EFFECTS OF CULTIVATION ON SEED DORMANCY IN WILD VIOLETS: IMPLICATIONS FOR RESTORATION

David Nguyen[1], Marcello De Vitis[2], Andrea Kramer[2]

[1]Loyola University Chicago, Chicago, IL, 60660 [2]Chicago Botanic Garden, Glencoe, IL, 60022

2021 Research Experiences for Undergraduates Program

Introduction

The Tallgrass Prairies are one of the most endangered ecosystems in the world, mostly due to land conversion for purposes of agriculture [1]. Violets are important species of the Tallgrass Prairies because they are the host plants to the larvae of Regal Fritillary Butterflies (Regals) [2], which is why they are of high restoration interest and several nurseries have been propagating them. The cultivation of wild plants for restoration is a process that could lead to unwanted selection through changes in seed physiology and dormancy [3]. Wild violet seeds are known to require the cold stratification pre-treatment to break their physiological dormancy [reviewed in 4]; however, the cultivation process for conservation is likely causing changes in adaptive traits such as seed germination and dormancy. Dormancy loss has implications for wild plant demography, with consequences that could compromise reintroduction success [3].

Hypothesis

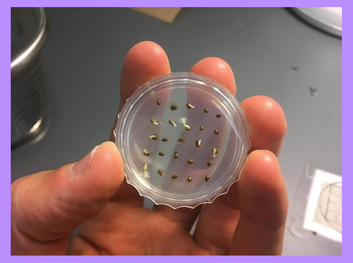
Our hypothesis is that seeds sourced from violets in cultivation from one to multiple generations show some loss of dormancy

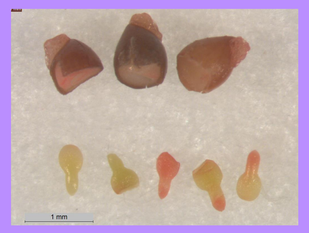
compared to their wild counterparts.

Materials & Methods

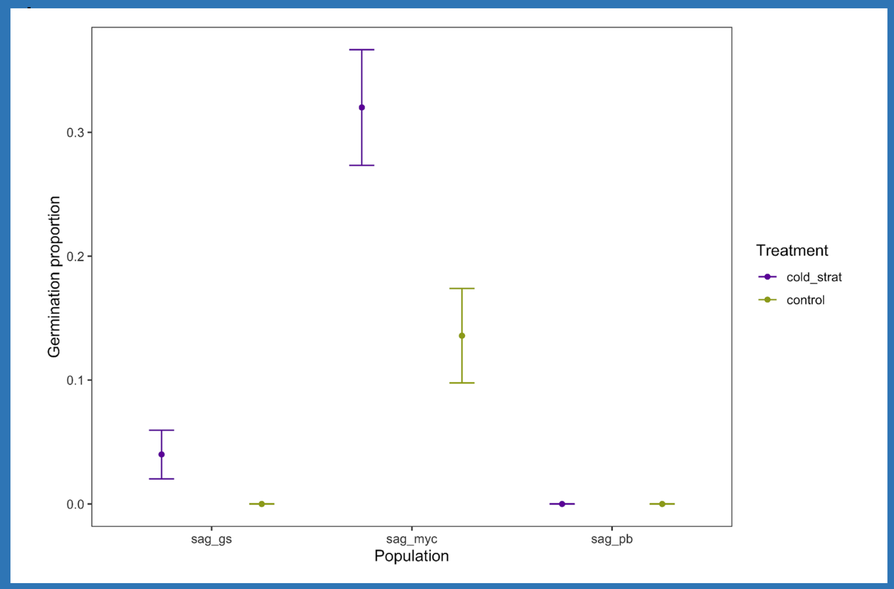
In order to test our hypothesis, we tested the germination of wild-collected vs. cultivated seeds in two species of violets from the Midwest: *Viola lanceolata* and *V. sagaittata.*
For *V. lanceolata,* we studied three populations: one wild population (LAN GS), one population cultivated for one generation (LAN 1YC), and one population cultivated for multiple generations (LAN MYC). For *V. sagittata*, we studied two wild populations (SAG GS and SAG PB) and one population cultivated for multiple generations (SAG MYC).
In order to test any loss of dormancy, we tested germination of all the above populations by comparing fresh seeds (non-pre-treated) and cold stratified seeds.

1. Specifically, for each population (6 in total) and each treatment (fresh seeds and cold stratified seeds), we sown four replicates of 25 seeds (except for SAG PB where ten seeds per replicate were sown due to seed shortage) filled with 1.5% agar solution.
2. Fresh seeds were incubated at 25/15ºC right after sowing; while cold stratified seeds were exposed to six weeks of cold stratification at 0-3ºC and then incubated at 25/15ºC.
3. Germination was scored two days a week for 14 days; each seed was considered germinated based on visible radicle emergence.
4. The remaining ungerminated fresh seeds were tested for viability via Tetrazolium (TZ) Test.



