Population Differentiation for Plasticity in *Arabidopsis thaliana*

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Introduction

- Plasticity is the ability of a genotype to produce different phenotypes in different environments.
- Plasticity is favored in variable environments and plants from more variable environments exhibit stronger plastic responses.
- Adaptively plastic populations are more likely to survive rapid environmental changes and persist long enough to genetically adapt to new environments.
- While within-population genetic variation for plasticity (i.e., genotype-by-environment interactions) has been frequently documented in plants, genetic differentiation for plasticity between populations is not well documented.[1]

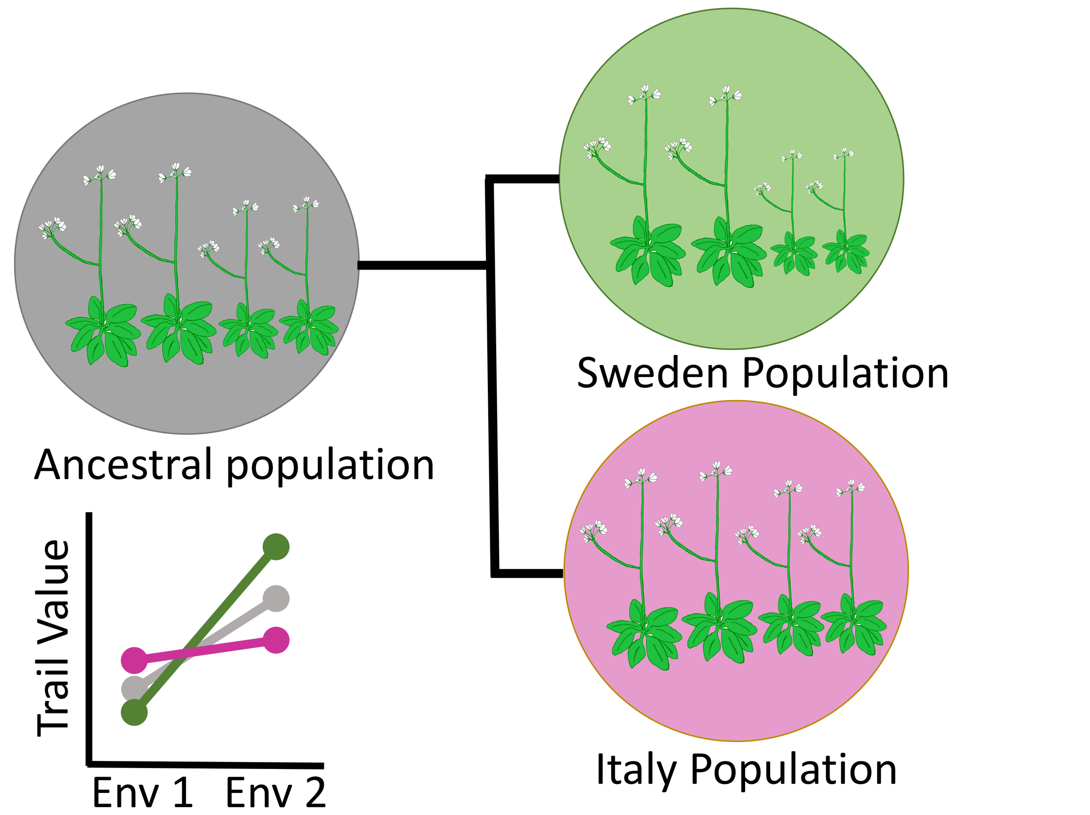


Figure 1: Population Differentiation results from past selection and drift. Mean differences between current populations in a common environment reflect how selection and drift have acted on each population in their home environment.

Significance: Understanding plasticity will be important during rapid environmental change and in the increasingly variable climates projected for the future. Increased knowledge of plasticity can increase accuracy of range shift predictions, inform assisted migration efforts, and impact food system sustainability.

