

Isotopic and Water Relation Responses to Ozone and Water Stress in Seedlings of Three Oak Species with Different Adaptation Strategies

Claudia Cocozza¹, Elena Paoletti², Tanja Mrak³, Saša Zavadlav³, Tom Levanič³, Hojka Kraigher³, Alessio Giovannelli², Yasutomo Hoshika²

¹Department of Agriculture, Food, Environment and Forestry, University of Florence, Via San Bonaventura 13, Florence, Italy; claudia.cocozza@unifi.it

²Institute of Research on Terrestrial Ecosystems (IRET), National Research Council (CNR), Via Madonna del Piano 10, 50019, Sesto Fiorentino, Italy; yasutomo.hoshika@cnr.it, alessio.giovannelli@cnr.it, elena.paoletti@cnr.it

³Slovenian Forestry Institute, Večna pot 2, 1000 Ljubljana, Slovenia; tanja.mrak@gozdis.si, sasa.zavadlav@gmail.com, tom.levanic@gozdis.si, hojka.kraigher@gozdis.si

* Correspondence: claudia.cocozza@unifi.it;

Supplementary materials

Table S1. ANOVA of $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, $\delta^{18}\text{O}$, $\Psi_{\text{pre-dawn}}$, Ψ_{midday} and LWC (one-way analysis) of *Q. robur*, *Q. ilex* and *Q. pubescens* exposed to O_3 and water treatments. P-level values of differences between WW vs WS at the same O_3 level and AA vs 1.2AA vs 1.4AA within the same water level were reported; significant p-level values are shown in bold character.

	WW vs WS			AA vs 1.2 AA vs 1.4AA	
	AA	1.2 AA	1.4 AA	WW	WS
$\delta^{13}\text{C}$					
<i>Q. robur</i>	0.099	0.007	0.168	0.417	0.764
<i>Q. ilex</i>	0.973	0.061	0.056	0.163	0.378
<i>Q. pubescens</i>	0.222	0.846	0.216	0.477	0.987
$\delta^{15}\text{N}$					
<i>Q. robur</i>	0.064	0.871	0.374	0.003	0.999
<i>Q. ilex</i>	0.555	0.238	0.270	0.457	0.666
<i>Q. pubescens</i>	0.279	0.761	0.507	0.472	0.760
$\delta^{18}\text{O}$					
<i>Q. robur</i>	0.017	0.066	0.180	0.198	0.959
<i>Q. ilex</i>	0.004	0.253	0.112	0.614	0.805
<i>Q. pubescens</i>	< 0.001	0.030	0.013	0.579	0.036
$\Psi_{\text{pre-dawn}}$					
<i>Q. robur</i>	0.046	-	0.409	0.910	0.431
<i>Q. ilex</i>	0.039	-	0.200	0.886	0.143
<i>Q. pubescens</i>	0.037	-	< 0.001	0.310	0.419
Ψ_{midday}					
<i>Q. robur</i>	0.122	0.827	0.724	0.622	0.079

<i>Q. ilex</i>	0.149	0.869	0.203	0.005	0.003
<i>Q. pubescens</i>	0.005	0.075	0.895	0.006	0.050
LWC					
<i>Q. robur</i>	0.935	0.296	0.072	0.771	0.010
<i>Q. ilex</i>	0.835	0.919	0.400	< 0.001	< 0.001
<i>Q. pubescens</i>	0.126	0.069	0.273	0.083	0.066

Table S2. ANOVA (three-way analysis) of net photosynthetic rate (A_{sat}) and stomatal conductance (g_s) of *Q. robur*, *Q. ilex* and *Q. pubescens* exposed to three levels of O_3 (ambient, AA; 1.2 times ambient O_3 concentration, 1.2AA; 1.4 times ambient O_3 concentration, 1.4AA) and two levels of water treatments (well-watered, WW; water-stressed, WS). Measurements were conducted in different months (June, August, September-October). Significant p-level values are shown in bold character.

	A_{sat}				g_s		
	<i>Q. robur</i>	<i>Q. ilex</i>	<i>Q. pubescens</i>		<i>Q. robur</i>	<i>Q. ilex</i>	<i>Q. pubescens</i>
ANOVA (p-values)							
O_3	<0.001	0.920	0.002	0.040	0.729	0.096	
water	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	
month	<0.001	0.064	<0.001	<0.001	<0.001	<0.001	
O_3 x water	0.002	0.397	0.183	0.011	0.816	0.379	
O_3 x month	0.375	0.648	0.309	0.044	0.747	0.322	
water x month	0.055	0.011	0.001	0.330	0.069	0.017	
O_3 x water x month	0.188	0.816	0.982	0.211	0.978	0.994	

Table S32. Slope, y-intercept and determination coefficient (R^2) of the regression relationships between light-saturated net photosynthetic rate (A_{sat}) and stomatal conductance (g_s) of *Q. robur*, *Q. ilex* and *Q. pubescens* exposed to three levels of O_3 (1.0, 1.2 and 1.4 times the ambient concentration, denoted as AA, 1.2AA, 1.4AA, respectively) and two levels of water irrigation (treatment: WW, 100% field capacity; WS, 40% field capacity). See the detail in Fig. 4.

		WW			WS			All WW	All WS
		AA	1.2AA	1.4AA	AA	1.2AA	1.4AA		
<i>Q. robur</i>									
	Slope	29	35	42	57	41	53	38	52
	y-intercept	3.5	1.4	-0.47	-1.1	1.2	-1.4	0.85	-0.85
	<i>R</i> ²	0.70	0.50	0.44	0.96	0.57	0.76	0.62	0.79
<i>Q. ilex</i>									
	Slope	13	21	18	41	29	30	18	36
	y-intercept	7.0	4.8	5.9	2.3	3.6	2.9	5.7	2.7
	<i>R</i> ²	0.33	0.42	0.34	0.68	0.34	0.60	0.39	0.57
<i>Q. pubescens</i>									
	Slope	21	22	35	41	33	37	28	38
	y-intercept	5.9	5.4	2.2	0.48	2.6	0.91	4.0	1.1
	<i>R</i> ²	0.49	0.42	0.80	0.93	0.57	0.89	0.61	0.84

Table S3. ANOVA (three-way analysis) of net photosynthetic rate (A_{net}) and stomatal conductance (g_s) of *Q. robur*, *Q. ilex* and *Q. pubescens* exposed to three levels of O_3 (ambient, AA; 1.2 times ambient O_3 concentration, 1.2AA; 1.4 times ambient O_3 concentration, 1.4AA) and two levels of water treatments (well-watered, WW; water-stressed, WS). Measurements were conducted in different months (June, August, September October). Significant p level values are shown in bold character.

	A_{net}				g_s		
	<i>Q. robur</i>	<i>Q. ilex</i>	<i>Q. pubescens</i>		<i>Q. robur</i>	<i>Q. ilex</i>	<i>Q. pubescens</i>
ANOVA (p-values)							
O_3	<0.001	0.920	0.002		0.040	0.729	0.096
water	<0.001	<0.001	<0.001		<0.001	0.006	<0.001
month	<0.001	0.064	<0.001		<0.001	<0.001	<0.001
O_3 x water	0.002	0.397	0.183		0.011	0.816	0.379
O_3 x month	0.375	0.648	0.309		0.044	0.747	0.322
water x month	0.055	0.011	0.001		0.330	0.069	0.017
O_3 x water x month	0.188	0.816	0.982		0.211	0.978	0.994