Carbon assimilation in oak (*Quercus* spp.) populations under acute and chronic high-temperature stress

R. HORAK[*, ¥], M. ŽUPUNSKI[**, ¥, +], S. PAJEVIĆ[**], M. BORIŠEV[**], D. ARSENOV[**], N. NIKOLIĆ[**], S. ORLOVIĆ[***]

University of Novi Sad, Hungarian Language Teacher Training Faculty in Subotica, Serbia[*]

University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, Serbia[**]

University of Novi Sad, Institute of Lowland Forestry and Environment, Novi Sad, Serbia[***]

[¥]Authors contributed equally to this work

[+] Corresponding author:

Trg Dositeja Obradovica 2, University of Novi Sad, Serbia

+381214852650

milan.zupunski@dbe.uns.ac.rs

Table S1: Minimum, maximum and average temperatures (°C) in glasshouses I (Gh-I) and II (Gh-II) during the experimental period

Glasshouse	Date	Minimum	Maximum	Average
I	28th June 3rd July	25	28	27
	28th June	34	41	37.5
II	30th June	33	47	40
	2rd July	37	45	41

Table S2: Average temperature of leaves (T_l) in the glasshouses (°C)

Control group	Exp. group after two days of HT treatment	Exp. group after five days of HT treatment
27.49	42.30	45.95

Table S3. Linear correlation coefficients between investigated parameters of stressed plants (*p<0.05).

Variable	Correlations (korelacija.toplotni (B2:K11))Marked correlations are significant at p < .05000N=10 (Casewise deletion of missing data)											
	Means	Std.Dev.	A	E	WUE	gs	Ci	Chl a	Chl b	Chla a+b	Car	Proline
A	0.132754	0.701231	1.000000	0.461789	0.835021	0.894969	-0.773749	-0.816101	-0.791403	-0.807700	-0.753477	0.983538
E	0.089827	0.541518	0.461789	1.000000	-0.095750	0.802425	0.199957	-0.813496	-0.811834	-0.813338	-0.833794	0.574498
WUE	0.142367	0.590684	0.835021	-0.095750	1.000000	0.516583	-0.994415	-0.386844	-0.356242	-0.376164	-0.298912	0.736829
gs	0.191463	0.589006	0.894969	0.802425	0.516583	1.000000	-0.423425	-0.921834	-0.900965	-0.914917	-0.885199	0.930076
Ci	-0.120391	0.578616	-0.773749	0.199957	-0.994415	-0.423425	1.000000	0.297602	0.267996	0.287224	0.209341	-0.666098
Chl a	0.175945	0.736927	-0.816101	-0.813496	-0.386844	-0.921834	0.297602	1.000000	0.998655	0.999839	0.994645	-0.905584
Chl b	0.214407	0.699923	-0.791403	-0.811834	-0.356242	-0.900965	0.267996	0.998655	1.000000	0.999424	0.998152	-0.888068
Chl a+b	0.189966	0.724961	-0.807700	-0.813338	-0.376164	-0.914917	0.287224	0.999839	0.999424	1.000000	0.996174	-0.899716
Car	0.227575	0.682244	-0.753477	-0.833794	-0.298912	-0.885199	0.209341	0.994645	0.998152	0.996174	1.000000	-0.858788
Proline	0.019981	0.770283	0.983538	0.574498	0.736829	0.930076	-0.666098	-0.905584	-0.888068	-0.899716	-0.858788	1.000000

Analyzes have been done on data collected from 5 days exposure of oak plants to elevated temperature.

Table S4. Fluorescence parameters Fv/Fm and F0 in oak plant`s exposed to acute and chronic HT stress. Significance codes: ‘ ’ 0; ‘***’ 0.001; ‘**’ 0.01; ‘*’ 0.05; ‘·’ 0.1. F_v/F_m - maximal quantum yield of PSII photochemistry*; F_0* - minimal fluorescence yield of the dark adapted state. Fixed effects estimates for applied stresses and *Q. robur* plants are presented as a deviations from the Control group and *Q. cerris*, respectively.

