Systems-level analysis of metabolic responses of the diatom *Phaeodactylum tricornutum* to phosphorus stress

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ABSTRACT

Phosphorus (P) is an important macronutrient and a component of key molecules such as phospholipids and nucleic acids. To better understand the molecular and cellular responses to P stress, transcriptome profiling in combination with biochemical investigations were conducted in the model diatom *Phaeodactylum tricornutum*., Out of 10,402 predicted genes, 2,491 and 405 genes were significantly upregulated or downregulated respectively (False Discovery Rate (FDR)≤0.001 and $\log_2$Ratio≥1) following -P. Unsurprisingly, genes associated with phosphate uptake were upregulated, such as the phosphate transporters and alkaline phosphatases. Genes encoding stress-shock proteins were accordingly upregulated including genes associated with stress-responsive proteins, signal transduction, and secondary metabolism. In addition, genes related to protein translation, carbon fixation, glycolysis, citric acid cycle, pyruvate metabolism were also upregulated. Genes associated with gene transcription were downregulated, thus resulting in the upregulation of translation in compensation to the limited supply of mRNA. The downregulation of genes related to β-oxidation could contribute to the accumulation of fatty acids. Accordingly, triacylglycerols, which are important for energy storage, were determined to increase by 1.65-fold. Significant changes in fatty acid composition suggest that increased palmitic and palmitoleic acids were due to the detriment of long-chain polyunsaturated fatty acids. Intracellular membranes other than chloroplast membranes tended to be dispersed, in accordance with the increased transcription of totally 11 genes encoding putative phospholipase. Taken together, this work revealed the coordination of multiple metabolic pathways and some key genes involved in the adaption to phosphorus stress in *P. tricornutum*.

Key words: Phosphorus; stress; transcriptome; diatom; *Phaeodactylum tricornutum*.