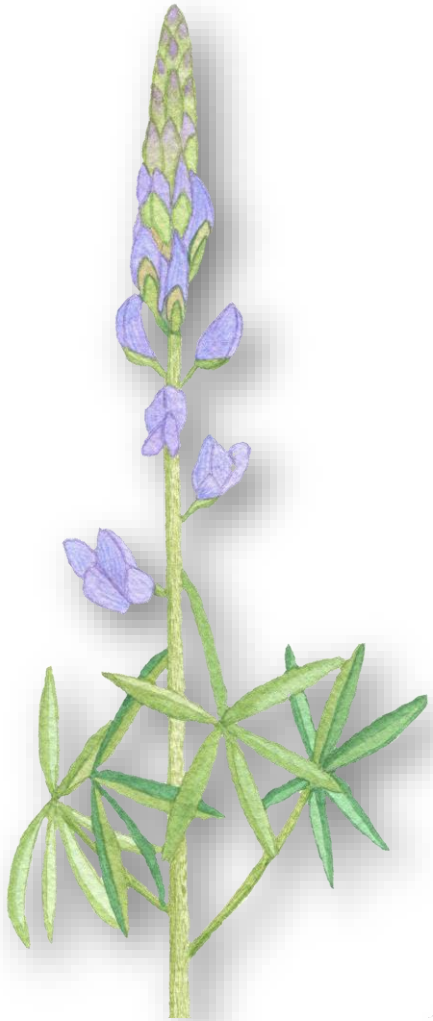
4th Mediterranean Plant Conservation Week

VALÈNCIA | 23-27 OCTOBER | 2023

Evaluation of assisted evolution as a conservation strategy for climate change adaptation



Sacristán-Bajo, S. , Lara-Romero, C. , García-Fernández, A. , Prieto-Benítez, S. , Morente-López, J. , Rubio Teso, M.L. , Torres, E. , Iriondo, J.M.

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Universidad Rey Juan Carlos

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Climate change & species response

Current climate change is the main threat to biodiversity.

Migrate

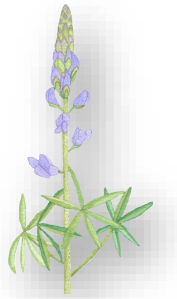
Adapt

Change

Research has been focused in how the species react.

What should we do with those species that are unable to move-adapt-change?

Assisted evolution prompt responses

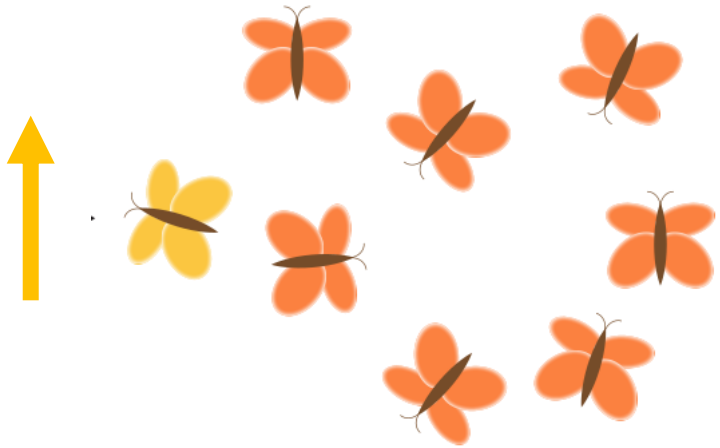


Human mediated actions to increase adaptative potential and foster species adaptation.

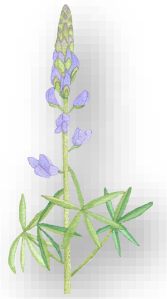
Assisted evolution prompt different strategies:

Artificial selection

Detect & increase the frecuency of target alleles that are naturally present in the populations.



Assisted evolution prompt responses



Human mediated actions to increase adaptative potential and foster species adaptation.

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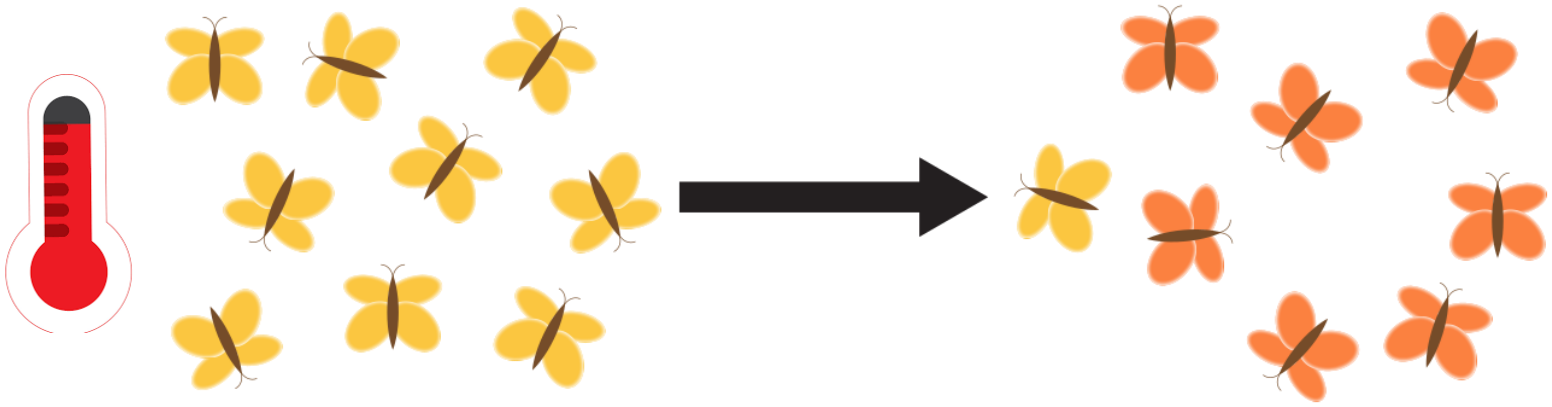
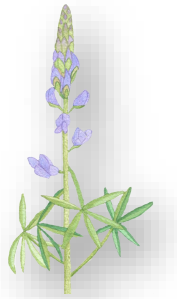


Assisted gene flow

Move target alleles from some populations to others.