Fixed effects	**F_v/F_m**		**F_0**	
	Estimate	Std. Error	Estimate	Std. Error
Control group	0.79126	0.01346	289.48	12.31
Stress acute	-0.02751	0.01648	35.25	15.08
Stress chronic	-0.00550	0.01648	59.53	15.08
Q. robur	0.00298	0.01346	33.93	12.31
Random effects	Variance	Std. Dev.	Variance	Std. Dev.
Stress:Provenience	0.000	0.000	332.2	18.35
Treatment:Provenience	0.000	0.000	0.000	0.000
Stress:Species	0.000	0.000	0.000	0.000
Residual	0.004892	0.06994	1093.1	33.06
Tukey HSD post-hoc test				
Species level:	P *value*	Sign. difference	P *value*	Sign. difference
Q. cerris	0.824	a	0.00585^{**}	b
Q. robur		a		a
Stress level:				
Stress acute-Control	0.217	a	$0.050628^{\cdot}$	ab
Stress chronic-Control	0.940	a	0.000226^{***}	a
Stress chronic-Acute	0.376	a	0.241241	b

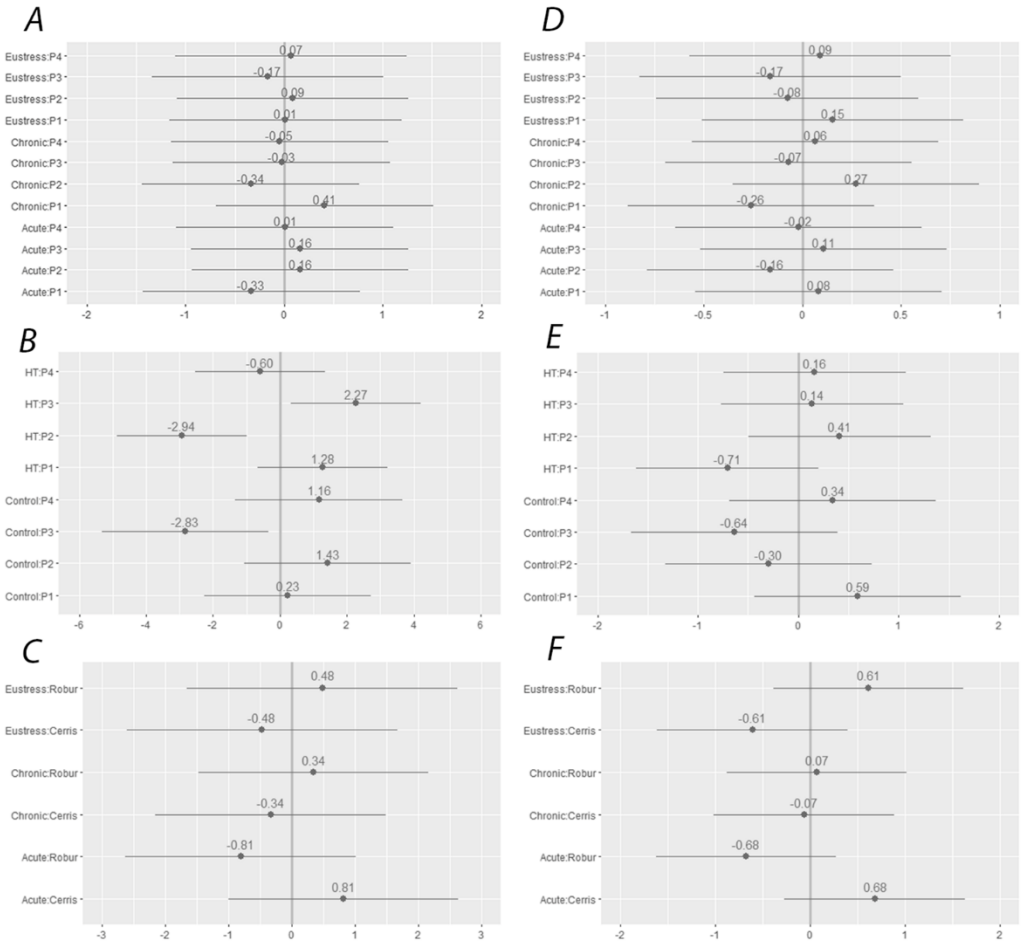

Fig. S1 Random effects coefficient estimates for P_N (*A*, B and *C*) and E (*D*, E and *F*). P1 and P2 – *Q. robur* populations; P3 and P4 – *Q. cerris* populations. Eustress presents the control group of oak plant`s.

