

Establishment of a new white oak common garden on the Green Mountain National Forest

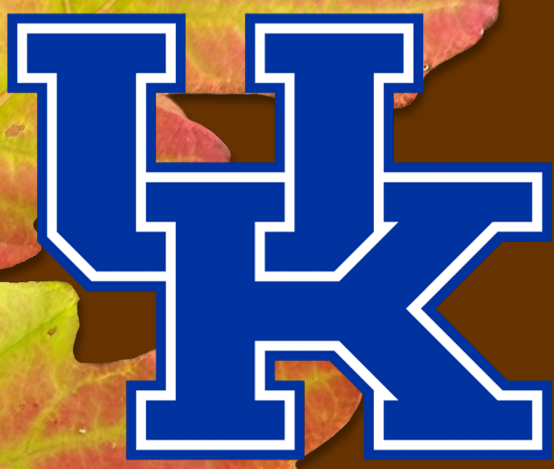
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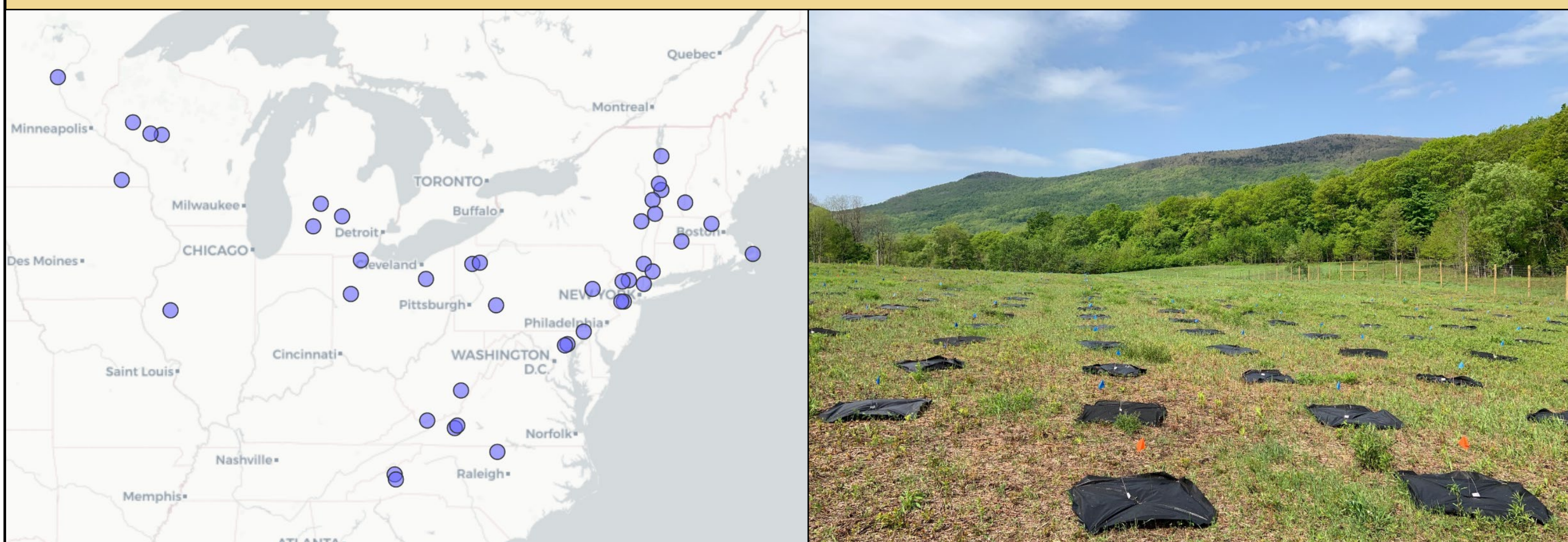
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BACKGROUND

White oak (*Quercus alba*) occurs throughout eastern U.S. forests where it is an important component of forest biodiversity. It is highly valued by wildlife as well as the forest products industry. There is concern related to: regeneration of oak seedlings and saplings in existing stands, re-establishment of oak within stands that have been harvested, and future availability of desirable quality oak. Environmental threats, including invasives and pests, as well as a warming climate, challenge the long-term sustainability of this vital forest tree species and its habitat.