Assisted evolution prompt responses



The main questions:

A - Are artificial selection/Assisted gene flow valid tools to increase adaptive potential in plant populations?

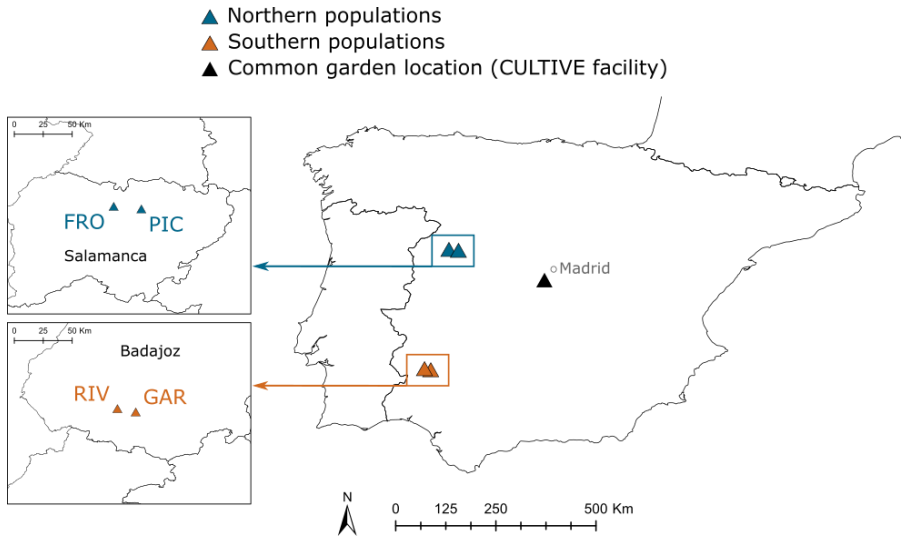
B – What are the consequences of implementing Artificial selection /Assited gene flow approaches?

C – Are these strategies useful under different environments?

Model species & Population origin

Lupinus angustifolius L.

- Annual species.
- Mediterranean distribution, with ruderal and spontaneous populations.
- Close to cultivated varieties.
- Highly autogamous (close to 99%).



Four populations for study design. ***Base Populations***

Two at North – Colder populations.

Two at South – Warmer populations.

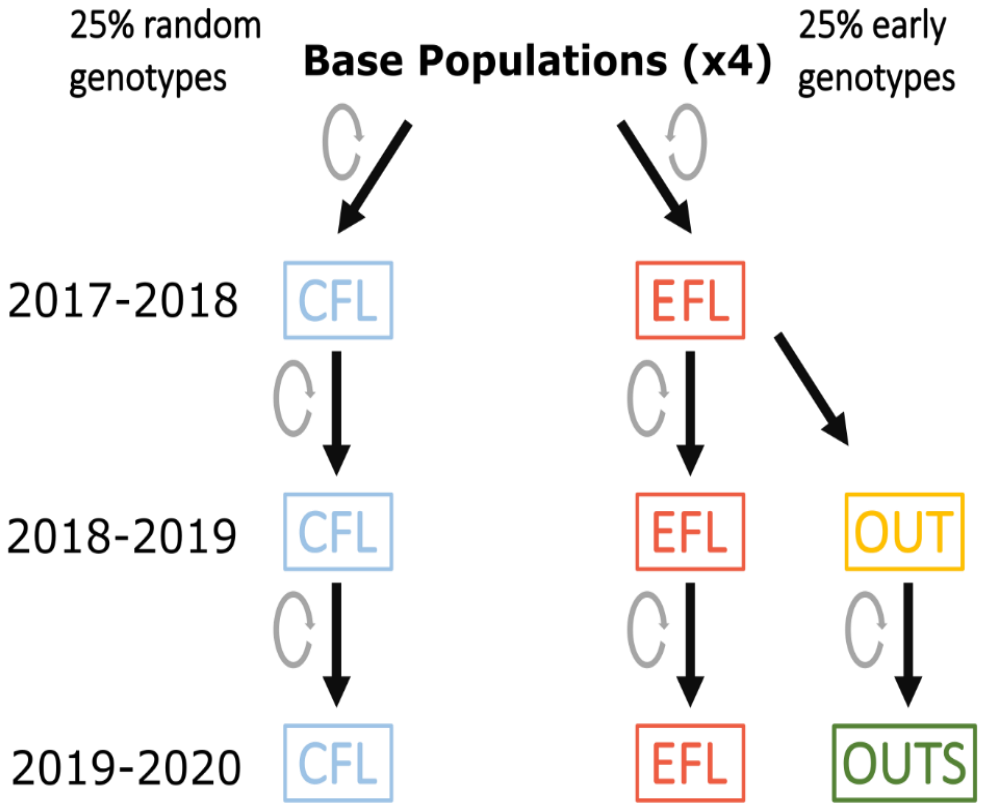
100 individuals sampled to create *ex-situ* populations.