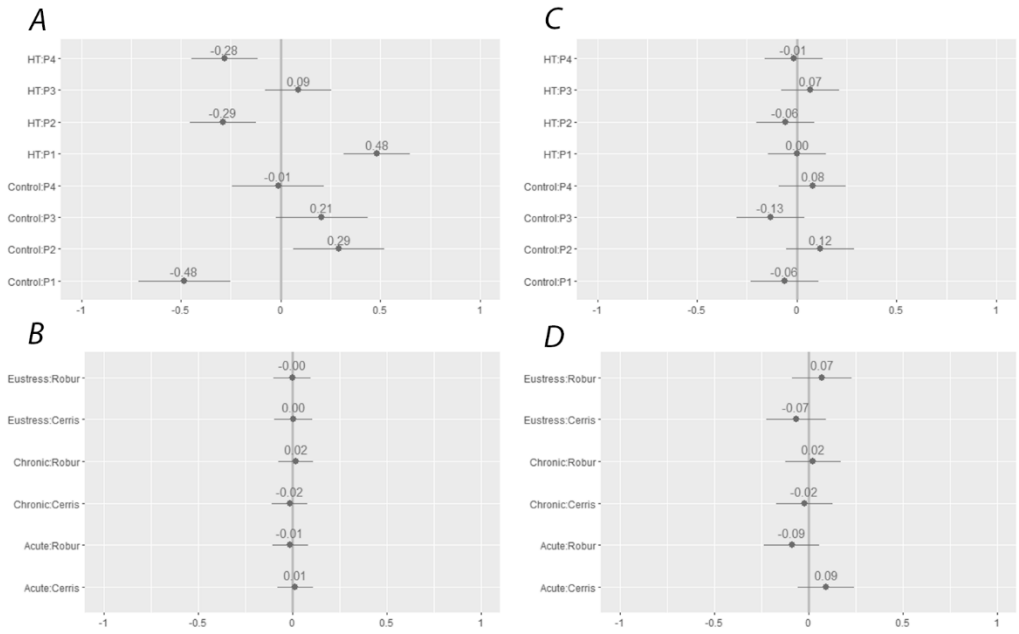

Fig. S2 Random effects coefficient estimates for WUE (*A* and *B*) and g_s (*C* and *D*). P1 and P2 – *Q. robur* populations; P3 and P4 – *Q. cerris* populations. Eustress presents the control group of oak plant`s.

