DETPOP

Detoxification responses of poplar under oxidative stress induced by drought or ozone: focus on the role of glutathione metabolism

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Context — Many forest trees are already affected by first events of climate changes, causing major forest losses worldwide. Future issues in forestry industry will concern tree capacity to survive and acclimate to a changing environment. This emphasizes the economic necessity of working on mechanisms underlying tree response to drought and ozone, two major future threats. More research, particularly on cell detoxification parameters, is thus needed in order to better understand the mechanisms involved in tree detoxification processes.

Objectives — The main objective of this project is to investigate the role of glutathione metabolism for detoxification processes in trees submitted to drought or chronic ozone, using two poplar genotypes differing in their oxidative stress sensitivity as tools. This will help us to decipher the poplar response to abiotic stresses, particularly in establishing the specific key elements of detoxification network involved in each stress, and highlighting the putative common mechanisms.

Approach — We plan two experiments to compare the response of these genotypes to drought and ozone, respectively. Our study will focus at both the stomata and whole leaf levels by developing the subsequent tasks: i) analysis of the specificity of each stress on cell; ii) study of the regulation of enzymes implicated in

glutathione metabolism at gene and protein levels and iii) identifying new actors relative to glutathione metabolism.

Key results —

- **Metabolite pools** (17 days). Differences between the two genotypes:
- For Robusta we noted a higher level of oxidized ascorbate under O_3 and drought stresses. The effect is also significative for the level of oxidized glutathione under drought.
- For Carpaccio, the glutathione content increased under O_3 and the combined stresses ($D+O_3$).
- **Gene expression** (17 days) for cytosolic GR: For Carpaccio, higher transcript levels under O_3 was observed. This stimulation had been noted in Robusta after 2 days but it was not maintained after 17 days.
- **Enzymes of the Halliwell-Asada-Foyer cycle**: Based on enzyme activities, the two genotypes displayed a quite similar response. O_3 tended to stimulate MDHAR, implied in ASA regeneration, while the activity of DHAR was inhibited. Concerning glutathione regeneration, the GR activity was stimulated under O_3. Drought alone did not modify the activity of the 3 enzymes and the combined stresses ($D+O_3$) often implied an attenuated effect compared to O_3 alone.

Main conclusions including key points of discussion — This work highlights differences in poplar genotypes responses based on detoxification processes. Thus, under O_3, the more tolerant genotype (Carpaccio) displayed higher amount of glutathione, a stimulation of GR activity which could be associated to a higher expression of a gene coding for a cytosolic isoform. The response to drought differed from the response to O_3 and the combination of the two constraints did not imply a synergistic effect, the effect of O3 being globally attenuated.

Future perspectives — Data acquired on drought and ozone stress separately represent a good basis for understanding responses to a single stress before integrating them in a more complex situation, i.e. the combination of multiple abiotic stresses. These data will help to improve detoxification parameters, and are notably needed to improve the indices for ozone risk assessment on plants currently used at the European level.

Valorisation —

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