Common garden facilities – Controlled conditions

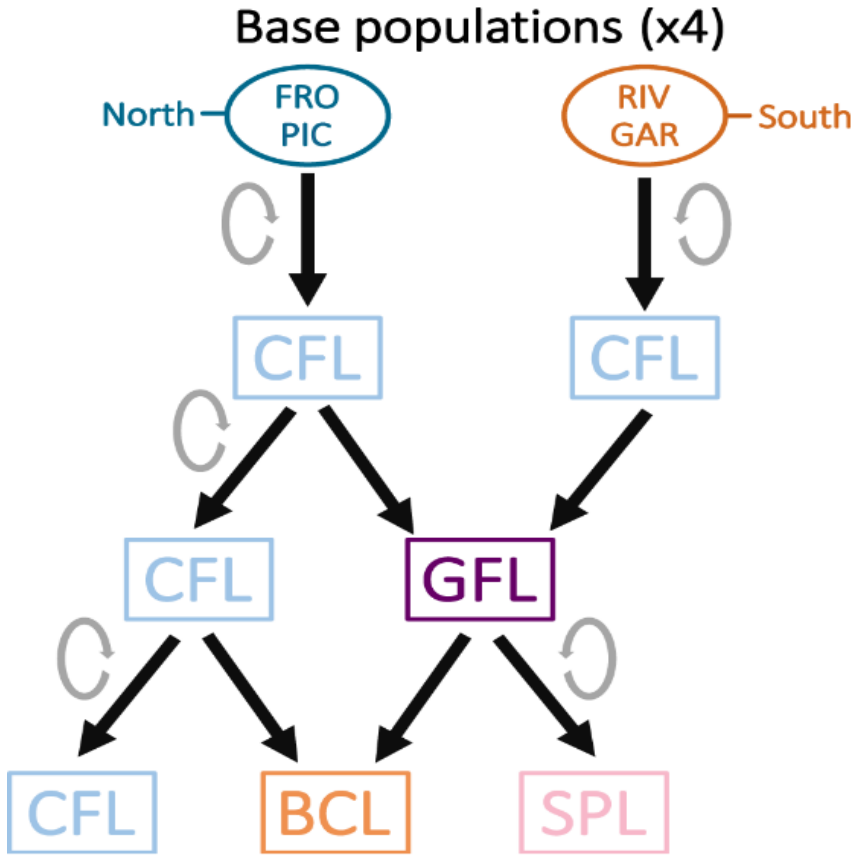
Artificial selection & Gene Flow

Flowering time as key trait to increase adaptative potential.

Artificial Selec – Early Flowering Genotypes



Gene Flow Treatment – South to North

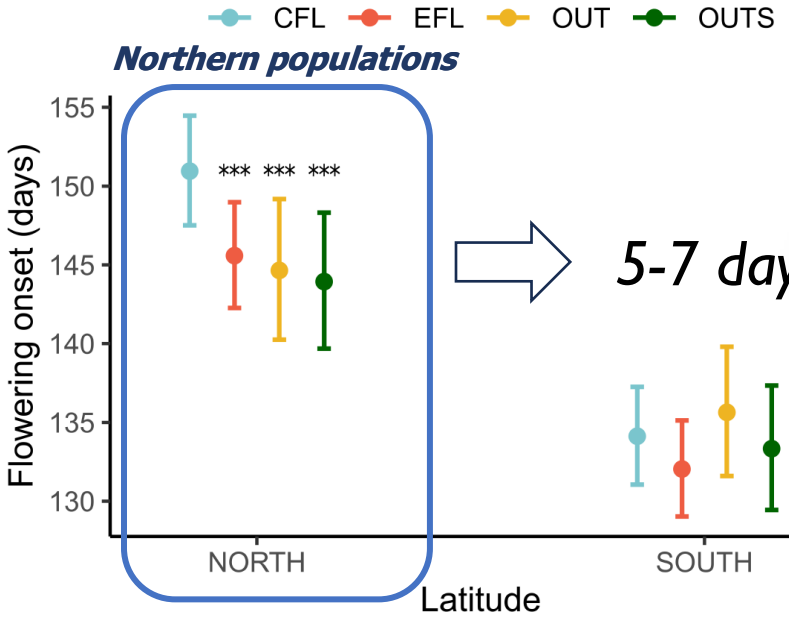


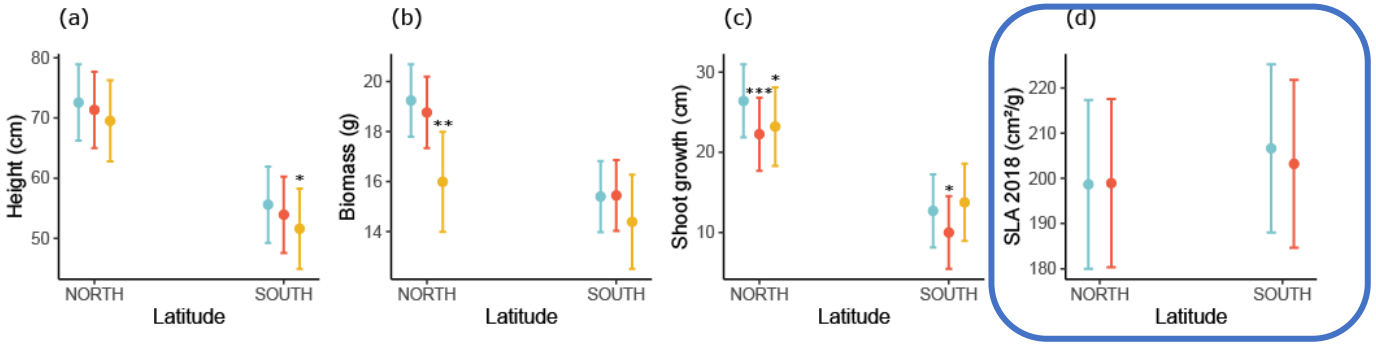
Sacristán-Bajo et al. 2023 (Evo App)