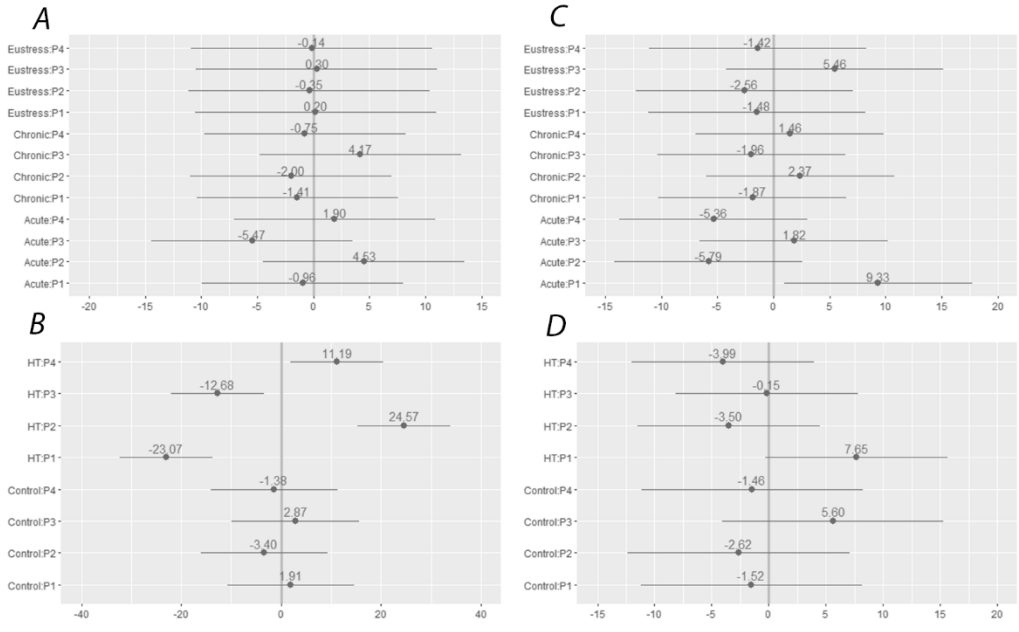

Fig. S3 Random effects coefficient estimates for WUEi (A and B) and Ci (C and D). P1 and P2 – *Q. robur* populations; P3 and P4 – *Q. cerris* populations. Eustress presents the control group of oak plant`s.

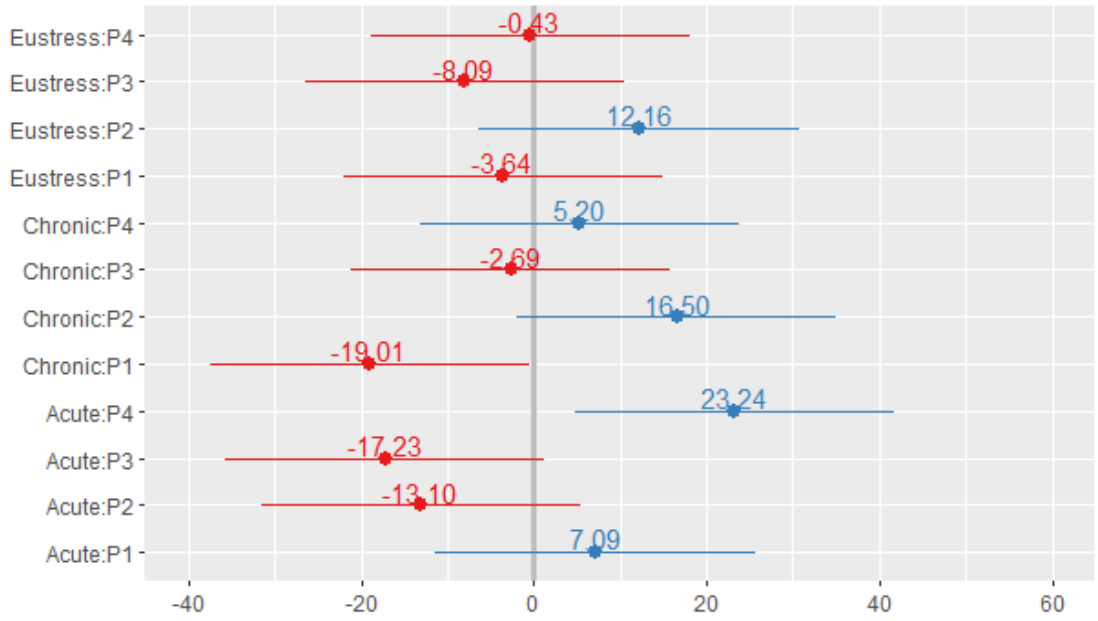

Fig. S4. Random effects estimates of F_0 fluorescence parameter. P1 and P2 – *Q. robur* populations; P3 and P4 – *Q. cerris* populations. Eustress presents the control group of oak plant`s.

