Wheat developmental stage conditions different photosynthetic strategies under elevated CO2 conditions

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Introduction

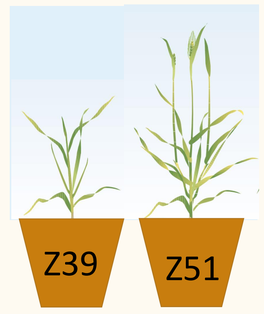
- Climate scenarios have predicted an increase in CO_2 concentration that may favor C assimilation.
- Biochemical and/or stomatic processes might reduce photosynthetic efficiency under elevated [CO_2].
- The increase of [CO_2] impacts on crop phenology, nutrient assimilation and translocation factors, conditioning photosynthetic performance.

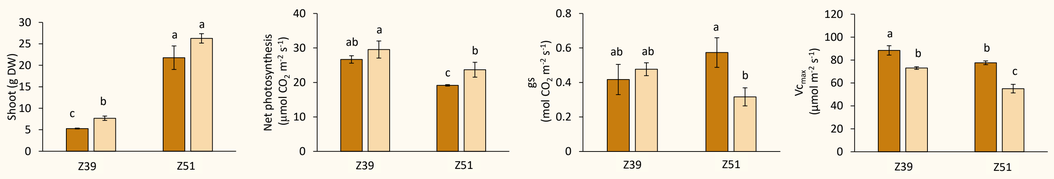
Objective

Evaluate the effect of elevated [CO_2] (400 versus 700 ppm) on photosynthetic apparatus in durum wheat (Triticum durum, var. Amilcar) plants at two different developmental stages.

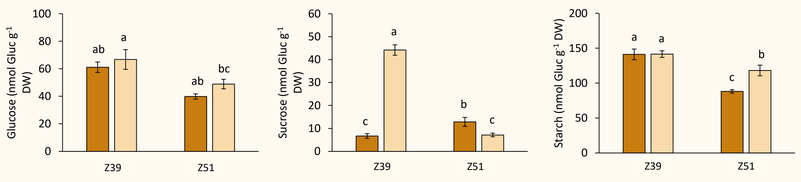
Materials and methods

- **Durum wheat** *(Triticum durum cv. Amilcar)* plants were grown in 5 L hydroponic pots in two independently controlled environmental chambers (Phytotron Service, SGIker, UPV/EHU) under two different controlled atmospheres of 400 ppm and 700 ppm CO2 levels.
- Environmental conditions were 550 µmol m-2 s-1 light intensity, 25/17 °C temperature, and 50/60% relative humidity during the 14/10 h of the day/night-photoperiod to ambient (**400 ppm**) and elevated (**700 ppm**) [CO_2].
- Hoagland solution based on calcium nitrate at a rate of 10 mM N was replaced three times per week.
- Leaf gas exchange, chlorophyll fluorescence analyses combined with the determination of genes involved in light, carbohydrates and cytokinins contents were analyzed in wheat plants in at the end of the elongation stage Z39 and at the beginning of ear emergence Z51