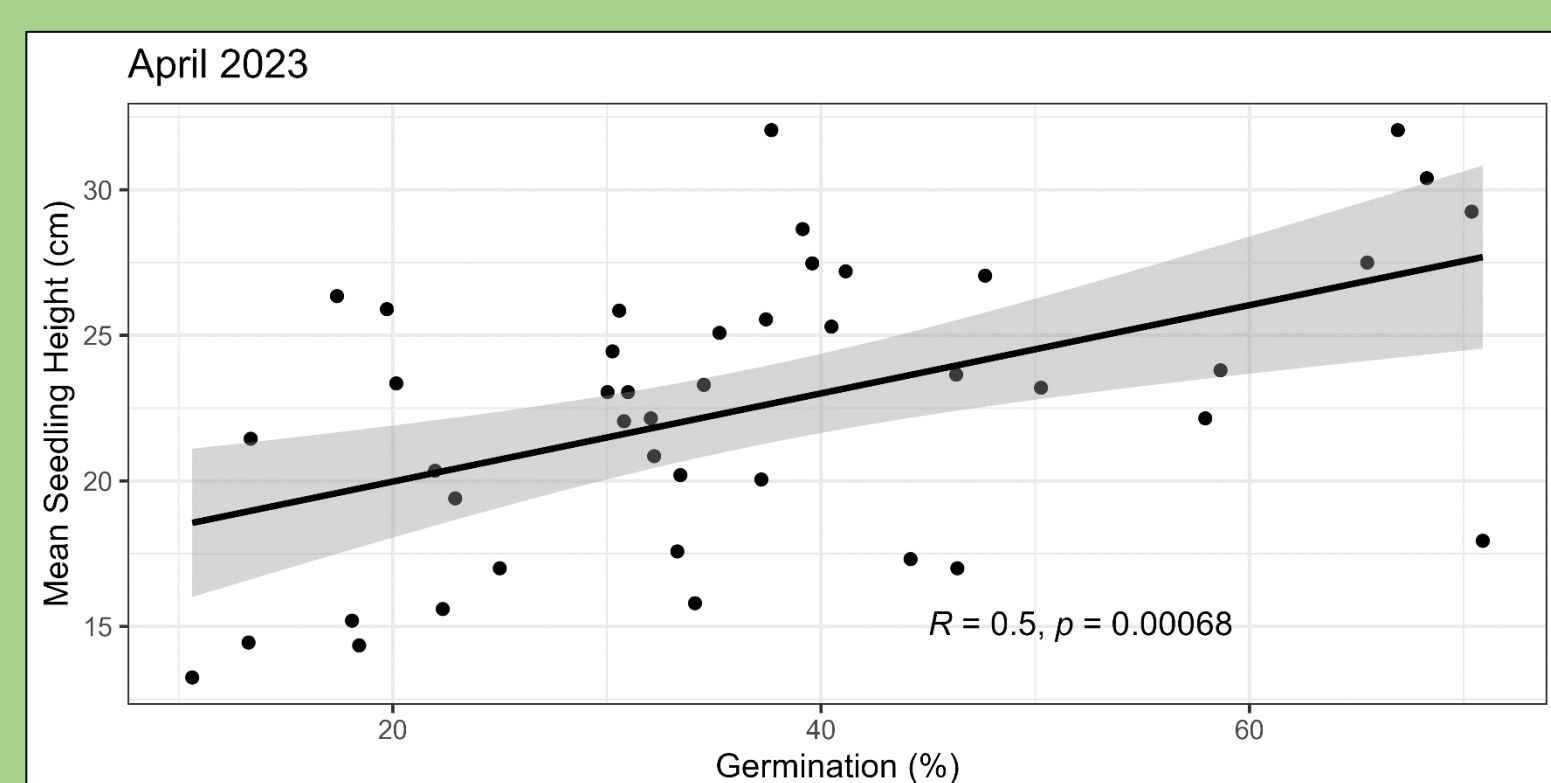
We established a white oak common garden on the Green Mountain National Forest (GMNF) in East Dorset, Vermont in April 2023, as part of a collaboration with the White Oak Genetics and Tree Improvement Project at the University of Kentucky. The aim of the project is to evaluate climate adaptative traits, assess suitability on a wide range of sites, identify superior performance, and inform restoration and assisted migration strategies for the species. We planted seedlings from 44 half-sib families in 20 replicates and assessed their growth and foliar phenology during the 2023 growing season. The families are broadly grouped geographically with an eastern transect from North Carolina to Vermont and a mid-western transect from Ohio to Minnesota.