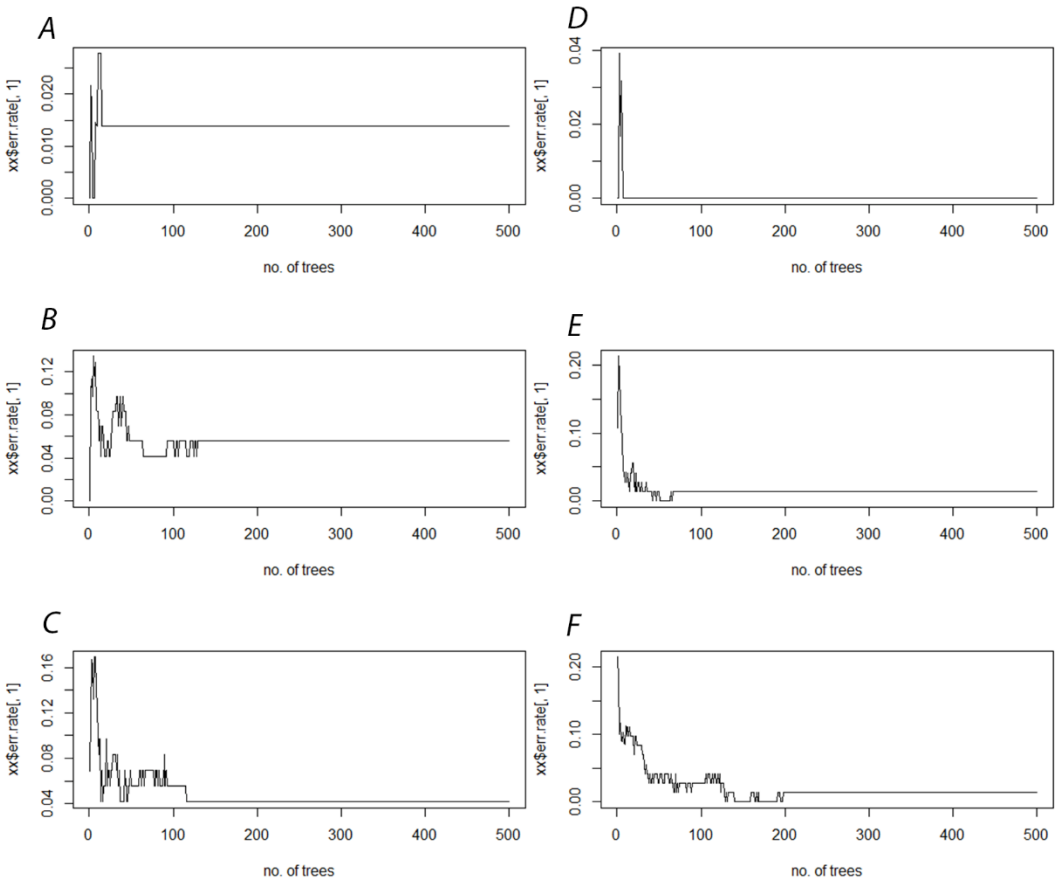

Fig. S5 OutOfBag Error plots calculated for each varied factor in datasets. Results are presented in six graphs, for acute (plots *A*, *B* and *C*) and chronic (plots *D*, *E* and *F*) day dataset analysis. OutOfBag errors were calculated by varying the factor in analysis, like treatment (graphs *A* and *D*), provenience (graphs *B* and *E*) or species (graphs *C* and *F*).