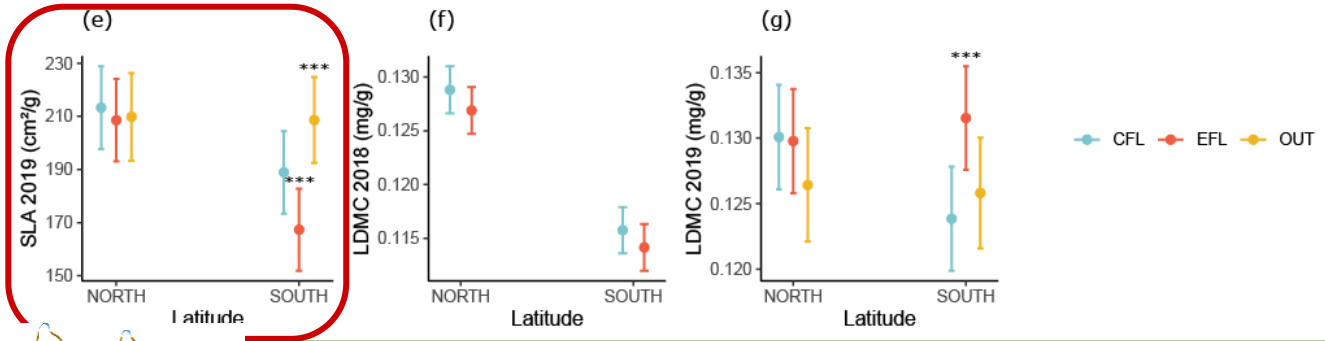
Artificial selection – Controlled conditions

Flowering onset:

- Lupins are able to flower earlier
- Northern populations showed great potential for early flowering.







Other plant traits:

- Great variability between populations.
- Traits have polygenic regulations.

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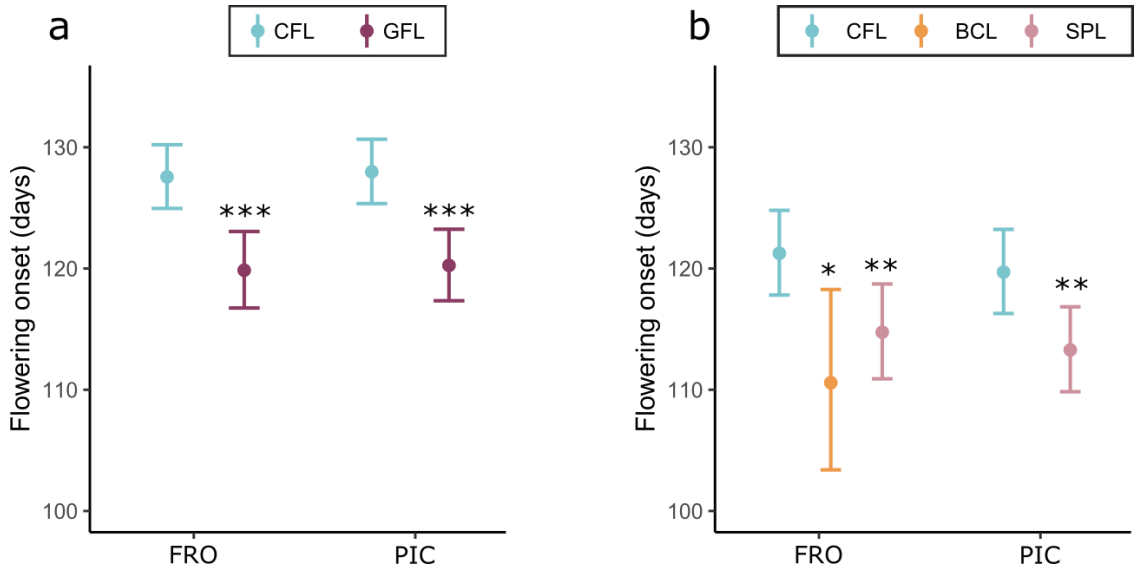
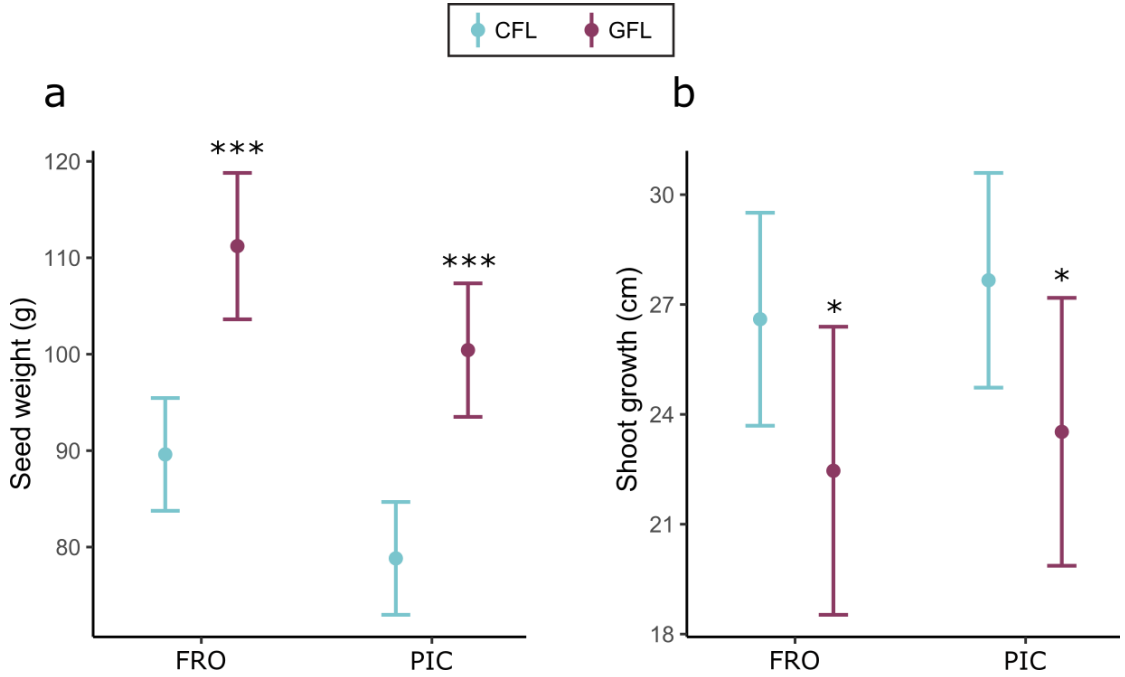
Assisted Gene Flow – Controlled conditions

