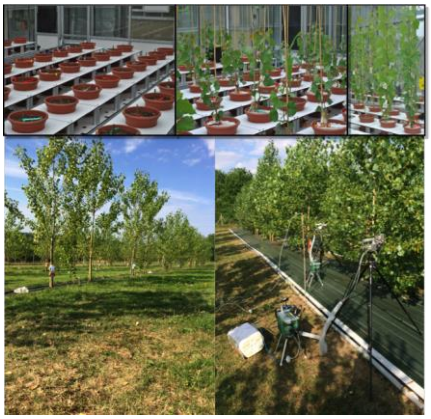
UPTRANS



UPscaling of anatomical, physiological and molecular determinisms of TRANSpiration at wood and leaf levels in poplar trees submitted to water stress

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Collaboration: PTEF, Xylosciences, PIAF (Clermont-Ferrant)

Context — The most widely used broadleaved species for plantation in Europe belong to the genus *Populus and Salix*. As a consequence of their high productivity, these plantations use large amounts of water. However, the on-going climate change is predicted to result in a higher frequency of dry and warm summers (IPCC, 2007, 2013, scenario RCP8.5) even for temperate regions, comparable to those observed in 2003 and 2005. This kind of events increases the risk of water supply shortage for tree plantations as well as for natural populations, with an increased risk of wood production reduction, or even a reduction in land-area suitable to grow poplar. Therefore the optimization of water use for the production of biomass is an important research aim in poplar. Irrigation of such plantations is not a relevant alternative from economic and environmental points of view. Appropriate answers to these climatic risks might be found in the selection of genotypes able either to find larger amounts of water from the soil, or to use the transpired water more efficiently, i.e. increasing the biomass production per unit of transpired water.

Objectives — The principal objective of the UP-TRANS project is to evaluate the relative importance of adaptive mechanisms of water transport in response to drought that are essential for maintaining or increasing the transpiration efficiency at different scales of space and time

Approach — To track down the adaptive mechanisms, two poplar genotypes (selected on their biomass productivity regarding their drought response) will be grown in controlled conditions (greenhouses) for numerous analyses and then a confirmation in semi-controlled conditions (field drought in nursery) (tasks 1 and 2). Following this step, the validation under natural conditions will be performed with several genotypes installed for short rotation coppice purposes (task 3) and for mature plantations goals to test whether processes studies in tasks1 & 2 are still relevant on adult trees (task 4).

Key results —

- In 2016, we performed one drought experiment in greenhouse with robot for irrigation. All samples were collected and we analysed growth, transpiration efficiency, hydraulic conductance, gas exchanges.
- In 2016, we installed in nursery a precipitation exclusion structure and performed gas exchange and groth measurement.

- In 2017, we performed one drought experiment in nursery with a rain exclusion system. All samples were collected and we analysed growth, transpiration efficiency with sap flow sensors, and leaf gas exchanges.
- In 2018, we submitted a first article to The New Phytologist on the first experience in the greenhouse: it is accepted after corrections. We are waiting for the definitive answer. A second article is being written, he is focused on the expression of genes in stomata. It should be submitted mid-December 2018.
- In the spring of 2018, we sampled wood samples from the Echigey site; this site is a clonal test in TCR and TTCR.

Main conclusions including key points of discussion —

Since first results, stomatal conductance is the key factor controllind water use efficiency. We found significant genotypic variability of stomatal conductance dynamics to both irradiance and VPD. Genotypes with faster stomatal dynamics were correlated with higher stomatal density and smaller stomata.

Drought slowed g_s dynamics, especially during stomatal closing. This is contrary to previous research on more drought-tolerant species. Independently of the treatment, faster stomatal dynamics were negatively correlated with daily whole plant transpiration, presenting new evidence of a previously hypothesized contribution of stomatal dynamics to whole plant water use.

Analyzes on wood anatomy show genotypic differences with changes in response to the drought but without affecting the hydraulic conductance. In the nursery, we confirm the key role of stomatal functioning, analysis on wood anatomy are still outstanding achievement.

Future perspective — Further ecophysiological and anatomical analyzes. Writing of two other articles as part of Maxime Durand's thesis.

Valorisation —

Publications

Durand M, Brendel O, Le Thiec D. 2015. Upscaling morphological, physiological and molecular determinisms of transpiration from the leaf level to water use at the whole plant level in poplar trees. PEPG workshop, Lisbon, Portugal, 12th September 2015. Poster

Durand M, Brendel O, Le Thiec D. 2016. Upscaling morphological, physiological and molecular determinisms of transpiration from the leaf level to water use at the whole plant level in poplar trees. EEF Doctorants and Post-Doctorants annual meeting, Nancy, France, 05th July 2016. Présentation orale

Durand M, Brendel O, Le Thiec D. 2017. Upscaling morphological, physiological and molecular determinisms of transpiration from the leaf level to water use at the whole plant level in poplar trees. EEF Doctorants and Post-Doctorants annual meeting, Nancy, France, 25th June 2017. Présentation orale

Durand M, Brendel O, Le Thiec D. 2017. Upscaling morphological, physiological and molecular determinisms of transpiration from the leaf level to water use at the whole plant level in poplar trees. IUFRO side event on WUE, Nancy, France, 18th September 2017

Le Thiec D, Durand M. 2017. UPscaling of anatomical, physiological and molecular determinisms of TRANSpiration at wood and leaf levels in poplar trees submitted to water stress. Colloque annuel Labex ARBRE. 13 décembre 2017. Présentation orale invitée.

Durand M, Brendel O, Buré C, Le Thiec D. 2018. Contrasting dynamics of water use efficiency under drought on four poplar genotypes: leaf level causes and whole plant consequences" for an oral presentation. Seventh International poplar Symposium, New bioeconomies: exploring the potential role of Salicaceae. October 28 - November 4, Buenos Aires, Argentina. Présentation orale.

Durand M, Brendel O, Buré C, Le Thiec D. 2018. Altered stomatal dynamics induced by changes in irradiance and vapour-pressure deficit under drought: impacts on the whole plant transpiration efficiency of poplar genotypes. Soumis à New Phytologist.

Articles in preparation

Durand M, Aubry N, Cohen D, Hummel I, Brendel O, Le Thiec D. Contrasted stomatal conductance between leaf sides and time of day shape guard cell element content and gene expression in poplars genotypes.

Durand M, Buré C, Brendel O, Le Thiec D. Genotype differences in transpiration efficiency at leaf and whole-plant levels in four poplar genotypes, effect of drought.