INTRASPECIFIC EFFECTS OF SHORT-TERM ELEVATED ATMOSPHERIC CO_2 IN YIELD AND NUTRITIONAL PROFILE OF *PHASEOLUS VULGARIS*

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INTRODUCTION

Legumes are key contributors of essential nutrients for human health, namely iron (Fe) and zinc (Zn), but they are one of the most sensitive plant families to elevated concentrations of atmospheric CO_2 (eCO_2), a major threat to global agriculture and human nutrition. Therefore, unravelling the effects underlying eCO_2 responses on biomass yield and nutritional value is of utmost importance to anticipate potential negative effects on human nutrition and expedite mitigation strategies.

METHODS

P. vulgaris (common bean) genotypes (Logan, G1378 and Kazak) were grown in field conditions under ambient concentrations of atmospheric CO_2 (aCO_2, 400 pm) or eCO_2 (600 pm). Plant's above ground biomass of the three genotypes was collected after 1 month of exposure to aCO_2 or eCO_2. Biomass estimation considered 10 representative plants, per genotype and plot, randomly selected and uprooted. Seed samples were analyzed for important micronutrient concentrations, namely zinc (Zn), manganese (Mn), iron (Fe) and boron (B), following the procedure described by Santos *et al*. (2020). Mean comparisons were performed through analysis of variance (ANOVA) followed by Fisher's LSD test ($p < 0.05$) in GraphPad Prism version 9.0.

RESULTS AND DISCUSSSION

Exposure to eCO_2 resulted in a significant increase of plant biomass in Logan and G1378 (between 1.2- to 2.1-fold), whereas Kazak was less impacted. As CO_2 is a substrate for photosynthesis, an increase in plant growth was expected, although few studies focused on short-term exposures (Shimono *et al*., 2008).

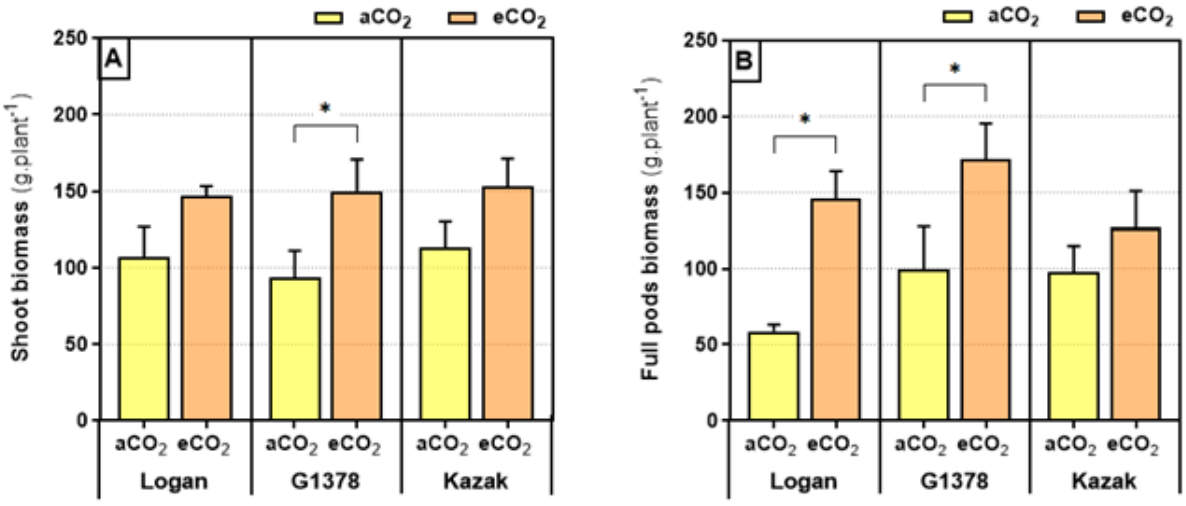

Figure 1 - Shoot (A) and full pods (B) biomass of 'Logan', 'G1378' and 'Kazak' grown under aCO_2 or eCO_2. Each value represents the average ± SEM and asterisks indicate significant differences at $p<0.05$

Zn and Fe accumulation in Logan was significantly reduced by eCO_2 in grains, whereas in Kazak it decreased in shoots and grains. These fluctuations in edible tissues such as the grains were also reported for wheat and barley (Loladze *et al*., 2014) and could exacerbate dietary micronutrient deficiencies in the near future (Soares *et al*., 2019). Contrarily, in G1378, Fe concentration increased in both shoots and grains. Different genotypes displayed contrasting behaviors behaviours, with Logan and G1378 appearing to be more resilient to nutritional losses caused by eCO_2.