Methods

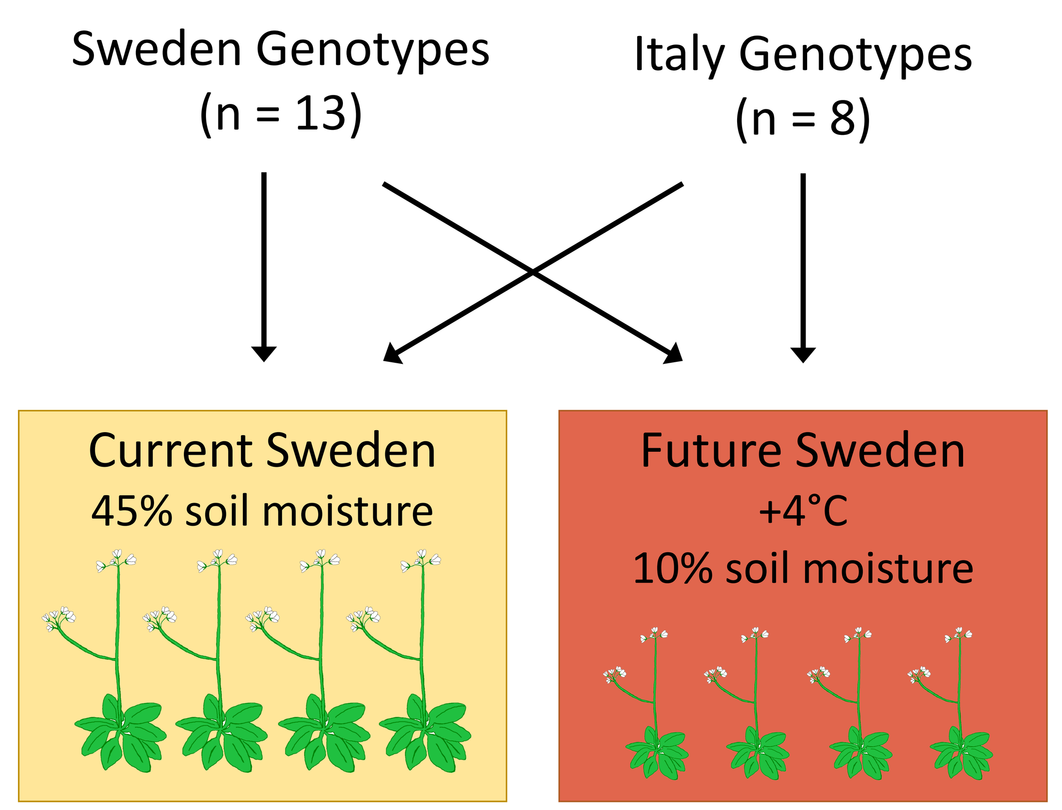
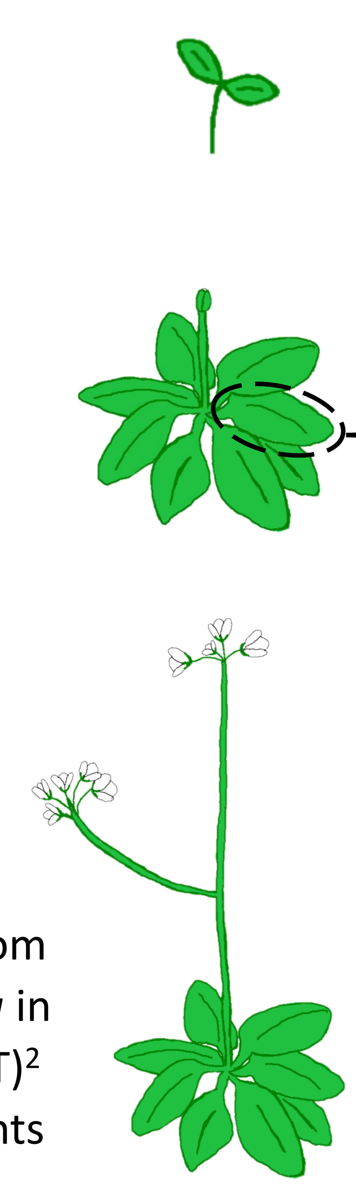


Figure 2: Methods Schematic. In Fall 2021, genotypes from two locally adapted populations[3] of *Arabidopsis thaliana* in Rödåsen, Sweden (SW) and Castelnuovo di Porto, Italy (IT)[2] were grown in a current and future environment (50 plants x 2 treatments = 100 plants) and phenotyped for traits related to phenology, drought response, biomass allocation, and fitness. Chamber temperatures were adjusted weekly.



- Emergence Date
- Bolting Date
- Flowering Date
- Specific Leaf Area
- Leaf Dry Matter Content
- Water Stress
- Harvest Date
- Rosette Leaf Number
- Above Ground Biomass
  - Rosette
  - Reproductive
- Fruit Number
- Seed Number *(ongoing)*