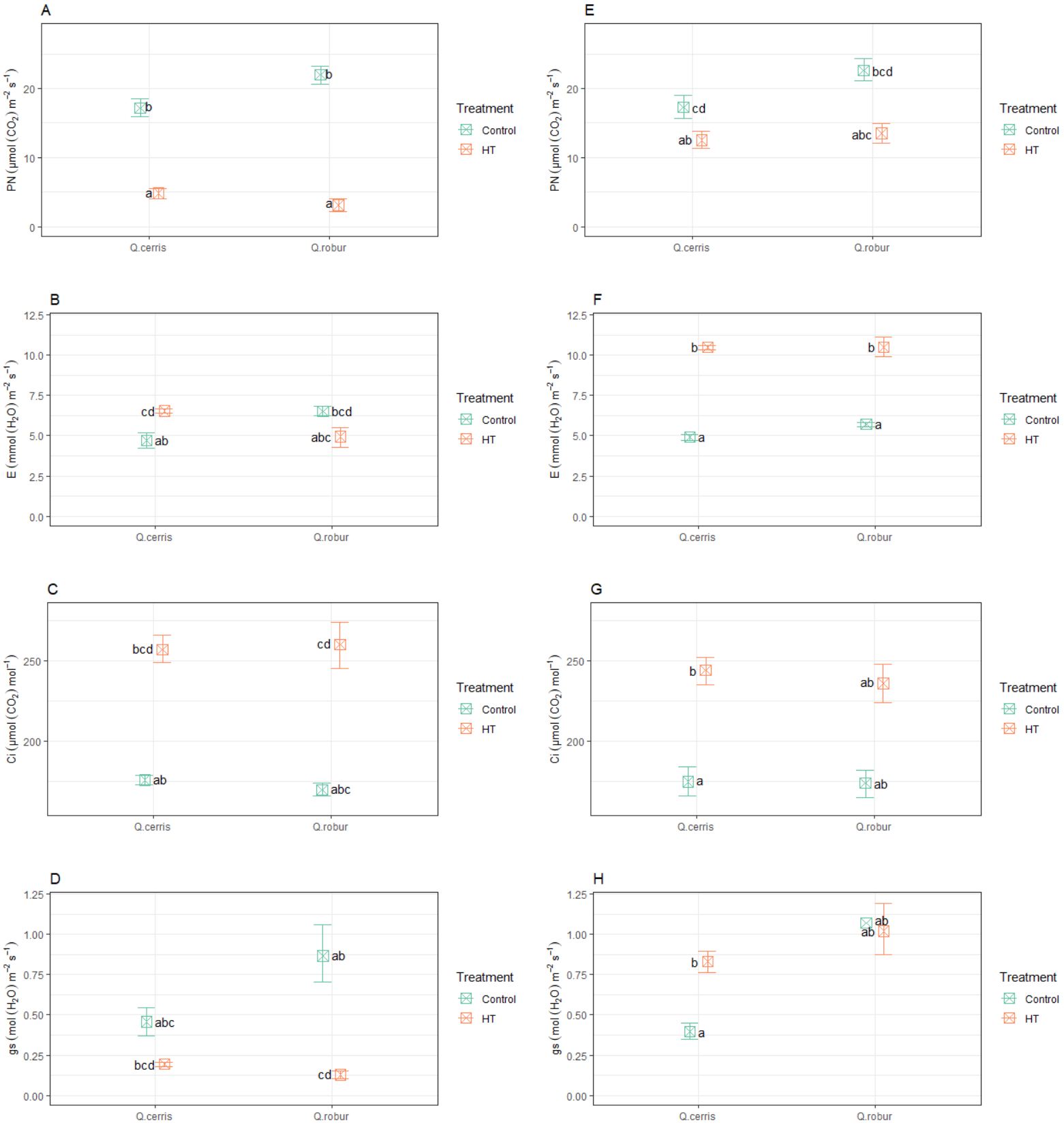

Fig. S6 Gas-exchange parameters of *Q. cerris* and *Q. robur* plants under acute (*A*, B, *C*, *D*) and chronic (E, *F*, G, *H*) exposure to HT treatment. The data is presented with mean value ± the upper and lower percentile for the confidence interval $p < 0.05$ ($n = 9$). Accompanying letters indicate statistically significant difference according to the Tukey HSD test. *C*i - intercellular CO_2 concentration; *E* – transpiration rate; g_s - stomatal air conductance; P_N – net photosynthesis.