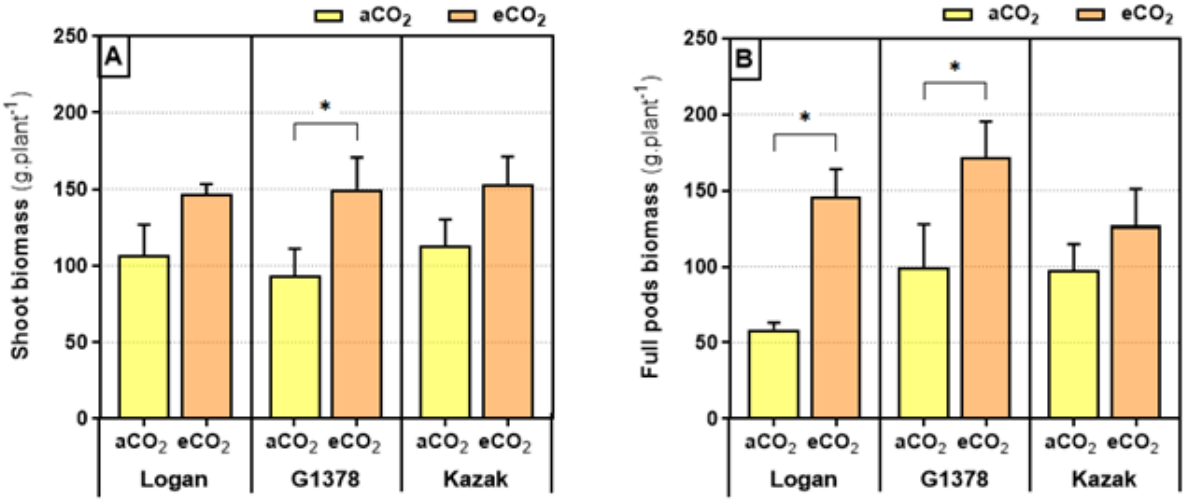

Figure 2- Leaf and grain micronutrients concentration, respectively, of 'Logan', 'G1378' and 'Kazak' grown under aCO_2 or eCO_2. Each value represents the mean ± SEM. Asterisks represent statistical differences at $p < 0.05$.

CONCLUSIONS

Elevated atmospheric CO_2 impairs common bean productivity and nutritional quality in an intraspecific manner, and genotypes such as Logan and G1378 may present higher resilience to this environmental stress.

Identifying resilient genotypes could lead to improved crops as an adaptative strategy to mitigate nutritional shortcomings under predicted eCO_2 conditions.

REFERENCES

Loladze, I. (2014). Hidden shift of the ionome of plants exposed to elevated CO?depletes minerals at the base of human nutrition. eLife 3, e02245-e02245. doi: 10.7554/eLife.02245.

Santos, C.S., Silva, B., Valente, L. M. P., Gruber, S. and Vasconcelos, M. (2020) The Effect of Sprouting in Lentil (Lens culinaris) Nutritional and Microbiological Profile. Foods. 9(4): 400

Shimono, H., and Bunce, J. (2008). Acclimation of nitrogen uptake capacity of rice to elevated

atmospheric CO2 concentration. Annals of Botany 103. doi: 10.1093/aob/mcn209.

Soares, J.C., Santos, C.S., Carvalho, S.M.P., Pintado, M.M., and Vasconcelos, M.W. (2019b). Preserving the nutritional quality of crop plants under a changing climate: importance and strategies. Plant and Soil 443(1), 1-26. doi: 10.1007/s11104-019-04229-0.

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