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Authors: Eva Pšidová, Marek Živčák, Sran Stojnić, Saša Orlović, Dušan Gömöry, Jana Kučerová, Ľubica Ditmarová, Katarína Střelcová, Marián Brestič, Hazem M. Kalaji

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Altitude of origin influences the responses of PSII photochemistry on heat waves in European beech (*Fagus sylvatica* L.)

Eva Pšidová[a], Marek Živčák[b*], Srđan Stojnić[c], Saša Orlović[c], Dušan Gömöry[d], Jana Kučerová[a], Ľubica Ditmarová[a], Katarína Střelcová[d], Marián Brestič[b], Hazem M. Kalaji[e,**]

[a]*Institute of Forest Ecology,Slovak Academy of Science, Štúrova 2, 960 53 Zvolen, Slovak Republic; psidova@savzv.sk; majerova@savzv.sk; ditmarova@savzv.sk*
[b]*Department of Plant Physiology, Slovak University of Agriculture, Nitra, A. Hlinku 2, 94976 Nitra, Slovak Republic; marek.zivcak@uniag.sk; marian.brestic@uniag.sk*
[c]*University of Novi Sad, Institute of Lowland Forestry and Environment, Antona Čehova 13, 21000 Novi Sad, Serbia; srdjan.stojnic@uns.ac.rs; sasao@uns.ac.rs*
[d]*Faculty of Forestry, Technical University in Zvolen, T.G. Masaryka 24, 960 53 Zvolen, Slovak Republic; katarina.strelcova@tuzvo.sk*
[e]*Institute of Technology and Life Sciences (ITP), Falenty, Al. Hrabska 3, 05-090 Raszyn, Poland; hazem@kalaji.pl*

*Eva Pšidová and Marek Živčák equally contributed to this work
**corresponding author

Highlights:

- Combined effect of drought and heat on beech provenances was studied.
- Chlorophyll fluorescence kinetics were analysed.
- Distinct response of PSII was correlated with altitude.
- Provenances originating from higher altitudes possess enhanced phenotypic plasticity.

Abstract

The photosynthetic responses to the combined effect of drought and heat stress were studied in leaves of 17-years-old European beech (*Fagus sylvatica* L.) trees originating from five provenances in Central Europe differing by altitude (55-1250 m), and grown in the same experimental plot. The measurements were conducted at the beginning of heat waves, under two different conditions: during the dry period (middle of July) and after recovery in wetter period, in the beginning of August. The decreases of stomatal conductance (g_s) and net photosynthesis rate (A_{CO2}) during drought and heat wave stress were very similar in all provenances. However, we observed distinct response of PSII photochemistry on combined drought and high temperature stress, well associated with altitude of origin of the beech provenances. Measurements of pulse amplitude modulated (PAM) fluorescence identified maintenance of a high electron transport rate in beech provenances from high altitudes under drought and heat wave conditions, associated with some decrease of excitation pressure on PSII. This can be explained by enhanced capacity of alternative electron sinks to utilize the excess of electrons as a photoprotective mechanism. The analyses of fast chlorophyll fluorescence kinetics confirmed the differences in responses of PSII photochemistry between provenances originating from different altitudes. Compared with provenances at higher altitudes, we found more sensitive response (i.e. more limited electron transport at the PSII acceptor side and changes in the size of light harvesting complexes) to drought and heat stress, in those growing at low altitudes. Our results support the hypothesis that the provenances