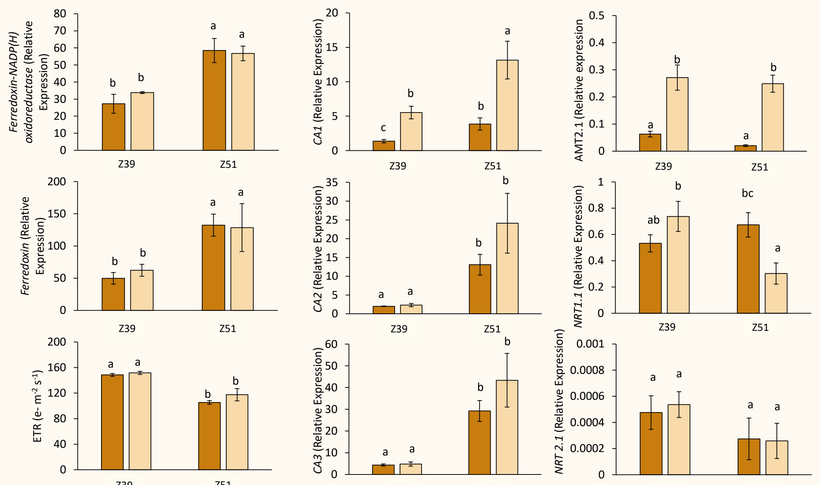


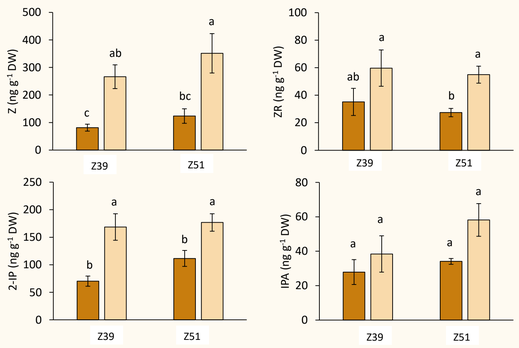
- Exposure to elevated CO_2 increased plant biomass at Z39.
- Wheat plants at the end of elongation stage grown under elevated CO_2 did not present differences in leaf photosynthetic rate and stomatal conductance, whereas Vcmax was decreased respect plants grown under ambient CO_2 conditions.
- Wheat plants at the beginning of ear emergence exposed to elevated CO_2 showed higher leaf photosynthetic rates than plants under ambient CO_2 conditions. However, both stomata conductance and Vcmax rates were decreased respect plants grown under ambient CO_2.



- Leaf glucose contents were not affected by exposure to elevate CO_2, but decreased with wheat development, regardless the environmental CO_2 condition.
- Leaf sucrose contents increased in wheat plants at Z39 grown under elevated CO_2, whereas decreased at Z51.
- Leaf starch contents were higher at Z39 than at Z51, regardless CO_2 concentration. Leaf starch contents in plant grown at ambient CO_2 experienced a higher decrease compared to plants exposed to elevated CO_2 as the developmental stages advanced from Z39 to Z51.

- Exposure to elevated CO_2 did not affect the thylakoid electron transport rate (ETR) and the expression of Ferredoxin and Ferredoxin-NADP(H) oxidoreductase gene expressions.
- Whereas ETR decreased with phenology, the relative expression of *Ferredoxin* and *Ferredoxin-NADP(H) oxidoreductase* genes increased.
- Relative expression of carbonic anhydrases genes also denoted a higher expression at the beginning of ear emergence than at the end of the elongation stage. Only *CA1* relative expression was enhanced by elevated CO_2, regardless the phenological stage observed.
- Elevated CO_2 increased the expression of the ammonium transporter *AMT2.1* regardless the developmental stage.
- Relative gene expression of the nitrate transporter *NRT1.1* in wheat at Z39 did not show significant differences, but *NRT1.1* gene expression was repressed at Z51 by exposure to CO_2.
- Relative expression of *NRT2.1* gene did not vary with developmental stage or atmospheric CO_2 concentration.





- Leaf contents of the four cytokinin studied, trans-zeatin (Z), trans-zeatin riboside (ZR), the endogenous isopentenyladenosine (IPA) and Isopentenyl adenine (2iP), did not vary with developmental stage, regardless the CO_2 concentration.
- Leaves of wheat plants exposed to elevated CO_2 conditions presented high trans-zeatin (Z) contents at both developmental stages Z39 and Z51.
- Leaf contents of isopentenyl adenine (2-iP) and ZR were affected by elevated CO_2 at both developmental stages whereas the endogenous isopentenyladenosine (IPA) contents were not affected by CO_2 concentration or developmental stage.

Conclusion

- Photosynthetic machinery was affected differently in plants at the end of elongation stage (Z39) and at the beginning of ear emergence (Z51).
- Leaf photosynthesis was maintained (Z39) or increased (Z51) in wheat plants exposed to elevated CO2, which explained the increase trend in plant biomass under elevated CO_2.
- Wheat plants exposed to elevated CO2 decreased Vcmax regardless the developmental stage. The reduction of Vcmax suggested that photosynthetic acclimation to elevated CO2 was driven by a build-up of carbohydrates
- The expression of carbonic anhydrases and cytokinins profiles were adjusted in plants exposed to elevated CO2 to ensure an adequate C assimilation while delayed senescence

ACKNOWLEDGEMENTS

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