

FINAL REPORT

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The xanthophyll cycle is a ubiquitous activity in higher plants. A major function of the cycle is to protect the photosynthetic system from the potentially damaging effects of high light by dissipating excess energy that might otherwise damage the photosynthetic apparatus harmlessly as heat by a process termed non-photochemical quenching (NPQ). Our research focused on investigating the dynamics of the relationship between PsbS, subunit PSII protein required for NPQ, and zeaxanthin by perturbing the natural relationship of these components by overexpression of PsbS, violaxanthin de-epoxidase (VDE), and PsbS+VDE in tobacco. The effects of these treatments showed that the relationship between NPQ and zeaxanthin formation is more complex than previously indicated from studies carried out under high light. It is postulated that the xanthophyll cycle functions as a type of signal-transduction system within the thylakoid membrane. Recent studies in model lipid systems demonstrated that zeaxanthin exerts feedback inhibition on violaxanthin de-epoxidase. This feedback inhibition is consistent with the lipid phase functioning as a modulating factor in the dynamics of the cycle's operation. While this research and those in other laboratories have defined both the biochemistry and molecular mechanism of the cycle's operation, especially for violaxanthin de-epoxidase, there is yet insufficient knowledge that explains the ubiquitous presence of the cycle in all higher plants and a related cycle in diatoms. Antisense VDE tobacco plants (work carried out under another grant) withstood the high-light environment in Hawaii over one generation. Thus, it is speculated that the protective system was essential for survival in earth's high-light earth environment over multiple generations. The proposed signal transduction protective system, however, may explain the ability of the protective system to modulate or adapt to a range of environments.