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Plastidial Phosphate Transport in Plants

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ABSTRACT

Phosphorus is an essential element for all living organisms and is central to the genetics and energetics of life. Inorganic phosphate (P_i) is recurrently involved in protein regulation and signal transduction but also in energy transfer as a component of the ATP-molecule. When cells and cell organelles commence a plethora of energy-demanding processes associated with ATP hydrolysis to ADP and P_i, a balancing of the P_i content between compartments is crucial to prevent the ATP hydrolysis to be stalled from accumulation of P_i. The transport of P_i via specialized protein(s) is therefore essential for cellular P_i homeostasis since biological membranes are impermeable to P_i (Paper I, III).

This thesis shows that the plastid-localized P_i transporter PHT4;2 in *Arabidopsis thaliana* is nearly restricted to roots during vegetative growth, where it regulates plastid homeostasis by a Na^+-dependent P_i efflux. The accumulation of P_i in the root plastids of *pht4;2* loss-of function-mutants yields a reduced starch accumulation in roots, which is consistent with the inhibition of starch synthesis by a deficient P_i export. However, the *pht4;2* mutants display a 40% increased rosette area and a twofold larger shoot biomass as compared to wild type (WT) plants, indicating an involvement of PHT4;2 in signaling between roots and leaves. The larger leaf area and biomass accounts from an increased cell proliferation in *pht4;2* mutants compared to the WT plants. Nevertheless, the cell size and the photosynthetic electron transport rate are similar in all genotypes. (Paper I).

Another P_i transporter, PHT4;1, is located in the chloroplast thylakoid membrane of Arabidopsis. By using homology modeling, site directed mutagenesis and functional characterization in *Escherichia coli*, several residues important for P_i transport and its sodium dependency have been identified in PHT4;1 (Paper II). Rosette area and biomass of the *pht4:1* mutants are reduced to 70-80% of the WT plants. Absence of PHT4;1 does not affect the relative electron transport rates, pigment composition, and the expression of photosynthesis-related proteins. However, the ΔpH contribution to the proton-motive force across the thylakoid membrane is significantly higher in the *pht4;1* mutants as compared to the WT plants. Non-photochemical quenching kinetics in *pht4;1* mutants is transiently increased at the initial phase and declines to WT levels during the plateau phase. Moreover, the P_i content is elevated in the *pht4;1* mutants whereas the total Phosphor content is similar to the WT (Paper III).

This thesis shows that, through their activity, plastidial P_i transporters play role in plant growth and behavior under different environmental conditions. This is a subject still in its cradle of being understood. The data acquired in this work not only strengthen the importance for a normal daily life of plants, but also the relevance of P_i transporters as a research field.

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