Gene flow lines produce early flowering individuals.



8 -10 days earlier



Gene flow prompt differences in traits.

- Increase in seed weight.
- Smaller plants.

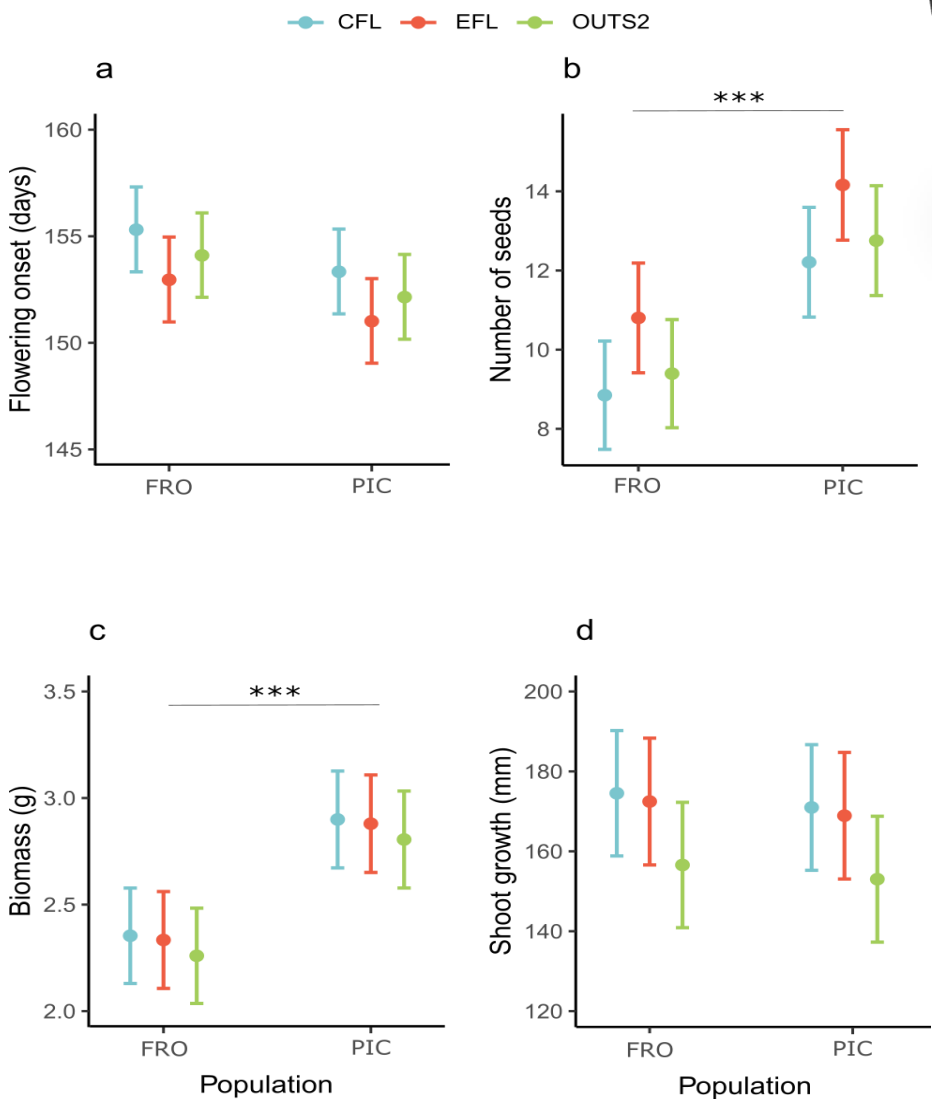
Gene flow produced more changes in traits than artificial selection.

Sacristán-Bajo et al. 2023 (Bioarx)

Field experiment approach

***In-situ* (field) experiment.**

Artificial selection lines did not show significant changes in plant traits (including flowering onset).



Sacristán-Bajo et al. (Under prep.)

