PROJECT: UV-Protect

Date: **10.12.2024** **REPORTING**

ID: 88

PROJECT TITLE

Sunlight simulation of elevated UV-B radiation to dissect the metabolic landscape as well as fitness within a global Arabidopsis thaliana population to identify novel UV-B protective components

CONSORTIUM

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SUMMARY OF THE REPORT

Despite UV-B radiation accounting for only 0.5% of solar energy reaching the Earth's surface, its potential to cause damage remains substantial. Numerous studies have documented its adverse effects, including damage to DNA, RNA, and proteins, disruption of lipid membranes, induction of cell death, and morphological abnormalities in flowers and pollen. Plants respond to UV-B exposure through hierarchical, multiphasic metabolic reprogramming. A key aspect of this response is the synthesis of antioxidant "sunscreen" compounds, such as phenylpropanoids (e.g., hydroxycinnamates and flavonoids) and other antioxidants like ascorbate. Extensive research using forward genetics has identified metabolites and genes involved in UV-B tolerance, often through mutant screens for UV-B sensitivity. The importance of photoprotective metabolites has been further clarified through studies of knockout mutants lacking compounds such as ascorbate, sinapoyl-esters, and flavonoids.

In the UV-Protect project, the impact of UV-B on both vegetative and reproductive organs is being explored using the HapMap population of Arabidopsis thaliana, consisting of 315 geographically distinct accessions. Our lab previously demonstrated that some Arabidopsis accessions produce novel UV-B-absorbing compounds called "saiginols" (phenylacylated flavonoids) that are more efficient in absorbing UV-B than their precursors. The genes responsible for saiginol production were identified through transcriptomic correlation analysis. However, no studies have yet linked metabolite variation to natural genomic variation using genome-wide association studies (GWAS). This project employs GWAS to investigate the diversity of UV-B responses in a hypothesis-free manner, aiming to identify quantitative trait loci (QTL) and genotype-by-environment (GxE) interactions. Further exploration of UV-B's effects on reproductive organs and yield performance across this diverse population is also needed. Access to facilities such as ExpoSCREEN and SunSCREEN provides new opportunities for groundbreaking research in this area.

For UV-Protect to succeed, several visits to the Helmholtz Institute were conducted. During the initial visit, plants were sown for experiments in the ExpoSCREEN and SunSCREEN chambers, with Helmholtz staff ensuring optimal conditions for UV-B and non-UV-B treatments. During subsequent visits, vegetative plant material was harvested, and new seeds were sown to replicate the experiment. Flowers were harvested throughout the growing season to account for variations in flowering time, with final collections including seeds from matured plants.

Currently, we are processing the extensive sample sets for downstream metabolic profiling and plant fitness assessments. This experiment's success would not have been possible without the exceptional support from the Helmholtz Institute, especially Jogi and Barbro, as well as the technical team, to whom we extend our deepest gratitude.