Title: Nitrate Reductase Genes AtNIA1 and AtNIA2 Confer Heat Stress Resilience via ROS Homeostasis and HSP Expression in Arabidopsis

Author names: Nusrat Jahan Methela , Mohammad Shafiqul Islam , Mahir Faysal Moon-Sub Lee Byung-Wook Yun Bong-Gyu Mun

Abastact: Heat stress is a key environmental factor that adversely affects plant growth, development, and productivity. Nitrate reductase (NR), encoded by *AtNIA1* and *AtNIA2*, plays a crucial role in nitric oxide (NO) biosynthesis, which mediates stress responses in plants. In this study, we investigated the roles of AtNIA1 and AtNIA2 in regulating plant heat stress tolerance. Under heat stress conditions, *Arabidopsis thaliana* plants maintained higher relative water content and chlorophyll levels, whereas atnia1 and atnia2 mutants exhibited greater physiological damage. Oxidative stress markers such as MDA and H_2O_2 accumulated to higher levels in nitrate reductase mutants than in Col-0, indicating increased heat sensitivity. Gene expression analysis further revealed a pronounced late-phase induction of MBF1c in atnia2 plants, accompanied by altered expression of heat shock proteins. These results suggest that nitrate reductase-dependent pathways contribute to heat stress tolerance by regulating water status, membrane stability, ROS detoxification, and heat shock gene expression. This study provides new insights into NR-mediated NO signaling in thermotolerance and highlights potential targets for improving crop resilience under rising temperatures.

Keywords: Arabidopsis thaliana; heat stress; Arabidopsis mutant; nitric oxide; nitrate reductase; oxidative stress

https://doi.org/10.3390/biom16030415