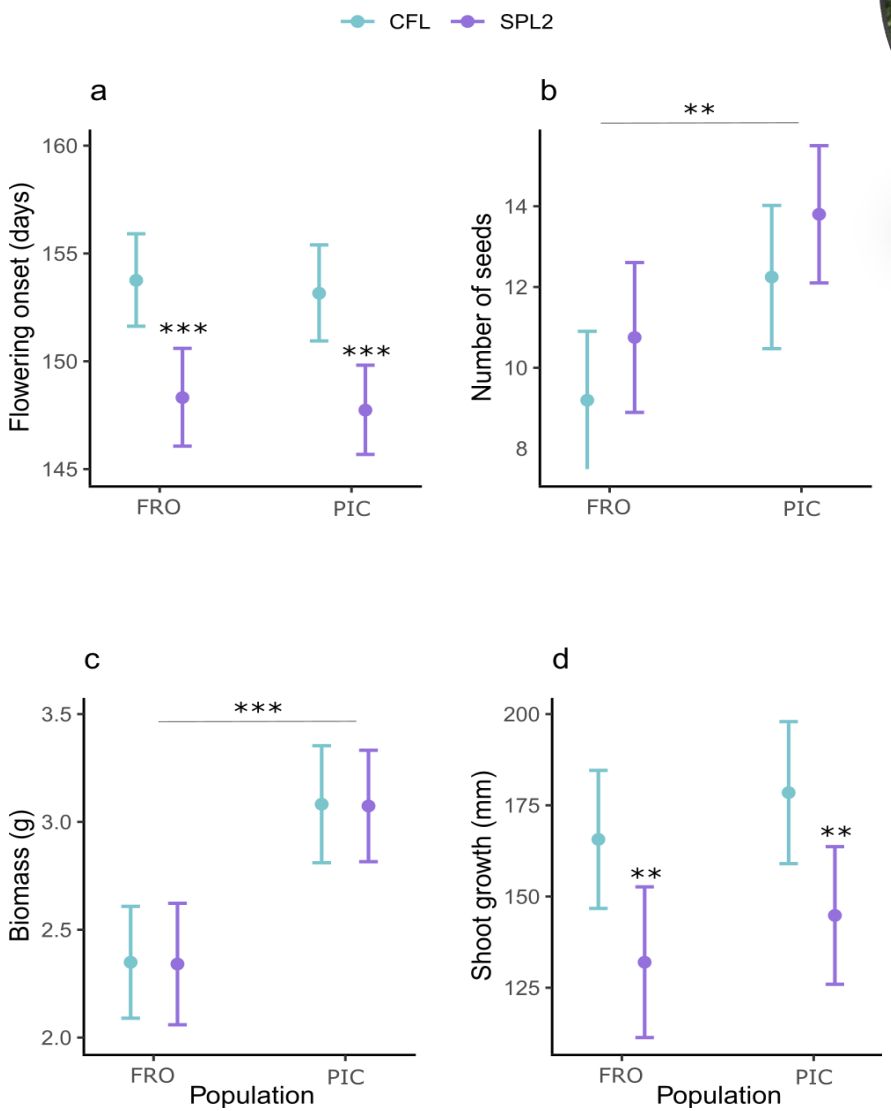
Field experiment approach

***In-situ* (field) experiment.**

Artificial selection lines did not show significant changes in plant traits (including flowering onset).

Gene Flow lines maintain changes showed in controlled conditions:

- Early flowering (6-8 days).
- More seeds.
- Smaller plants.



Sacristán-Bajo et al. (Under prep.)

The questions

A - Are Artificial selection/Assisted gene flow valid tools to increase adaptive potential in plant populations?

Yes, but…

B – What are the consequences of implement Artificial selection/Assisted gene flow approaches?

Several

C – Are these strategies useful under different environments?

Yes.

Take home messages

- Assisted evolution strategies are potential (and maybe unique) options to survive in current habitats for some species.

- Assisted evolution strategies can perform important changes, including unexpected shifts in traits.

- It is necessary to test different approaches & environments to test the potential use of these strategies.

Acknoledgements

AdAptA-lab

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Assisted evolution – Genomic approach

Genomic sequencing – Gene capture

- 180 individuals from four populations & three treatments (Control (**CFL**) – Early Flowering (**EFL**) – Outbreding (**OUT**).
- 1716 probes for regions related with abiotic stress, flowering, growing, etc.

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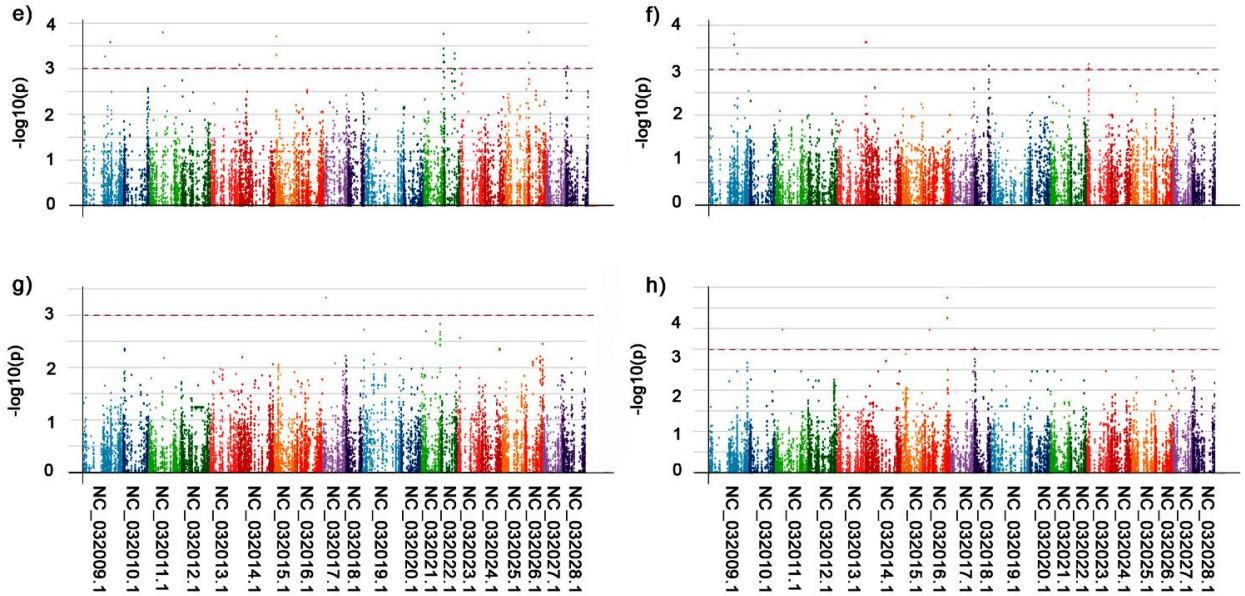

GWAS

- 165 SNPs associated with traits.
- Any of the SNPs is associated with more than one trait.