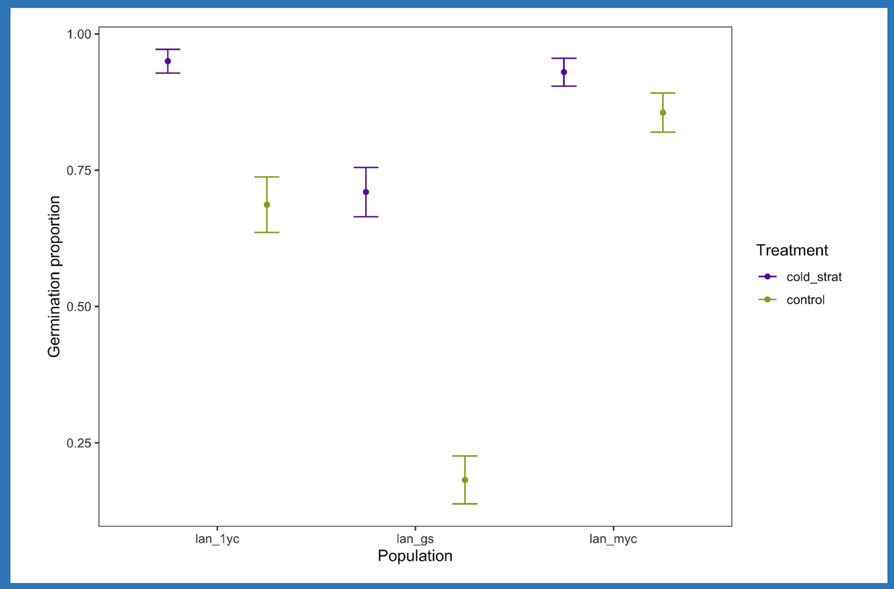


Results



	Df	Deviance	Resid. Df	Resid. Dev	Pr(>Chi)
NULL			23	147.629	
pop	2	68.854	21	78.775	1.119e-15 ***
treat	1	11.487	20	67.288	0.0007007 ***
pop:treat	2	1.706	18	65.582	0.4262060

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1



	Df	Deviance	Resid. Df	Resid. Dev	Pr(>Chi)
NULL			23	218.610	
pop	2	91.360	21	127.251	< 2e-16 ***
treat	1	71.621	20	55.629	< 2e-16 ***
pop:treat	2	6.533	18	49.096	0.03815 *

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Discussion

The results of the experiment confirmed our hypothesis, as we found for both species that cultivation is affecting the seed germination requirements. Cultivated populations of both species showed higher germination proportions than their wild counterparts and a loss of dormancy. Other studies have found similar results: For example, Ensslin et al. [3] observed changes in seed dormancy in 72 herbaceous plant species; Rojas-Arechiga et al. [5] also found in cultivated populations of *Stenocereus stellatus* that there were significantly higher germination than the wild ones. From the experiment on *V. lanceolata,* we were also able to observe that one generation of cultivation is enough to alter seed dormancy. Similarly, De Vitis et al. [6] found that one generation of cultivation significantly affected the germination requirements of *Malcolmia littorea.* The results we have found suggest that the seeds produced from cultivated populations would not be suitable for reintroducing violets back into the wild. Therefore, improvements in cultivating wild plants need to be implemented to prevent significant changes in adaptive traits that can hinder reintroduction success.

Conclusion

To improve the restoration of wild plant species, cultivation

conditions should replicate as much as possible the conditions of restoration sites.

Acknowledgements

We’d like to thank NSF-REU grant DBI-0353752 for support. Thank you as well to Erica Cao and Angelique Avecedo for providing some of their assistance to this project.

References

1. Noss, R. F., & Scott, J. M. (1995). Endangered ecosystems of the United States: a preliminary assessment of loss and degradation.
2. Henderson, R. A., Meunier, J., & Holoubek, N. S. (2018). Disentangling effects of fire, habitat, and climate on an endangered prairie-specialist butterfly. *Biological Conservation*, *218*, 41-48.
3. Ensslin, A., Van de Vyver, A., Vanderborght, T., & Godefroid, S. (2018). Ex situ cultivation entails high risk of seed dormancy loss on short-lived wild plant species. *Journal of Applied Ecology*, *55*(3), 1145-1154.
4. Baskin, C. and Baskin, J.M. (2014) Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press, San Diego, 150-162.
5. Rojas-Aréchiga, M., Casas, A., & Vázquez-Yanes, C. (2001). Seed germination of wild and cultivated Stenocereus stellatus (Cactaceae) from the Tehuacán-Cuicatlán Valley, Central México. *Journal of Arid Environments*, *49*(2), 279-287.
6. De Vitis, M., Seal, C. E., Ulian, T., Pritchard, H. W., Magrini, S., Fabrini, G., & Mattana, E. (2014). Rapid adaptation of seed germination requirements of the threatened Mediterranean species Malcolmia littorea (Brassicaceae) and implications for its reintroduction. *South African Journal of Botany*, *94*, 46-50.

REU Site: *Plant Biology & Conservation Research Experiences for Undergraduates - From Genes to Ecosystems* (Supported by NSF award DBI-0353752).