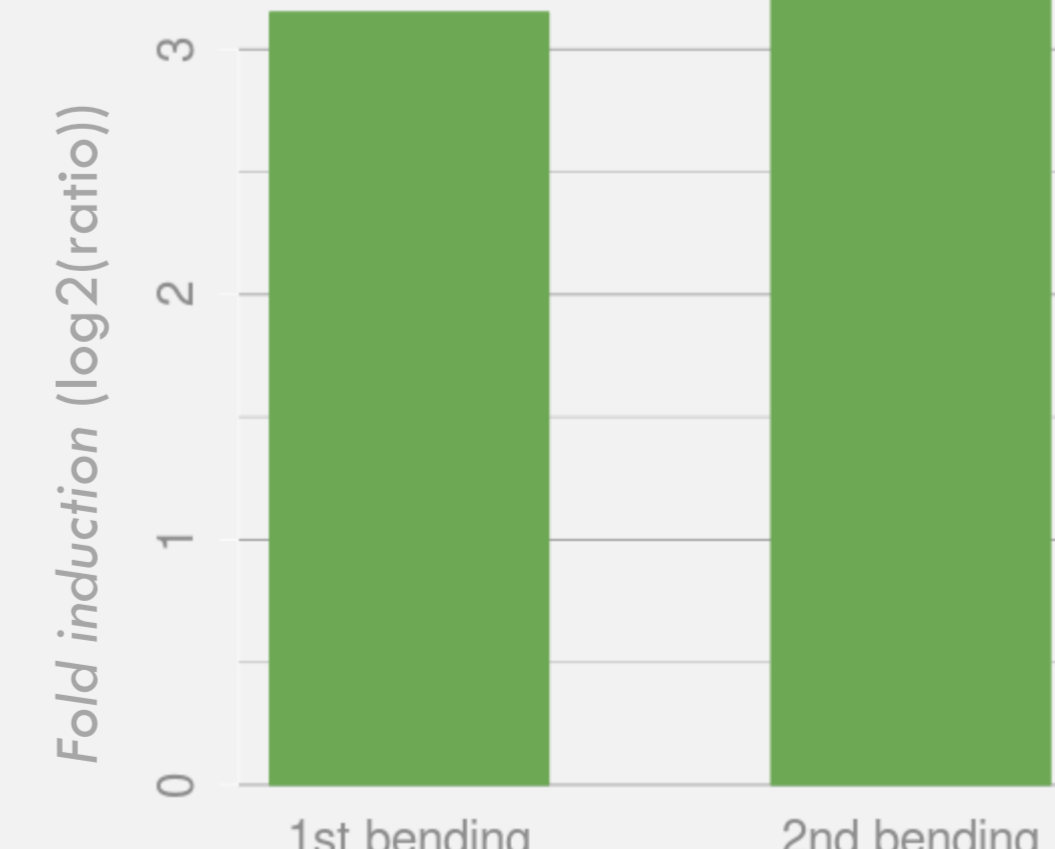


#### Non Accommodated

Equally regulated after the 2<sup>nd</sup> bending, than after the 1<sup>st</sup> one.

**44 genes**

Example : *PtaHRD* (Potri.006G021000)

