The impact of maternal environment on seed longevity of *Arabidopsis*

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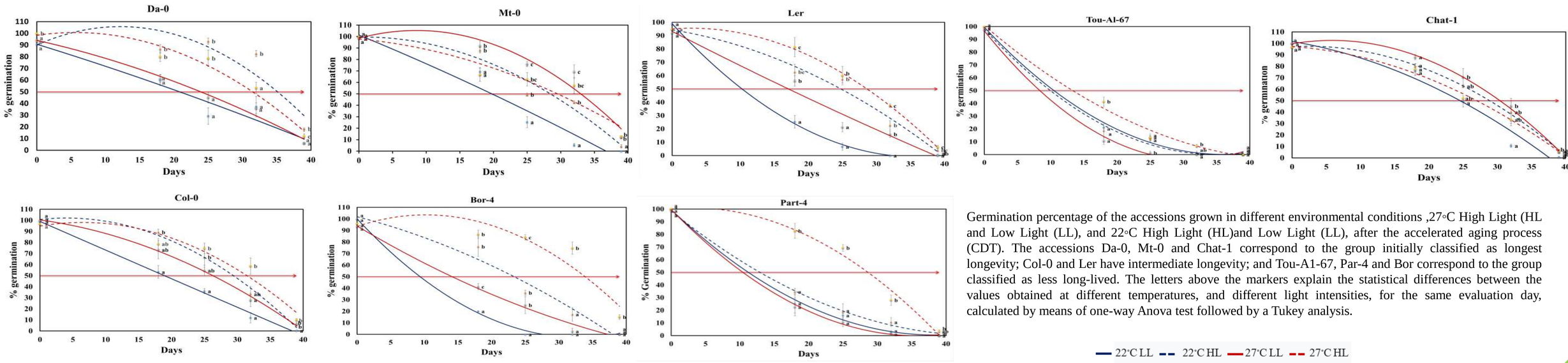
1 Introduction

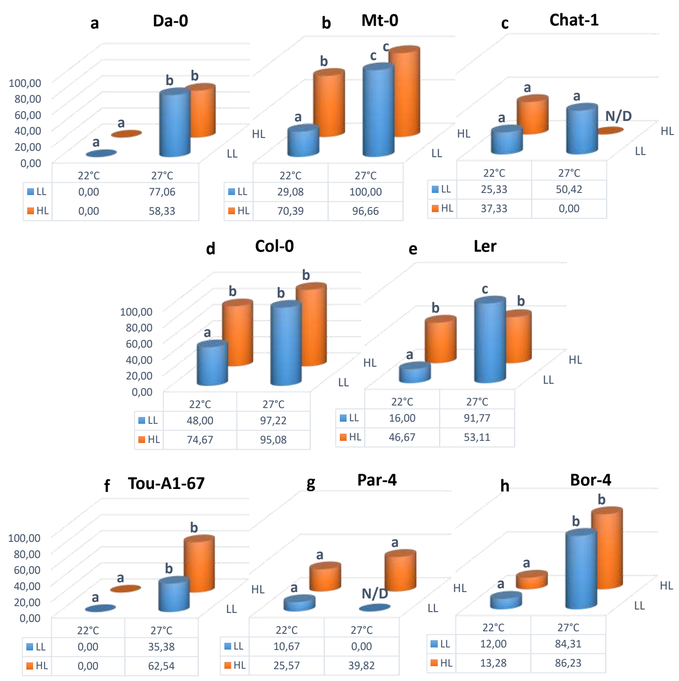
Seed preservation is of great value to agriculture and the economy, particularly in the current global changing climate. Seed longevity is defined as the time over which a seed can maintain its germination ability. Environmental conditions such as temperature, humidity, light have been shown to strongly affect seed longevity. Therefore, considering the changing environment and the importance of seeds in providing sustainable development and food security, in this study we examine the effect of the environment of mother plant, maternal environment, on seed longevity of eight *Arabidopsis* accessions. We found that higher temperature (27◦C) and higher light (HL) intensity extended seed longevity in most of the accessions. Accordingly, higher seed longevity was observed in higher temperature and higher light intensity, in addition, this impacted mainly on short-lived accessions. The effect of these environmental factors on seed dormancy was also assayed. Although a negative correlation between both traits could be observed, this was not a general rule for all accessions and environmental conditions, suggesting that a complex interplay between genotype and environment determine the quality properties of a seed. Transcriptomic analysis of a selected accession, based on the longevity phenotype, revealed potential molecular mechanisms used by seeds to increase the longevity at higher temperature and higher light intensity condition.