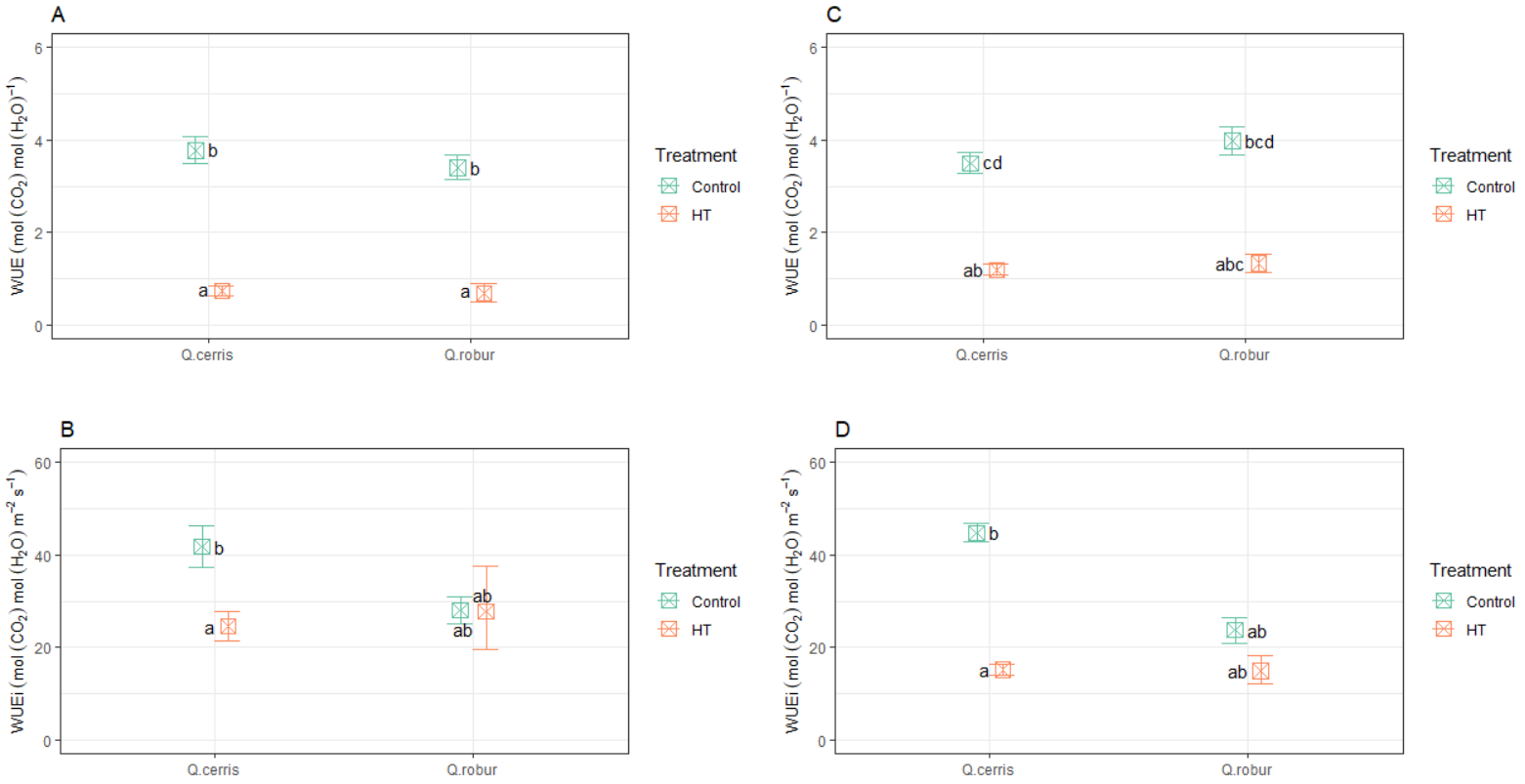

Fig. S7 WUE and WUE_i parameters of *Q. cerris* and *Q. robur* plants under acute (A, B) and chronic (C, D) exposure to HT treatment. The data is presented with mean value ± the upper and lower percentile for the confidence interval $p < 0.05$ ($n = 9$). Accompanying letters indicate statistically significant difference according to the Tukey HSD test. WUE – water use efficiency; WUE_i – intrinsic water use efficiency.

