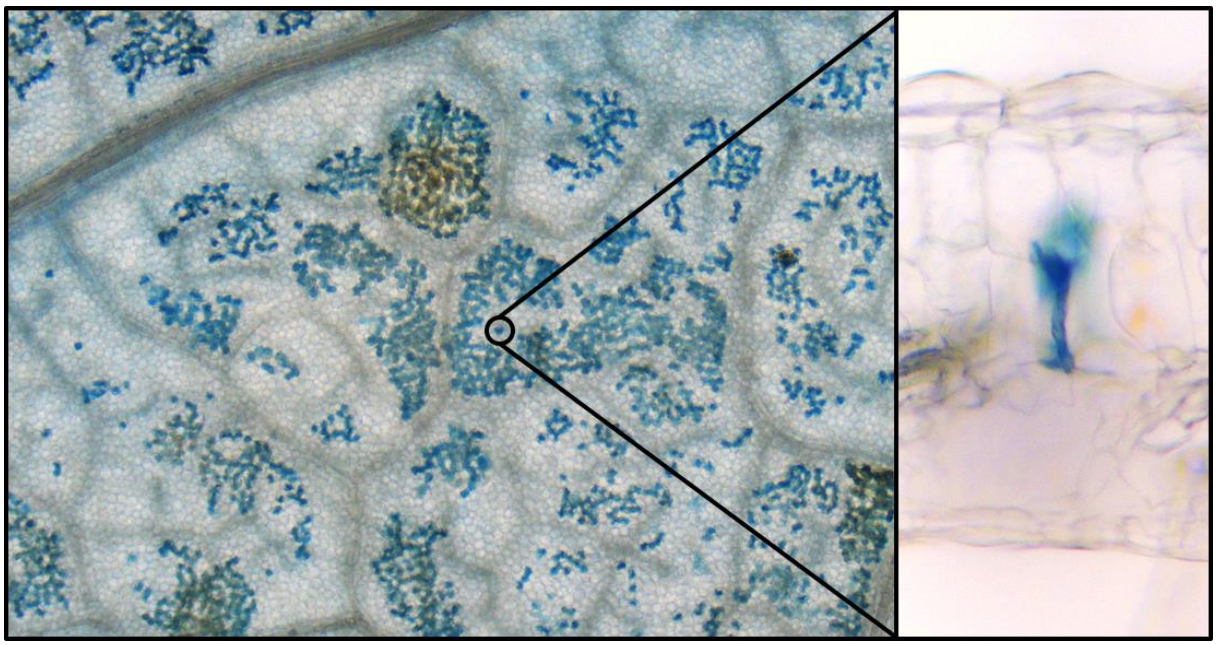
EFFECTO3-Flux



Impact of ozone and drought on carbon allocation in poplar: consequences for growth and biomass production

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Context —To develop viable alternatives regarding the use of fossil fuels, there is a growing interest for fast-growing tree plantations with high biomass yields. For this purpose, poplar appears as a particularly relevant model species. Generally, selection programs of poplar genotypes are based on their productivity, but seldom on their responses to combined abiotic constraints. However, the changes in water availability and air quality (ozone pollution) with accelerating global changes will increasingly affect the foreseen tree plantation in the future. Indeed, these abiotic constraints can significantly decrease the plant growth and productivity (Wittig *et al.* 2009, Bréda *et al.* 2006). At leaf level, they reduce photosynthesis and restrict carbon allocation to growth and biomass production as a consequence of increased allocation of assimilates to defense processes.

With a view to improved evaluation of economic losses by ozone stress, modern indicators for risk threshold are based on ozone fluxes into the assimilating leaves. Missing characterization of detoxification mechanisms however, these indicators still fail to adequately characterize the effective ozone dose which corresponds to the non-detoxified ozone molecules. Particularly, one of the main gaps of the ozone flux approach still concerns the sequential development of leaf injury upon ozone uptake up to visible damages, which is partly under the control of foliar detoxification processes.

Objectives — The main objective in this PhD is to provide an innovative mechanistic and integrative understanding regarding the dynamics of cellular processes leading to visible O_3 injury in foliage. The modifications in carbon allocation and biomass productivity will be studied as a consequence of symptom development. The interaction between oxidative constraints (ozone and drought) will also be investigated.

Main scientific questions to be addressed —

1. What are the links between the structural and histochemical modifications and the cellular metabolism during the development of the foliar symptoms in response to ozone?
2. How much carbon gets assigned to detoxification processes as a consequence of oxidative stress?
3. To what extent is plant growth affected by injury and detoxification processes at foliar level and in response to interactions between ozone and drought?

Approach — To answer these questions, the PhD student will use interdisciplinary approaches, applying various techniques in light and electron microscopy, RNAseq analysis, metabolite determination, leaf physiology and isotope labelling.

Key results —

- After a few days latency and below critical threshold, hypersensitive response-like (HR-like) lesions developed, first exponentially, before more or less stabilizing. Relative to chlorophyll degradation, the accelerated cell senescence (ACS) occurred later than HR.
- Distinct responses to O_3 treatments were observed in poplar's foliage. Delayed responses and higher O_3 tolerance in younger leaves suggested higher detoxification capacity.
- In relation to biomass, the ozone treatment applied seems not to have affected the carbon allocation between the organs of the shoot.

Main conclusions including key points of discussion — This study thus confirms the complexity of response dynamic to O_3 stress and its close dependency on both ontological development and environmental conditions. Ongoing transcriptomic analyses should provide factual evidence to confirm the time lag between the onset of HR and ACS as well as the differences of detoxification capacity between leaves.

Future Perspectives — The results of this project will help to better establish the dynamics of lesion formation and antioxidant capacity at the foliar level. Subsequently, the evaluation of carbon in the cellular detoxification mechanism and the consequences on carbon fluxes to other organs are to be addressed by an isotope experiment (13C). How drought in combination with ozone pollution episodes can also modify the dynamics of the response remains to be investigated. These two components (allocation and combination of constraints) could not be carried out within the framework of this study, but it can be an opportunity of future investigations for the continuation of the relations between Silva Unit and WSL.

Valorization —

Oral communications

12th SFBV Congress 16-18 July 2019, Strasbourg (France).

"Air Pollution threats to Plant Ecosystems" , International conference, 4-8 May 2020, Paphos (Cyprus).