Effect of ozone on respiratory and photorespiratory parameters in relation to the developmental stages of poplar leaves

Mathieu Bagard, Didier Le Thiec, Marie-Paule Hasenfratz-Sauder, Jacques Banvoy, Joelle Gérard, Pierre P. Dizengremel, Yves Y. Jolivet

▶ **To cite this version:**

Mathieu Bagard, Didier Le Thiec, Marie-Paule Hasenfratz-Sauder, Jacques Banvoy, Joelle Gérard, et al.. Effect of ozone on respiratory and photorespiratory parameters in relation to the developmental stages of poplar leaves. XVI Congress of the Federation of European Societies of Plant Biology, Aug 2008, Tampere, Finland. n.p. hal-02821364

HAL Id: hal-02821364
https://hal.inrae.fr/hal-02821364

Submitted on 6 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Effect of ozone on respiratory and photorespiratory parameters in relation to the developmental stages of poplar leaves

Bagard M., Le Thiec D., Delacote E., Hasenfratz-Sauder M.P., Banvoy J., Gérard J., Dizengremel P. & Jolivet Y.

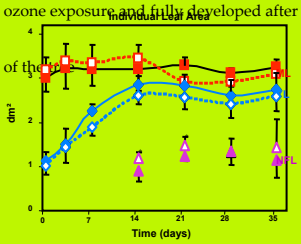
UMR 1137 INRA / UHP Nancy 1 – Ecologie et Ecophysiologie Forestières

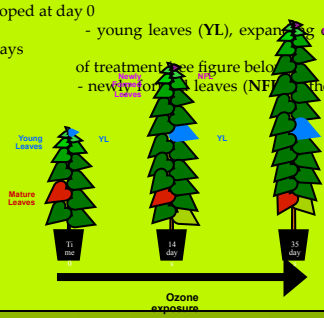
Introduction

Tropospheric ozone (O_3) is now considered as the major air pollutant affecting vegetation, causing reduction in photosynthesis, growth and yield. To unravel the effect of ozone on catabolism, we studied respiratory and photorespiratory parameters in leaves of young poplar trees submitted to 120 ppb O_3. Clearly, the results showed that the responses differed according to the developmental stages of the leaves.

Plant material and experimental conditions

- Micropropagated six-month-old poplar trees (*Populus tremula* L. x *alba* L., INRA 717-1-B4 clone) grown in controlled conditions in 8 fumigation chambers with charcoal-filtered air (control, *n*=48) or with charcoal-filtered air + 100 to 120 ppb of ozone 13 h daily during 35 days (*n*=48).
- Leaf stages: - mature leaves (**ML**), fully developed at day 0
- young leaves (**YL**), expanding during ozone exposure and fully developed after 14 days of treatment (see figure below)
- newly formed leaves (**NFL**) at the apex of the tree



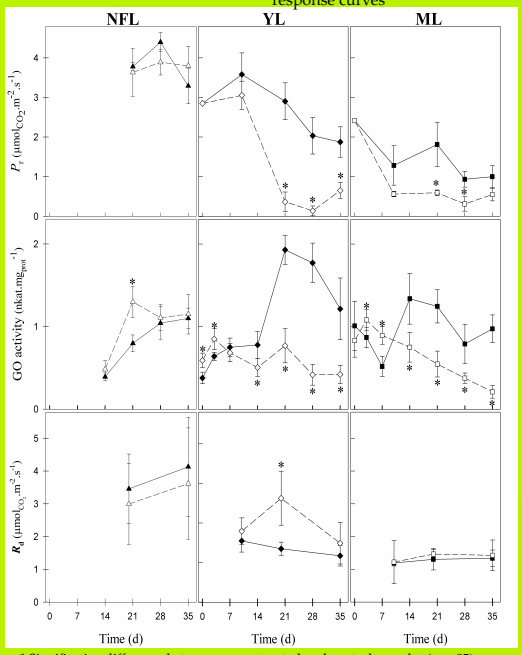


control: filled symbols ozone: open symbols

Results

Photorespiratory and respiratory rates

- *In vivo* determination of photorespiratory (*Pr*) rate was obtained from gas exchange and chlorophyll fluorescence measurements
- Glycolate oxidase activity was determined by monitoring the gloxylate phenylhydrazone complex formation at 324 nm
- day mitochondrial respiration (*Rd*) was calculated from A/Ci response curves



* Significative difference between ozone-treated and control samples ($p < .05$)

►Ozone treatment involved a reduced rate of photorespiration (*Pr*) in fully expanded leaves (ML and YL after 14 days)

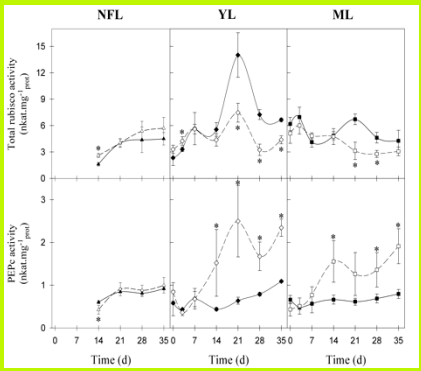
►The activity of the photorespiratory enzyme glycolate oxidase (GO) was also highly reduced by ozone from 14 days of fumigation in both fully expanded leaves (ML and YL after 14 days)

►In response to ozone, a stimulation of the mitochondrial respiration occurred transitorily in YL at 20 days of ozone exposure

control: filled symbols ozone: open symbols

Carboxylase activities

- *In vitro* determination of rubisco and PEPc activities was determined by spectrophotometric assays



* Significative difference between ozone-treated and control samples ($p < .05$)

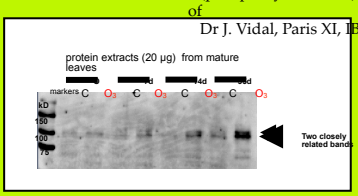
►In ML and YL, total rubisco activity was hugely inhibited (by up to 40%) from 14 days of ozone exposure

►On the opposite, in response to ozone fumigation, PEPc activity was stimulated 2- to 3-fold in ML and YL. This stimulation occurred as soon as the second week of fumigation

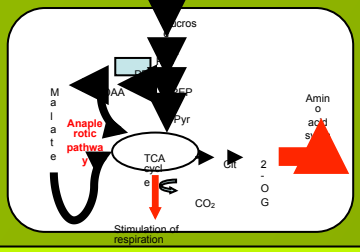
control: filled symbols ozone: open symbols

PEPc amount

- Western blot was performed with anti-N-terminal (phosphorylation site) peptide antibodies (gift of Dr J. Vidal, Paris XI, IBP, Orsay)



►In ML, two PEPc isoforms (≈ 110 kD) were detected. In response to ozone, the amount of the isoforms increased



Conclusion

As a consequence to chronic ozone, photorespiration was inhibited in fully expanded leaves (ML and YL after 14 days). This inhibition could be partly explained by an effect of ozone on biochemical parameters (lower glycolate oxidase and rubisco activities).

On the contrary, the PEPc activity and its amount were increased in these leaves but this did not inevitably occurred with the stimulation of the mitochondrial respiration. It is suggested that the replenishment of the TCA cycle by PEPc functioning could be also useful for amino acid synthesis.

Expanding leaves appeared resistant to ozone fumigation.

Prospects → Roles and regulation (translational and post-translational) of PEPc in leaves in response to ozone