Understanding the HAD domain function of the SUPPRESSOR OF QUENCHING 1 protein in photoprotection in *Arabidopsis thaliana*

Sham Vera[1], Berkley J. Walker[2] and Alizée Malnoë[1]

[1]Department of Biology, Indiana University Bloomington, USA
[2]Department of Plant Biology, Michigan State University, USA
shamvera@iu.edu & amalnoe@iu.edu

Abstract

Photosynthesis converts light into chemical energy, essential for food production and climate change mitigation. Yet, excess light can be detrimental, producing reactive oxygen species that damage plant cells and triggering photorespiration by prompting ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco) to react with O_2 instead of CO_2. Additionally, Rubisco activity can be impaired by sugar phosphate inhibitors. Plants employ non-photochemical quenching (NPQ) to dissipate excess light as heat. One form, qH, is a slowly reversible NPQ process mediated by the protein LIPOCALIN IN THE PLASTID (LCNP). The protein SUPPRESSOR OF QUENCHING 1 (SOQ1) negatively regulates qH, while RELAXATION OF QH1 (ROQH1) deactivates it. Loss of LCNP makes plants vulnerable to photobleaching in excess light, while constitutive qH activation in *soq1 roqh1* mutants severely restricts growth, highlighting the need to balance light harvesting and energy dissipation. SOQ1 has multiple isoforms and domains in the chloroplast stroma and lumen. While the lumenal domain inhibits qH, the function of the stromal haloacid dehalogenase-like hydrolase (HAD) domain remains unknown. This domain, unique to land plant SOQ1 proteins, is not required for qH inactivation but is closely related to CbbY, a sugar phosphatase protein that dephosphorylates xylulose-1,5-bisphosphate, a Rubisco inhibitor. We propose that under excess light or photorespiratory conditions, accumulating sugar phosphates may activate SOQ1-HAD sugar phosphatase activity, leading to downstream modulation of the lumenal domains of SOQ1, thereby triggering qH (Fig.1). Here, using chlorophyll fluorescence, we observed qH-dependent increase in NPQ during photorespiration. We will further investigate Rubisco activity and identify the SOQ1-HAD domain's substrates in qH transformants via gas exchange and mass spectrometry. These studies will enhance our understanding of SOQ1 domain crosstalk in photoprotection, offering insights for engineering resilient crops.

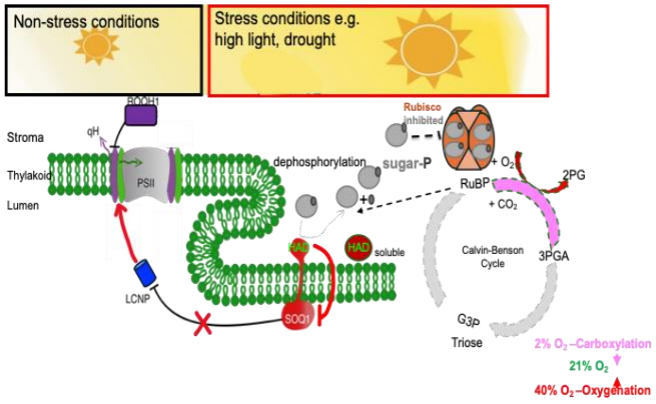

Fig.1. SOQ1-HAD domain functions as a sugar phosphatase