INTRASPECIFIC VARIATION IN GROWTH, PHOTOSYNTHETIC, AND FUNCTIONAL TRAITS IN *QUERCUS ROBUR* IN RELATION TO DROUGHT AND VAPOR PRESSURE DEFICIT

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PURPOSE AND SCOPE

Drought, driven by rising temperatures and decreasing soil moisture, has a profound influence on ecological shifts and species distribution. It is often assumed that tree seedlings from populations native to drier regions are more drought tolerant than those from wetter areas. However, intraspecific variation in drought tolerance has not been well characterized, despite its critical role in developing climate change mitigation and adaptation strategies and predicting the effects of drought on forests (Candido-Ribeiro et al. 2024). To better understand tree responses and intraspecific variability to drought and increased vapor pressure deficit (VPD), we conducted an experiment using four *Quercus robur* (QR) provenances from latitudes 44 to 54 °N.

METHODS AND APPROACH

One-year-old seedlings in a common garden experiment were subjected to three treatments: drought, water deficit (50 percent of control), and control (optimal irrigation) in a randomized complete block design. During the nearly 60-day drought treatment, we monitored short-term stress responses by measuring gas exchange parameters, including photosynthesis, stomatal conductance, and transpiration. These measurements were taken during both the drought phase and a subsequent 30-day regeneration period. Long-term effects on growth parameters, such as height, diameter, and biomass allometry, were assessed over 2 years. To analyze the data, we used general additive models to investigate stomatal sensitivity to VPD and linear mixed models to examine the responses of provenances to treatments over time.

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FINDINGS AND IMPLICATIONS

All provenances showed similar stomatal responses to decreasing soil moisture ($P \geq 0.54$), and the interaction between provenance, treatment, and time was not significant ($P \geq 0.85$) at the physiological level (gas exchange). Importantly, all seedlings quickly and completely recovered from the stress at the physiological level. The statistically significant differences in stomatal sensitivity were increasing VPD between provenances, with the most southern provenance being the least sensitive.

Growth responses revealed long-lasting consequences of reduced photosynthesis during drought stress, as the growth differences between contrasting treatments persisted for over a year after the stress period. The root-to-shoot ratio was highest in the water deficit treatment, but roots generally showed increased growth after rewatering in the drought treatment, demonstrating the great potential of oak to recover.

Our study has shown that decreasing soil moisture has a lasting effect on photosynthesis and consequently also on growth parameters. In forest ecosystems, this decrease can be reflected in lower biomass production. Furthermore, the study suggested limited local adaptation to soil drought, with adaptations observed mainly in response to a higher VPD in a clinal gradient. Although the southernmost provenance was less sensitive to increased VPD, it also exhibited maladaptation in phenology, compromising its growth. These findings highlight the potential limitations of utilizing assisted gene flow over long distances. Nevertheless, *Q. robur* exhibited a high recovery potential after stress on both physiological and allometric levels.

LITERATURE CITED

Candido-Ribeiro, R.; Aitken, S.N.; Sciences, C. 2024. Weak local adaptation to drought in seedlings of a widespread conifer. New Phytologist. 241: 2395–2409. https://doi.org/10.1111/nph.19543.

ACKNOWLEDGMENTS

The authors thank their colleagues, Szymon Krajewski and Piotr Zajączkowski, for their assistance in preparing the experiment and collecting data. They also extend their gratitude to Piotr Gołos, Rafał Mitlejner, and Marek Sybilski for their administrative support and help in constructing the experiment's infrastructure. This research was funded by the General Directorate of the State Forests (Poland), grant no. 500468, and by Forest Research Institute subsidies, grant no. 900253, awarded to Marzena Niemczyk.