The white oak common garden was planted on the GMNF in East Dorset, VT on April 19-20, 2023. Purple circles on the map above represent origins of 44 half-sib families that comprise the common garden in East Dorset, VT.

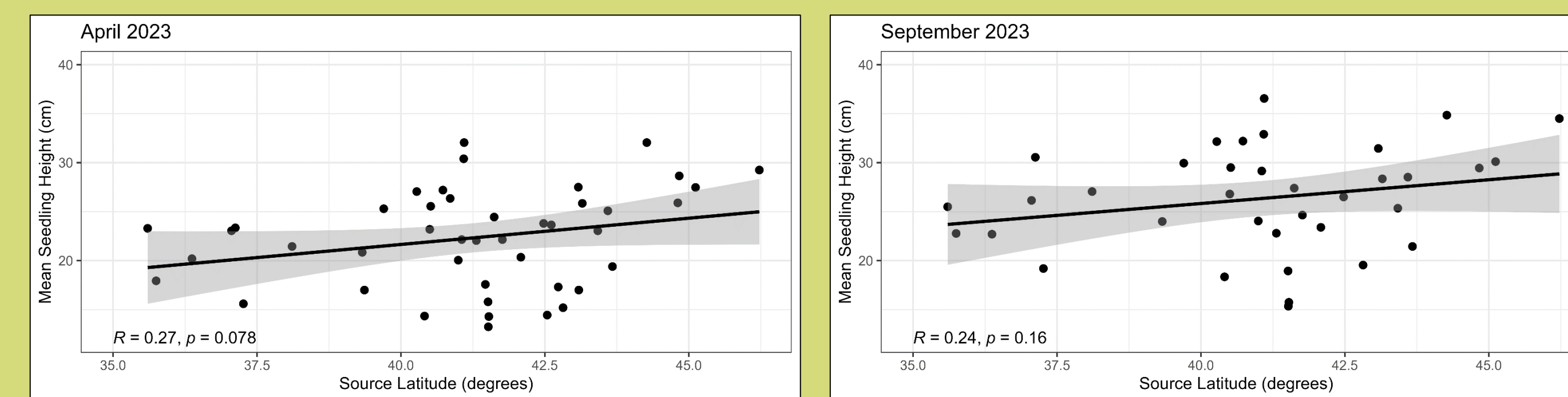
GERMINATION RESULTS

Mean seedling height of individual families at the time of planting in Vermont (April 2023), was positively related to germination success at the Kentucky State Nursery ($P=0.0007$). Many factors can impact acorn quality and germination, such as adequate pollen from nearby trees, local gene diversity, and environmental conditions at the time of flowering. We observed that families with higher germination rates were taller, and those with lower germination were shorter.

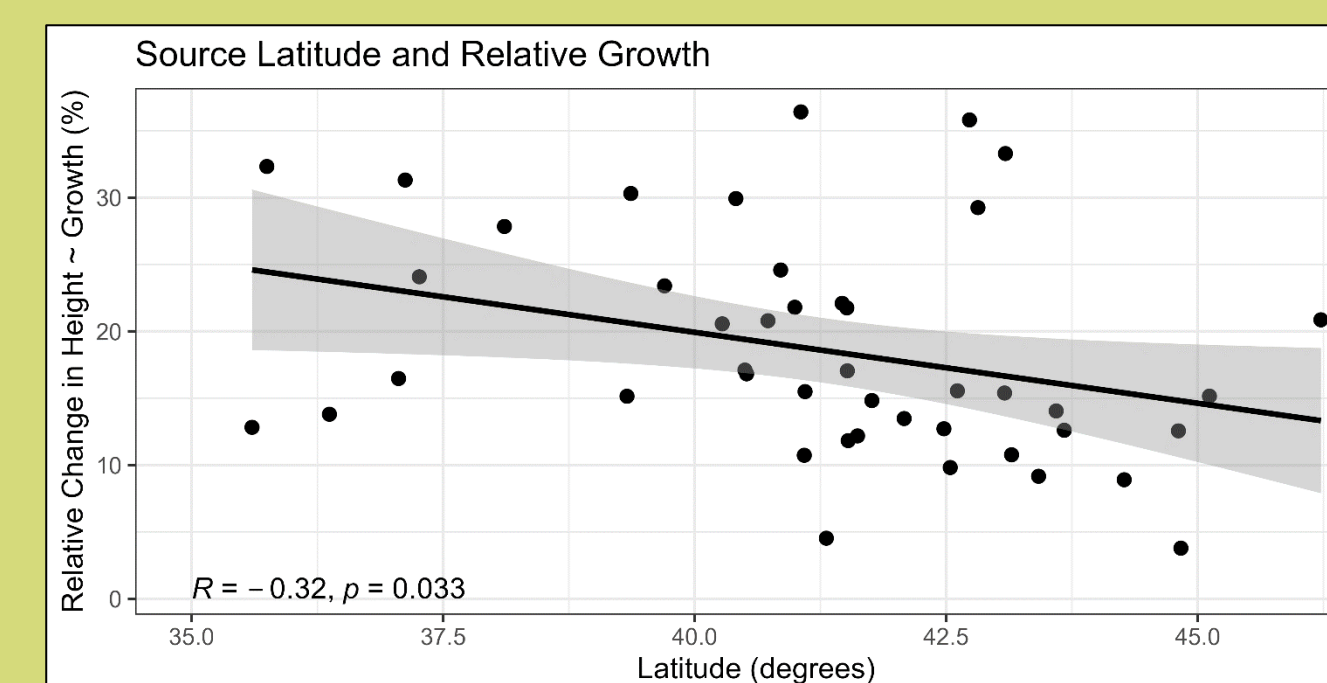


SURVIVAL AND GROWTH RESULTS

Seedling survival was excellent and ranged from 88 to 100 % depending on family, with no obvious latitudinal trends. Mean seedling height at the time of planting and at the end of the growing season (September 2023) was compared with source latitude to discern whether growth was influenced by north-south origins of individual families. While regression analyses indicated no significant associations at either timepoint, seedlings from more northerly latitudes tended to be taller at the time of planting ($P=0.078$) with the trend flattening by the end of the growing season ($P=0.160$).