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Assisted Gene Flow – Genomic approach

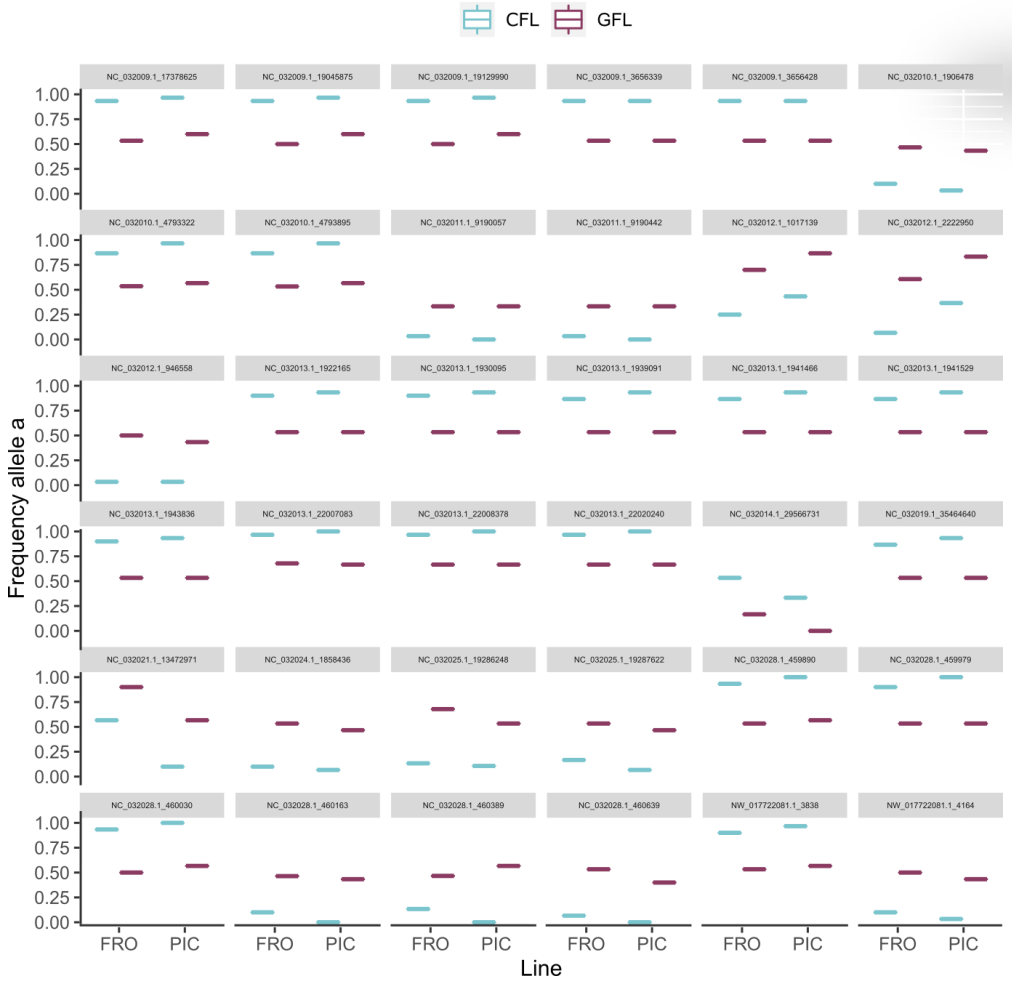
Gene flow genotypes sequenced.

Allele frequency modified (heterozigoty increase)

F_{ST} comparison analyses **CFL** *vs* **GFL**

36 SNPs with significant effect associated with:

- Flowering.
- Seed weight.
- Growth.