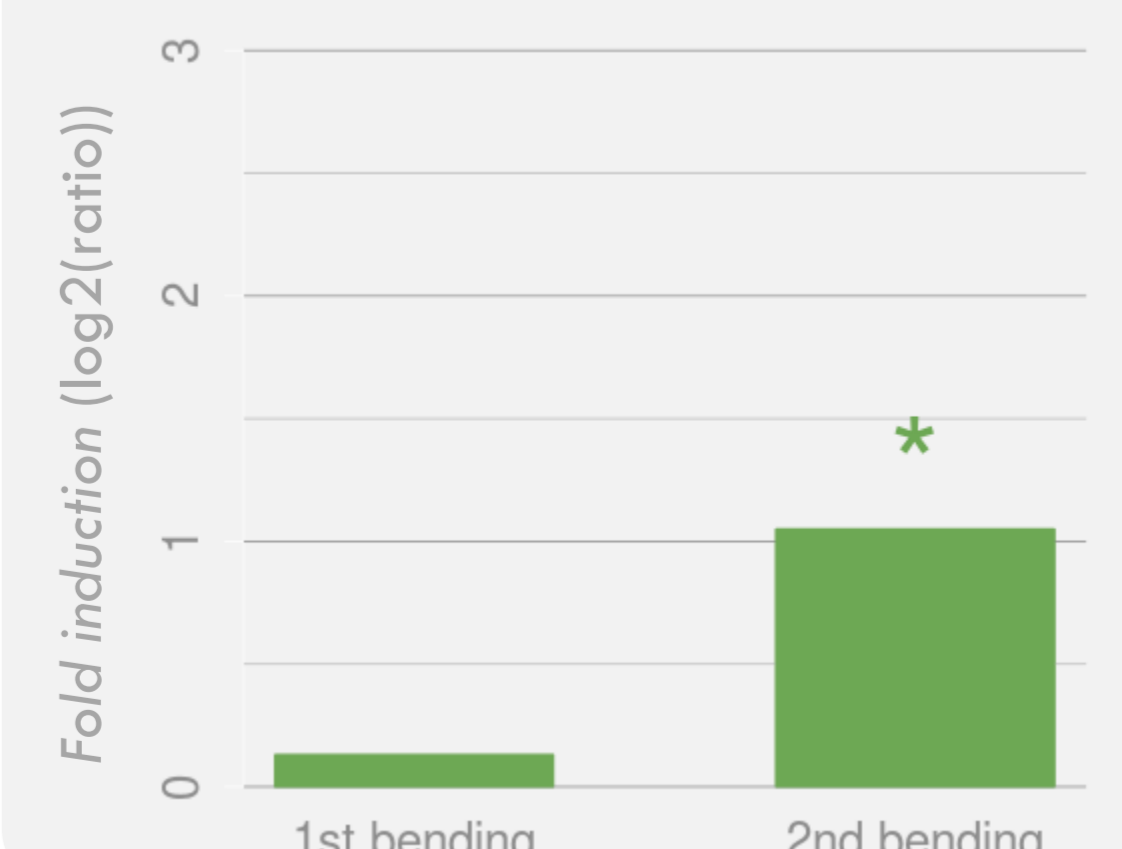


#### Newly Regulated

Regulated after the 2<sup>nd</sup> bending only.

**18 genes**

Example : *PtaPEROX* (Potri.007G096200)



**Perspectives :** We are currently working on new methods of gene network inference to understand the fine regulation of this mechanical signaling pathway.

[1] C. Coutand, L. Martin, N. Leblanc-Fournier, M. Decourteix, J.-L. Julien, and B. Moulià. 2009. "Strain mechanosensing quantitatively controls diameter growth and *PtaZFP2* gene expression in poplar". *Plant Physiol.* 151(1): 223–32

[2] L. Martin, N. Leblanc-Fournier, J.-L. Julien, B. Moulià, and C. Coutand. 2010. "Acclimation kinetics of physiological and molecular responses of plants to multiple mechanical loadings." *J. Exp. Bot.* 61(9): 2403–12

[3] N. Leblanc-Fournier, L. Martin, C. Lenne, and M. Decourteix. 2014. "To respond or not to respond, the recurring question in plant mechanosensitivity." *Front. Plant Sci.*, 5: 401

[4] R. J. Haarsma, W. Hazeleger, C. Severijns, H. de Vries, A. Sterl, R. Bintanja, G. J. van Oldenborgh, and H. W. van den Brink. 2013. "More hurricanes to hit western Europe due to global warming". *Geophys. Res. Lett.*, 40(9): 1783–1788