ELEVATED CO_2 DRIVE HIGHER GROWTH BUT LOWER WOOD DENSITY IN YOUNG SESSILE OAK TREES (*QUERCUS PETRAEA* (MATT.) LIEBL.)

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Keywords

elevated CO_2, biomass production, wood density,tree ring width,vessel lumen area, sessile oak saplings

ABSTRACT

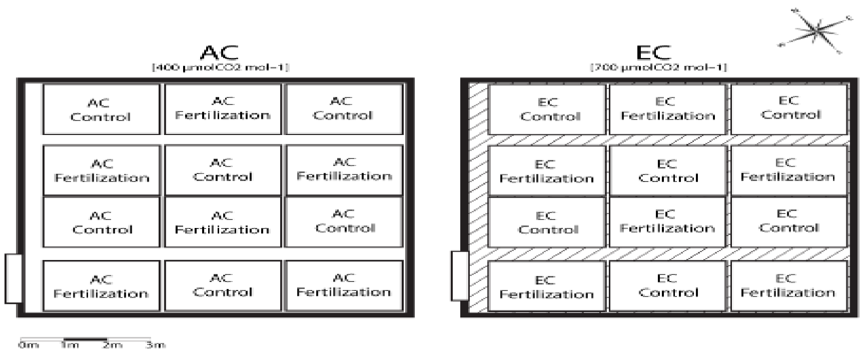
The annual rate of increase is about 1.5 ppm (0.4% yr^{-1}) and all representative concentration pathways (RCPs) scenarios predict levels of CO_2 in the atmosphere to rise between 421 ppm and 936 ppm at the end of this century (IPCC, 2013). Therefore, it is an urgent task to perform more studies examining the adaptive capacity of European tree species in the face of climate changes, because the forests regenerated today will have to adapt and cope to the climate conditions that will be present during the life of the trees in the stand. It is believed that properties and productivity of the trees will be strongly affected by the increasing CO_2 concentration in the atmosphere and global mean temperature. Ring-porous oak hardwoods (Quercus spp.) is characterized by the denser latewood part of the growth ring, higher percentage of libriform fibers and earlywood with large diameter vessels. Therefore, it is expected that strength properties and density of the oak wood would increase with increased growth rate.

AIMS OF THE RESEARCH

The objective of the present study was to investigate the effects of (i) elevated CO_2 and (ii) nutrient on wood density and biomass growth of sessile oaks saplings. Moreover, the effects of elevated CO_2 on annual ring characteristics (ring width, vessel lumen area, and vessel density) are investigated. In this research, we grow ring–porous species (*Quercus petraea* (Matt.) Liebl.).

MATERIALS AND METHODS

(i) Sampling and Biometrical analysis
(ii) Wood density
(iii) Anatomical measurements



Each lamellar glass–domes contains 144 saplings. In the beginning of 2017, both lamellar glass–domes were split into plots (Fig. 1.) and planted with two years old saplings of sessile oak, experiment with fertilization start in 2018.

Figure 1: Experimental design scheme. AC – ambient CO_2 concentration, EC – elevated CO_2 concentration, Control – plots without N fertilization, Fertilization – plots with N fertilization.

RESULTS

All investigated aboveground and belowground morphological characteristics showed to be significantly ($p \leq 0.05$) affected by elevated CO_2, whereas fertilization had no statistically significant effect. There were no significant interaction effects between CO_2 and nutrition on the aboveground biomass.Elevated CO_2 showed a statistically significant impact on ring width, latewood widths or their number. Latewood density was decreased by elevated CO_2 whereas the all biometrical characteristics were increased. We found that over the entire treatment period, WD was 1.75% and 0.77% less in EC and fertilized trees compared with control trees. Total area of vessel and vessel proportion seems to be larger under EC. We found, increasing in EC in vessel diameter 13.97%, vessel area 28.78%, DHP 13.47%, Ks 12.27%, and decreasing in TLVA 9.31% and vessel density 30.49%.

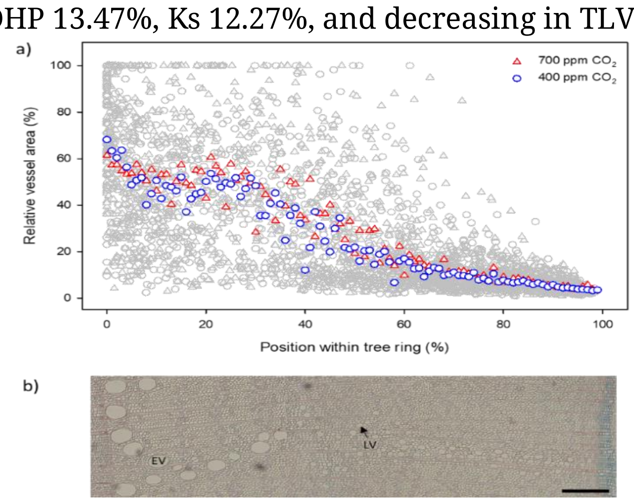


Figure 2: Overview of tree ring in 2019. (a) Relative position of vessel lumen areas within tree ring created in 2019 with applied General Anova linear model (GLM) denoted by red (elevated CO_2) and blue characters (ambient CO_2). (b) Microscope image of a cross-section of the 2019 annual ring of a tree (*Quercus petraea* (Matt.) Liebl.) tree growing in elevated CO_2 sphere. Abbreviations: EV – earlywood vessel; LW – latewood vessel. Scale bar = 200 µm.

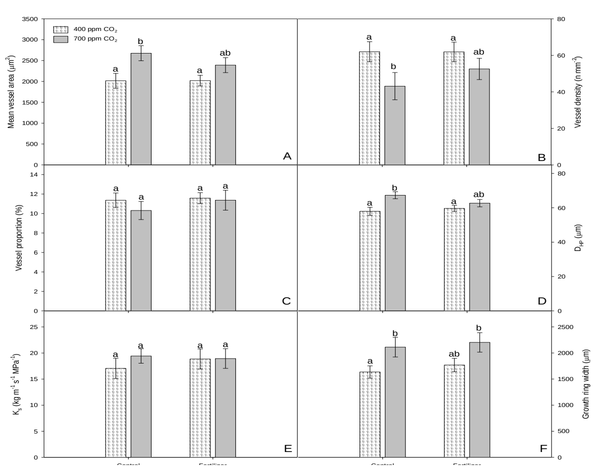


Figure 3: Wood anatomy: Mean vessel area [µm²], vessel density [N_o mm^{-2}], vessel proportion [%],) D_{hp} [µm], K_s [kg m^{-1} s^{-1} MPa^{-1}], growth ring width [µm]

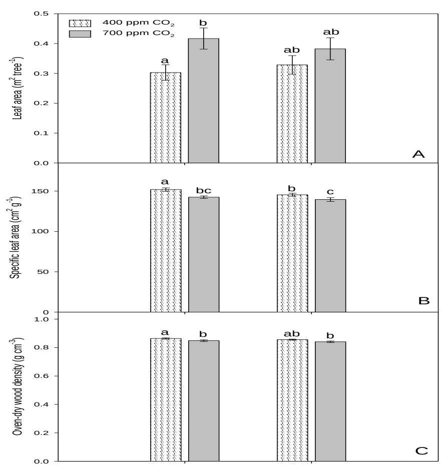


Figure 4: (A): Leaf area (m^2/plant); (B): Specific leaf area (cm^2 g^{-1}); (C): Over – dry wood density (g/cm^3)

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LITERATURE CITED: IPCC, 2013. Climate change 2013: the physical science basis. Fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA