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Nutrient fertilization mitigates the effects of ozone exposure on poplar plants

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During the last century, concentrations of tropospheric ozone (O_3) have risen substantially on a global scale as a result of increasing anthropogenic emissions. Nutrient availability in the soil, especially nitrogen (N) and phosphorus (P), is considered as a pivotal modifier of plant response to O_3. In this work, the interactions of three levels of O_3 (1.0, 1.5 and 2.0 times the ambient O_3 concentration; AA, 1.5 × AA and 2.0 × AA) and six combinations of nutrient treatment [two levels of N (0 and 80 kg N ha^{-1}; N0 and N80) and three P concentrations (0, 40 and 80 kg P ha^{-1}; P0, P40 and P80)] on biochemical traits were investigated in an O_3 sensitive poplar clone (rooted cuttings of *Populus maximoviczii* Henry x *P. berolinensis* Dippel) in an O_3 free air controlled exposure facility (FACE). Plants exposed to increasing O_3 concentrations (alone and in combination with N/P fertilization) developed visible stipples of browning tissue localized in the interveinal adaxial leaf area. This macroscopic effect was twinned with the alteration of membrane integrity and the impairment of PSII photochemistry: plants exposed to 2.0 × AA displayed 2-fold higher values of malondialdehyde and total carotenoids/chlorophylls ratio than plants exposed to AA. N fertilization had some “mitigating effects” against O_3-induced oxidative burst by activating different detoxification mechanisms, i.e. accumulation of proline (+12, +67 and +18% in comparison to AA, 1.5 × AA and 2.0 × AA) and reduced ascorbate (+10, +5 and +8%, respectively). P fertilization partially balanced the reactive oxygen species production as confirmed by the significant decrease of the hydrogen peroxide content, but did not prevent foliar damage. Nutrient fertilization induced qualitative change of the carbohydrate pool suggesting a possible effect on the photosynthetic process and allocation of resources.

Keywords: climate change, oxidative stress, nutrients availability, membrane integrity, reactive oxygen species, proline, carbohydrates, non-enzymatic antioxidants

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