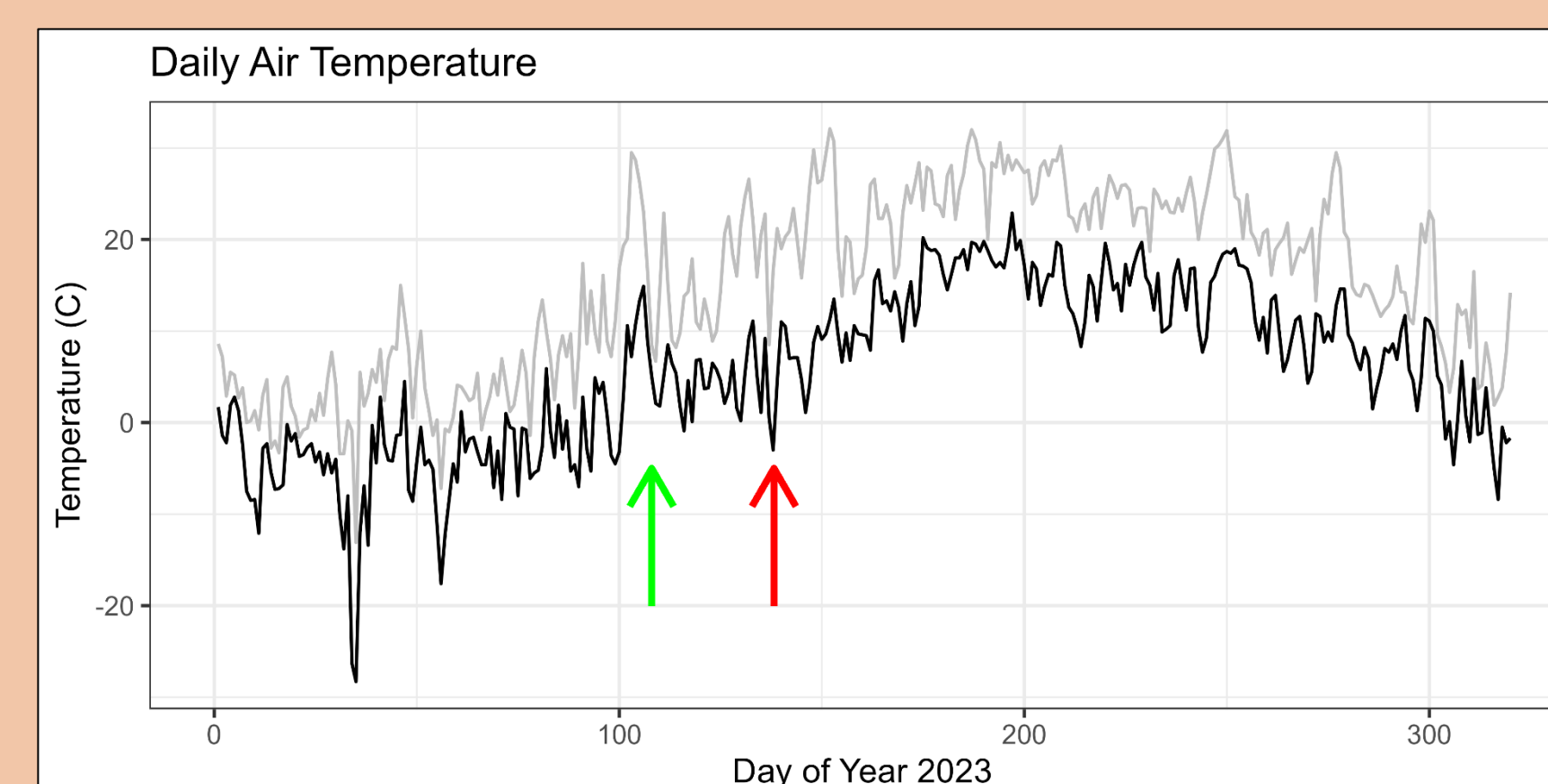


When relative change in seedling height from April to September was considered, a significant relationship emerged where families with southern origins tended to grow more than their northern counterparts in Vermont ($P=0.033$).