Results

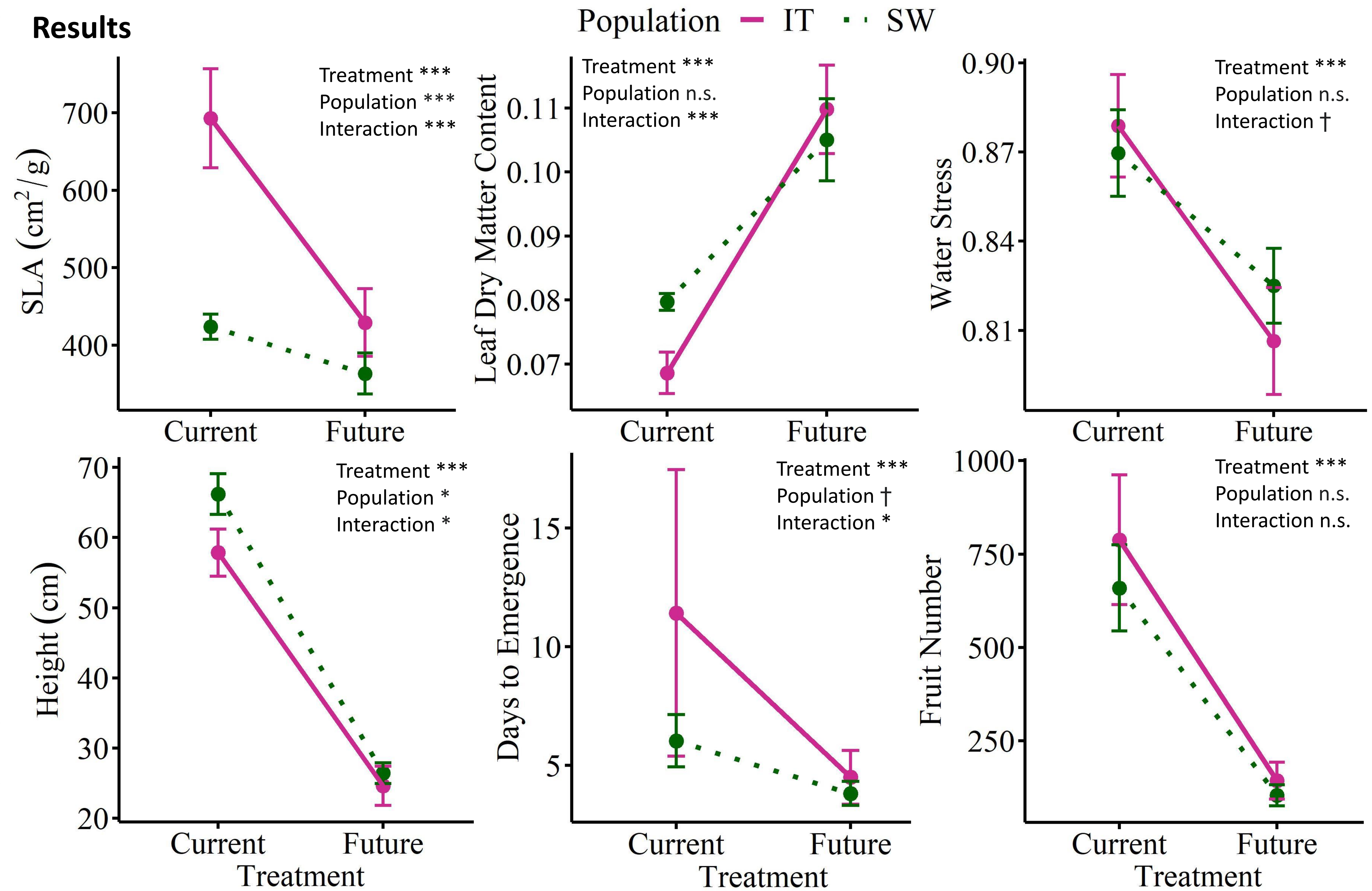


Figure 3. Some traits show genetic differentiation for plasticity. Points are means and error bars are 95% confidence intervals. Model statistics shown in each corner are described in Table 1.

Table 1. Some traits do not show genetic differentiation for plasticity. Results for a mixed model to test the effect of treatment (is there plasticity?), population (is there genetic differentiation?), and their interaction (is there genetic differentiation for plasticity?). *** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1; n.s. p > 0.1

Trait	Treatment	Population	Interaction
Bolting	n.s.	***	n.s.
Flowering	†	***	n.s.
Harvest Date	***	***	n.s.
Rosette Leaf Number	***	***	n.s.
Rosette Weight	***	*	n.s.
Reproductive Weight	***	n.s.	n.s.
Reproductive:Rosette	***	*	n.s.

Discussion

- Plasticity in all drought and biomass allocation traits was in the same direction for both populations.
- There is mean genetic differentiation between populations for 8 of 13 traits.
- There is genetic differentiation of plasticity in 4 of 13 traits, including two measurements of the leaf economics spectrum.
- Differentiation for plasticity did not result in fitness differences between the populations in either environment.

Future Work

- One line from each population is the parent of a large set of genotyped recombinant inbred lines.[2] Future work will phenotype the recombinant inbred lines and look for plasticity QTLs and selection gradients to investigate the direction of future evolution of plasticity.

References

[1]Droste et al.(2010). *Plant Ecol*. [2]Agren et al.(2013). *PNAS*. [3]Agren and Schemske (2012). *NewPhyt.*

Acknowledgements

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