2 High temperature and high light intensity in maternal environment extend seed longevity in *Arabidopsis* accessions



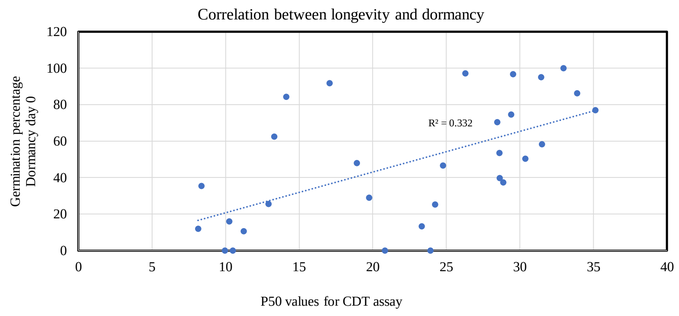
Germination percentage of the accessions grown in different environmental conditions ,27◦C High Light (HL and Low Light (LL), and 22◦C High Light (HL)and Low Light (LL), after the accelerated aging process (CDT). The accessions Da-0, Mt-0 and Chat-1 correspond to the group initially classified as longest longevity; Col-0 and Ler have intermediate longevity; and Tou-A1-67, Par-4 and Bor correspond to the group classified as less long-lived. The letters above the markers explain the statistical differences between the values obtained at different temperatures, and different light intensities, for the same evaluation day, calculated by means of one-way Anova test followed by a Tukey analysis.

3 Cold temperature and low light intensity induce dormancy in a general trend



Germination percentage just after harvest (day 0) in both temperatures (22 and 27°) and different light intensities (HL and LL). Columns with a value of 0 and a lowercase letter refer to non-germinated accessions. The columns with a value "N/D" above them refer to accessions that were not planted because they did not have seeds and, therefore, there is no value. The values related to low light intensity (LL) are shown in the blue columns; while the high light intensity (HL) data is defined by the orange columns. The N/D refer to those accessions for which there were not enough seeds to carry out the test.

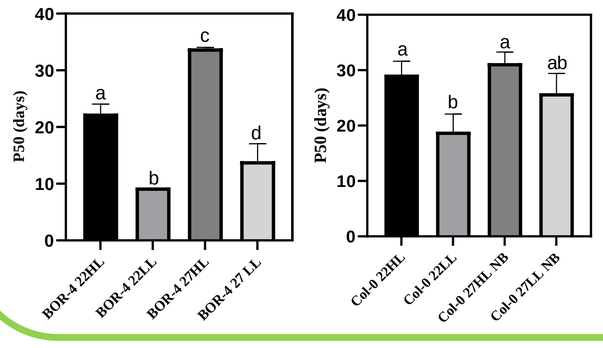
4 An overall negative correlation has been observed between seed longevity and seed dormancy



Correlation graph between longevity and dormancy of the accessions. This graph analyzes the possible relationship between the P50 values obtained in the longevity study and the existing germination on day 0 just after harvest in the dormancy test.

The strong seed longevity phenotype in BOR-4 in each four maternal environmental conditions made this accessions to be selected for further transcriptomic analysis.

6



P50 of Bor-4 in four different temperature and light intensity conditions, To compare the means obtained under different conditions, a one-way anova was performed followed by a Tukey analysis. Lower case letters above the columns represent significant differences for pvalue < 0.05..