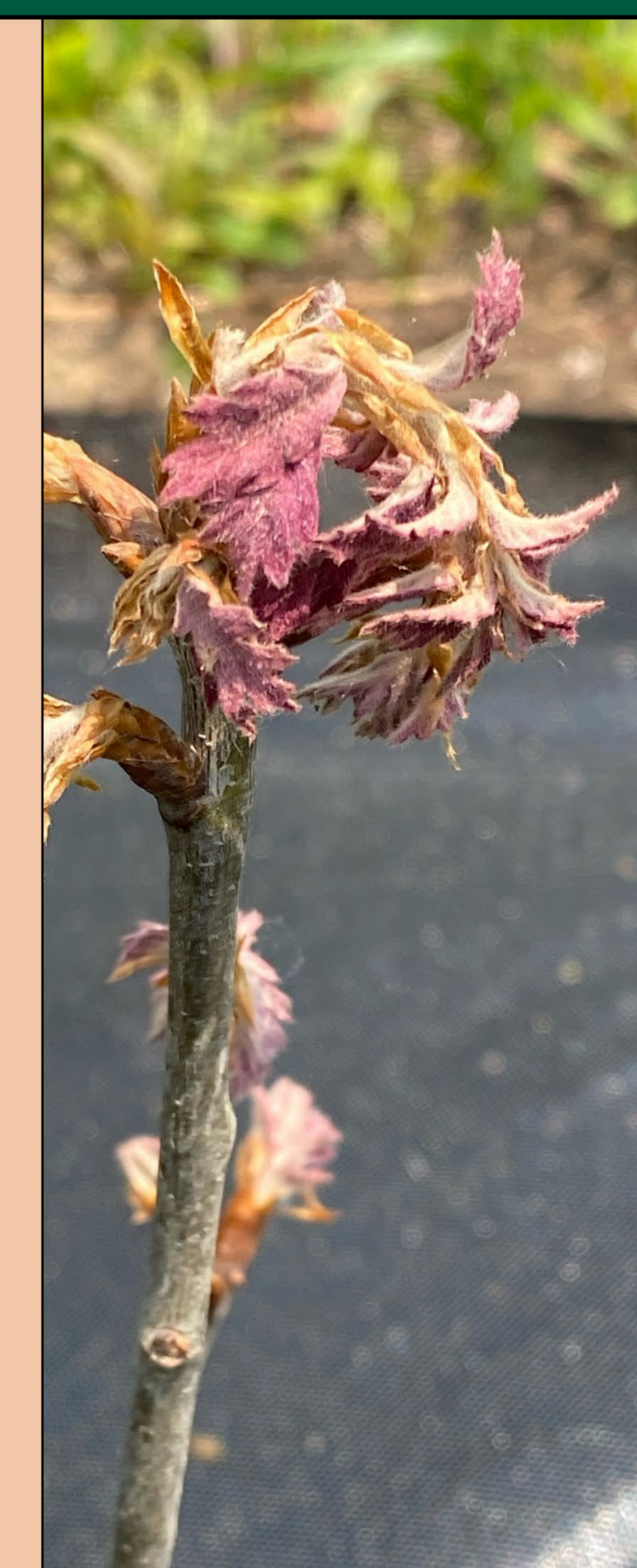


SPRING PHENOLOGY RESULTS

A freeze event on May 18, 2023, caused widespread damage throughout northern New England and New York. During this event, minimum air temperature reached a low of $-3\text{ }^{\circ}\text{C}$ in East Dorset, VT. In response, we conducted spring bud phenology assessments and quantified foliar frost damage on May 22, 2023.

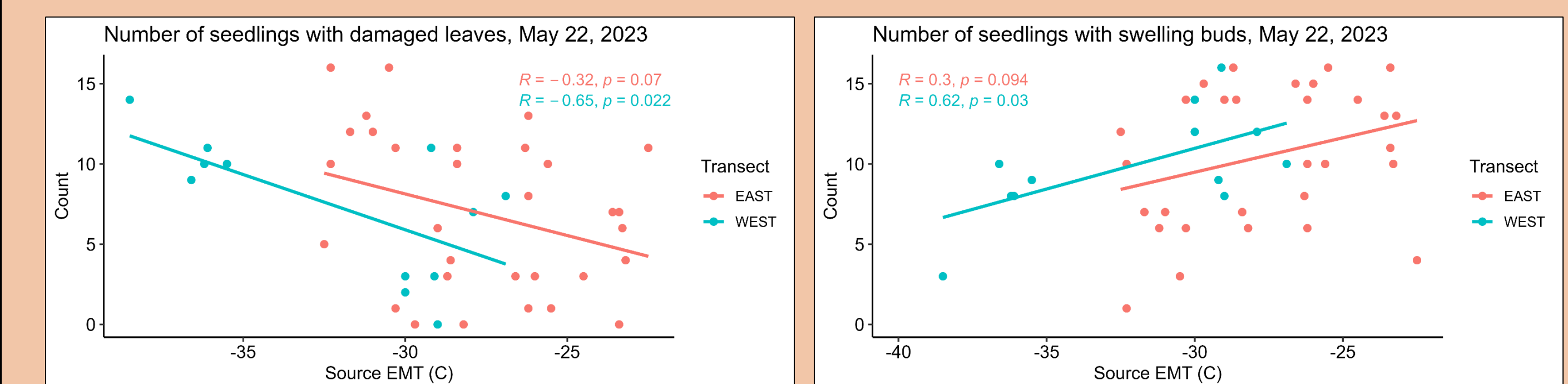


Seedlings were planted in East Dorset, VT on April 19-20, 2023 (green arrow). The grey line represents daily maximum temperature while the black line represents daily minimum temperature (www.visualcrossing.com). The red arrow represents a region-wide frost event that occurred on May 18, 2023.