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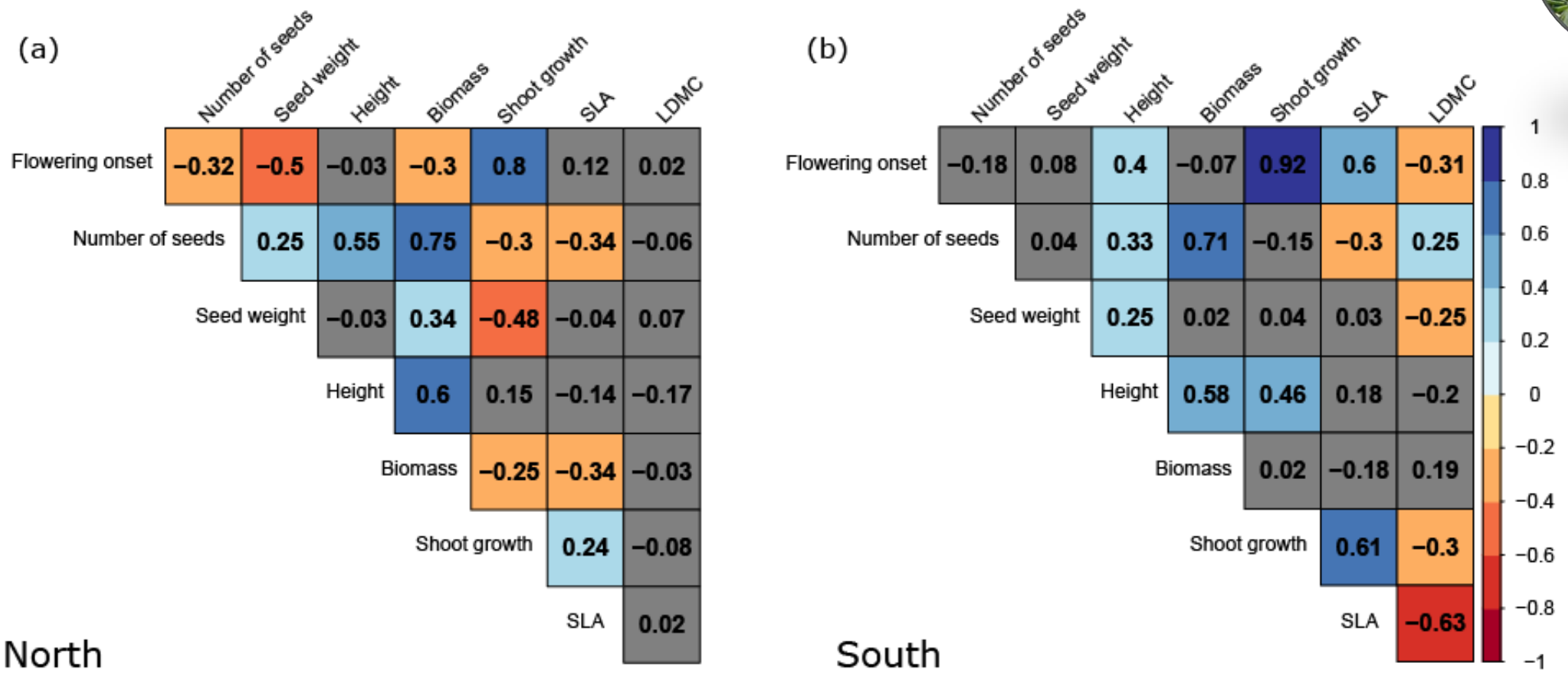
Assisted evolution – Correlated traits



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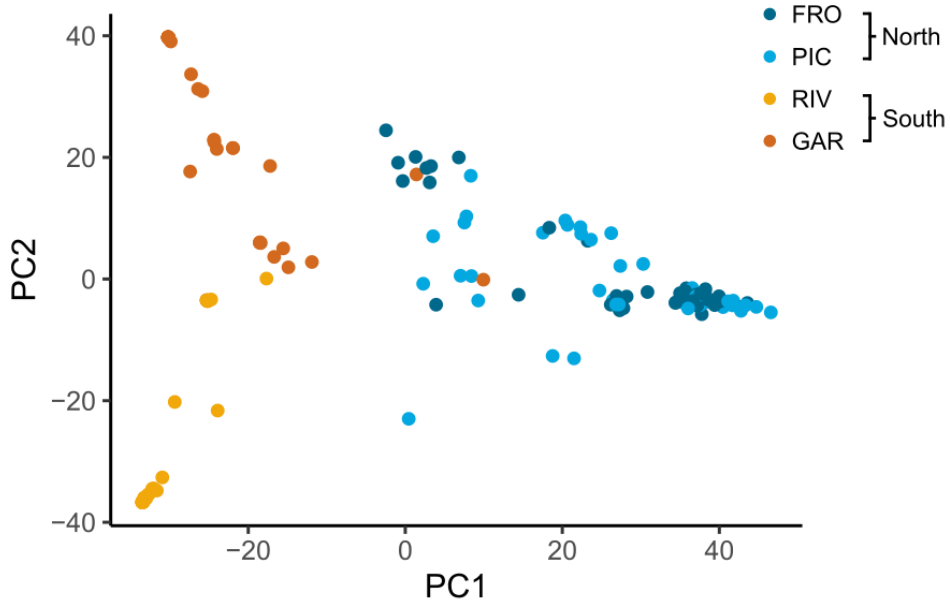

Genetic structure

- Clear genetic structure pattern.
- Wide genetic intrapopulation/region at north, straight at south

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Line	PiPerBP	ThetaPerBP	TajimaD
FRO CFL	0,161045	0,192215	-0,694835
FRO EFL	0,17177	0,186065	-0,28237
FRO OUT	0,19026	0,1999	-0,1905
PIC CFL	0,16589	0,20144	-0,77276
PIC EFL	0,23963	0,26449	-0,360315
PIC OUT	0,20523	0,204515	-0,127355
GAR CFL	0,11462	0,130705	-0,556785
GAR EFL	0,110105	0,12609	-0,56902
GAR OUT	0,095315	0,116865	-0,82258
RIV CFL	0,082155	0,084575	-0,245065
RIV EFL	0,033495	0,044595	-0,98531
RIV OUT	0,04008	0,04613	-0,412185

Genetic diversity

- No genetic diversity patterns.
- None significant changes in genetic diversity after treatments.

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Field experiment approach

***In-situ* (field) experiment.**

Genotypes obtained during the experiments were sowed in *in-situ* (field) conditions.

Northern localization – close to PIC population.

2.808 seeds sowed, from:

CFL – Control Line.

EFL – Early flowering line.

OUT – Outbreeding EF line.

SPL – Gene flow line.

Plant traits measurement and analysis.