5 Higher temperature increases seed permeability independently to light intensity on *Arabidopsis* accessions

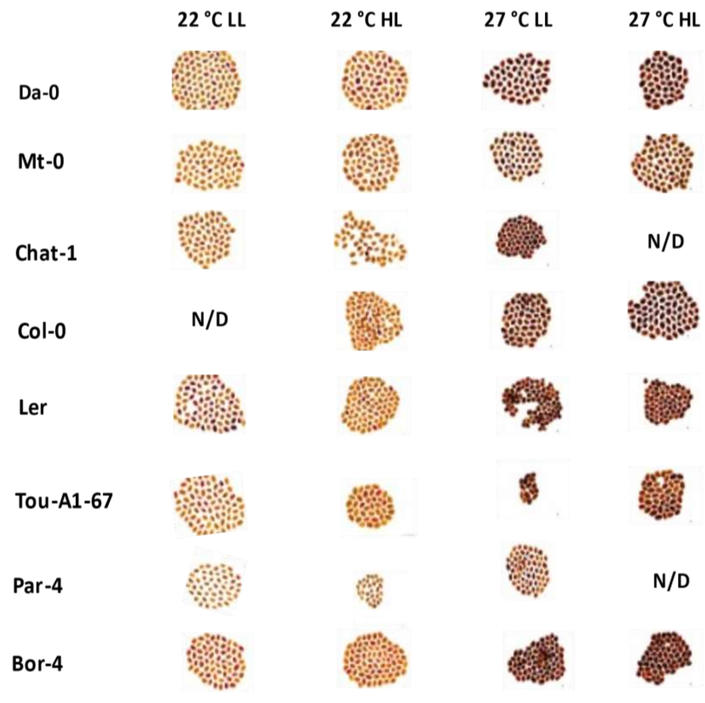
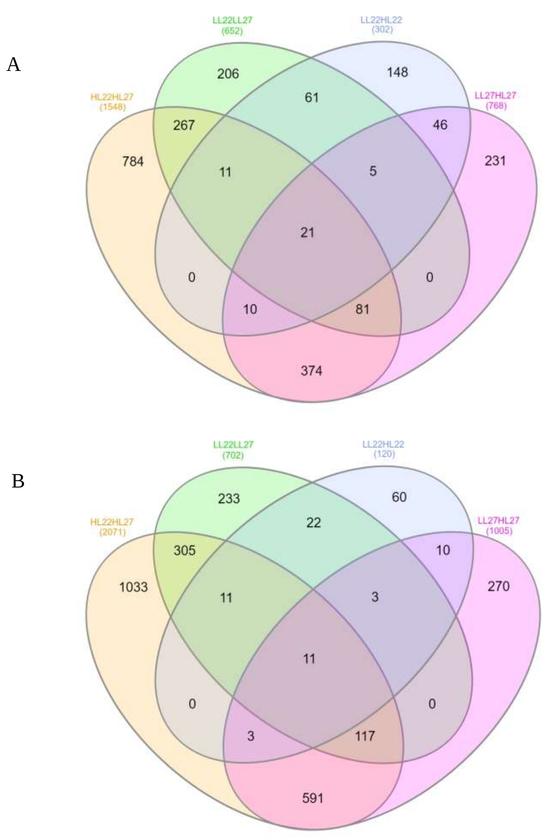


Image representing the permeability of the seeds of the accessions to tetrazolium salts. Seeds with darker color show higher permeability. Differences between accessions grown at 22°C (light yellow-brown color) and accessions grown at 27°C (dark brown-burgundy color) can be observed. The gaps marked as N/D refer to those accessions for which there were not enough seeds to carry out the test.

7 Transcriptomic analysis reveals potential genes and molecular pathway involved in determining seed longevity of *Arabidopsis* Bor-4 during four temperature and light intensity condition.



Venn diagram showing numbers of genes differentially expressed in Arabidopsis Bor-4 at four different temperature and light intensity condition. A) 2 folds down regulated genes, and B) 2 folds upregulated genes.

Gene ontology (GO) and pathway enrichment analysis. The bubble plot represents the significantly enriched terms of Arabidopsis Bor-4 seed under the effect temperature and light intensity.

8 Conclusion

1) **Seed longevity is extended by higher temperature and higher light intensity in *Arabidopsis*.**
2) **Seed dormancy is induced by lower temperature and lower light intensity in *Arabidopsis*.**
3) **Permeability of *Arabidopsis* seeds is increased by higher temperature in an independent manner from light intensity.**
4) **Different environmental conditions of mother plant strongly affect the RNA transcripts in seed cells.**

This work has been funded with support from: "Ayuda a primeros proyectos de investigación"(PAID-06-22), Vicerrectorado de Investigación de la Universitat Politècnica de València (UPV).