ABSTRACT

"Quantum-molecular, photo-electrochemical and algorithmic regulation of Darwinian fitness in Arabidopsis"

Prof Stanislaw M. Karpiński
Dept. of Plant Genetics, Breeding & Biotechnology
Faculty of Horticulture & Landscape Architecture
Warsaw University of Life Sciences
Warsaw
POLAND

In a simplified model of photosynthesis, light energy absorbed by chlorophylls of photosystem II is distributed between photochemistry, fluorescence, and heat. Spectrally and time-resolved fluorescence combined with foliar heat dynamics measurements demonstrates that higher plants evolved genetic and physiological global regulatory system, which optimizes photosystem II quantum-molecular functions and the fate of photons absorbed in excess *(1, 2)*. Our results indicate the role of the PsbS and the photosystem II antenna organization in efficient en discrete global regulation of the rates between photochemistry, fluorescence, and heat *(3)*. This in turn specifically influences global electrochemical signalling and regulates growth, acclamatory and defense responses in *Arabidopsis*.

Changes in phytochemistry, water use efficiency, hormonal and reactive oxygen species cellular homeostasis and seed yield of *Arabidopsis* can be defined by the exponential function and simple equation with natural logarithm ($y = y_0 * e^{-Kx}$), that depends on molecular regulators: LESION SIMULATING DISEASE 1 (LSD1), ENHANCED DISEASE SUSCEPTIBILITY 1 (EDS1) and PHYTOALEXIN DEFICIENT 4 (PAD4) *(4-8)*. The *LSD1* recessive null mutant *(lsd1)* regardless of permissive laboratory or non-permissive laboratory and field conditions demonstrates constant seed yield, but significant variation in phytochemistry and water use efficiencies, and in foliar transcriptomes that depend on EDS1 and PAD4. Obtained results suggest that LSD1/EDS1/PAD4 constitute at least tree component molecular machinery regulating plant Darwinian fitness. Our experiments supported with mathematical modelling indicate that *Arabidopsis* plants perform discrete global regulation of the rates between photochemistry, fluorescence and heat, thus perform biological processing aimed at optimizing and integrating photosynthesis, water use efficiency, reactive oxygen species and hormonal cellular homeostasis. This processing allows to reach the best possible seed yield and Darwinian fitness in multivariable natural environment.

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