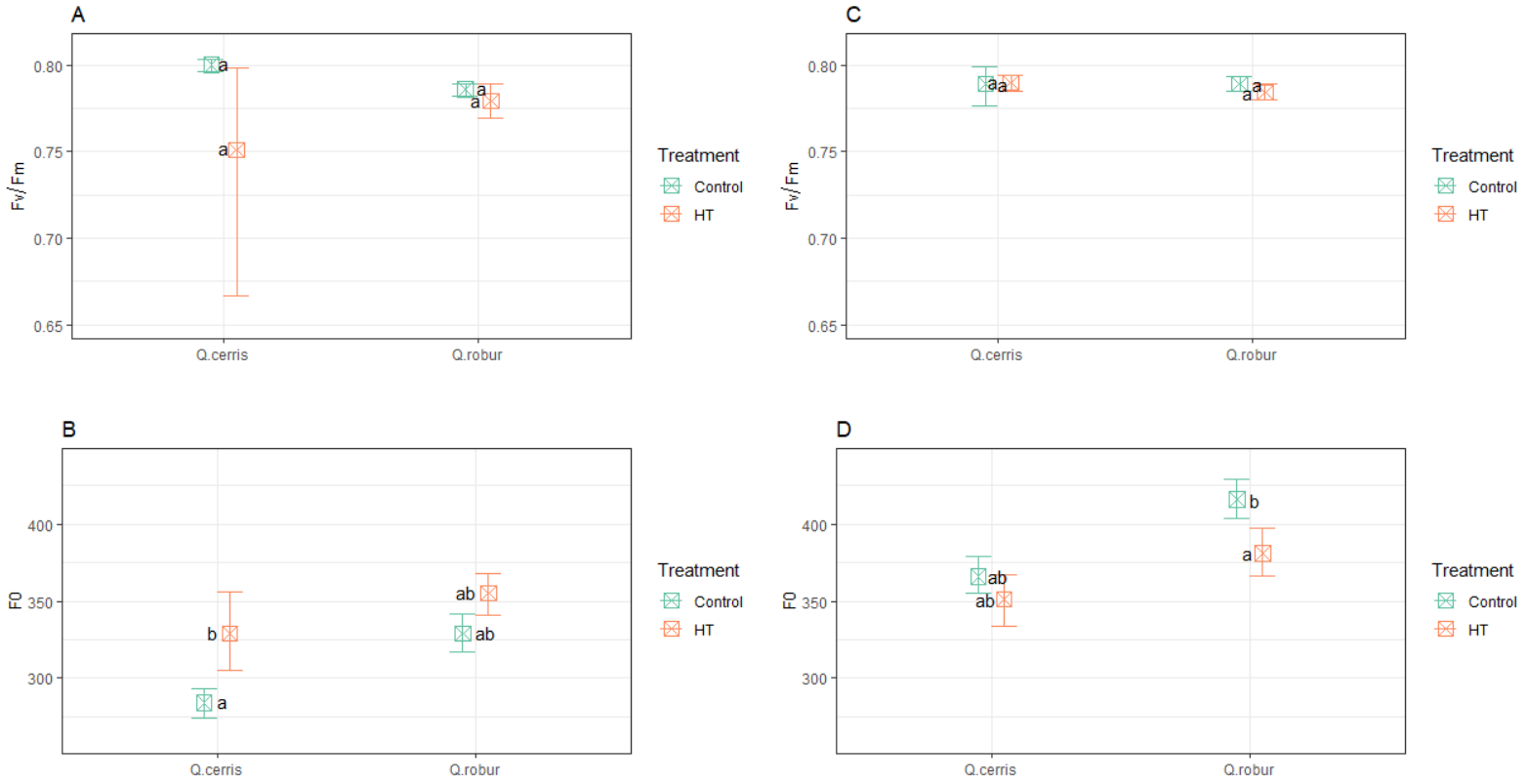

Fig. S8 Chlorophyll fluorescence parameters F_v/F_m and F_0 in *Q. cerris* and *Q. robur* plants under acute (A, B) and chronic (C, D) exposure to HT treatment. The data is presented with mean value ± the upper and lower percentile for the confidence interval $p < 0.05$ ($n = 9$). Accompanying letters indicate statistically significant difference according to the Tukey HSD test. F_v/F_m - maximal quantum yield of PSII photochemistry; F_0 - minimal fluorescence yield of the dark adapted state.