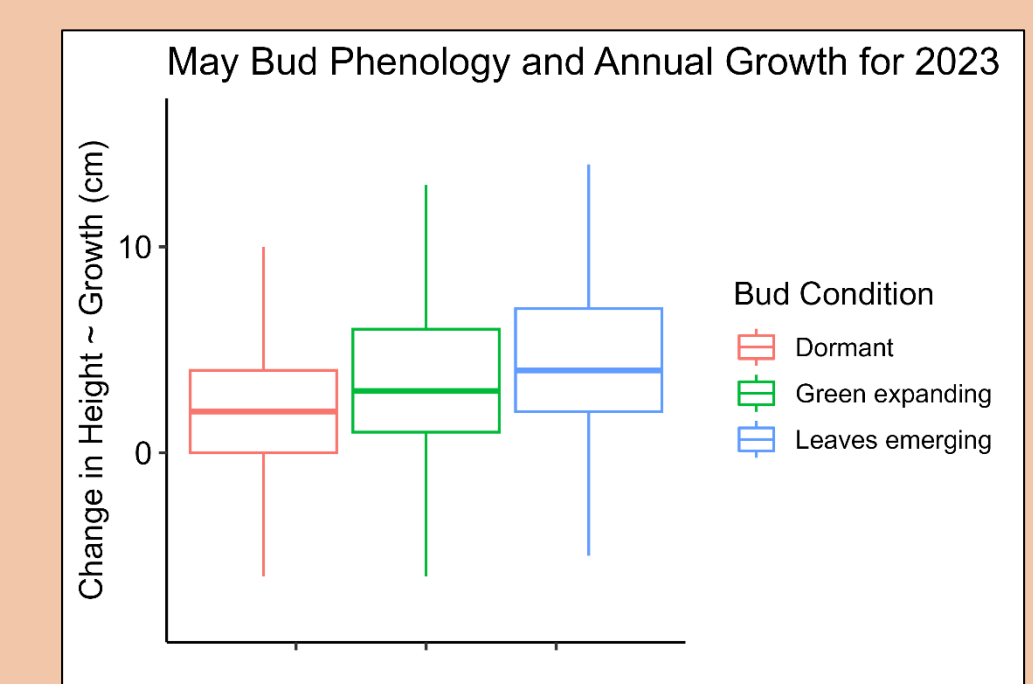


On May 22, we discovered that **all seedlings** with newly emerged leaves were damaged by the frost event. When the number of seedlings with foliar frost damage in each family was compared to the extreme minimum temperature (EMT) of their origin (ClimateNA), there was a significant relationship among seedlings in the West transect ($P=0.022$) and similar trend with the East transect. Families whose leaves emerged early were most susceptible to foliar frost damage. Seedlings with swollen buds were not damaged.

More seedlings from colder regions suffered freeze damage



Despite suffering significant foliar damage early in the growing season, these “early-emerging” individuals had superior height growth (see box plot to right).



CONCLUSION AND FUTURE PLAN

We are pleased with the successful establishment of this white oak common garden on the Green Mountain National Forest, despite experiencing significant freeze damage in mid-May. Families that experienced the most freeze damage exhibited greater growth by the end of the growing season. Instead of a single terminal bud, white oak have a cluster of buds which may offer ready “replacements” for isolated freeze events.

While these are very early results, there is **evidence of climate adaptation** in growth and phenology, which could inform future acorn collection and planting strategies.

In the years to come, we will assess survival, growth, and response to climate via assessments of spring bud and foliar phenology, leaf physiology, as well as winter cold tolerance. We plan to incorporate additional families from regionally sourced acorns (VT, NH, MA and NY). These families were planted at the New York State tree nursery in autumn 2023 and will be added to the white oak common garden in spring 2025.



ACKNOWLEDGEMENTS

We would like to acknowledge the many volunteers who collected the acorns that made this installation possible. The staff of the Green Mountain National Forest was instrumental in providing a planting location, site preparation, infrastructure support and ongoing maintenance especially Jeff Tilley, Josh Wills, Stacey Stratton and James Donahey. Peter Anderson, Steven Flurry, Bert Abbott and Pat Abbott all traveled to Vermont to help plant in April 2023.