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RESEARCH ARTICLES

Effect of heat stress on wild type and A7a knockout mutant *Arabidopsis thaliana* plants

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Abstract
Rise in temperature causes heat stress which is a major global risk that limits plant growth, metabolism and productivity. Plants possess various strategies and have numerous mechanisms at various levels like morphological, biochemical, physiological levels to withstand high temperature conditions. At molecular level, in *Arabidopsis thaliana* class A HSFs specifically AtHsfA1b, AtHsfA1d, AtHsfA7a act as activators of transcription reported to have a positive feedback during heat stress which helps in thermo-tolerance. Hence, this study was carried out to understand the role of transcription factor HsfA7a gene for the ability of sustaining heat stress by *A. thaliana*. Two ecotypes of *A. thaliana,* Col-0 (wild Columbia type) and HsfA7a knockout mutant were used for the study. Various morphological, biochemical and physiological parameters were analysed to evaluate the performance of the plants under stress. For treatment, 38 °C temperature (heat stress) for 24 h followed by a recovery of 24 h was used which were compared with plants grown under normal conditions. Consequently, it was found that heat stress and recovery both had significant effects on both the ecotypes whereas wild type was found to perform better under heat stress compared to the mutant. Thus, it can be concluded that HsfA7a gene is playing a key role in thermo-tolerance in *A. thaliana*, similar to other class A HSFs.

Keywords Abiotic stress · Knockout mutant · Plant performance · Thermo-tolerance

Introduction

Due to sessile nature of plants, they often experience some stressful conditions. Environmental conditions which are unfavourable for living organisms simply called as stress and the key players responsible for it are known as stress factors. These stress factors can be the biotic factors (e.g., microbes, herbivores, allelopathy) and the abiotic factors which includes physical (e.g., water, temperature, light) as well as chemical (e.g., salts, minerals, pollutants) (Wahid et al. 2007). Among all abiotic stresses, temperature plays a key role as a great modulator of growth and productivity. Therefore, heat stress occupied a great importance during early 21st Century where in the earth's climate is predicted to get warm by an average of 2–4 °C (IPCC report 2018). Major influence of various abiotic stress conditions like heat, cold, drought and salinity have perceived to be reason for the severe damage to organisms. These stresses can affect their growth and development and thus increases vulnerability to attack of pests, pathogens, diseases, etc., which ultimately be the major threat to their survival (Duveiller et al. 2007).

Plant responses to abiotic stresses are both elastic (reversible) and plastic (irreversible) (Skirycz et al. 2011). When plants get exposed to stress there are two types of strategies (namely resistance and susceptibility) which are adopted by them to respond to environmental changes. Responses towards these changes results in adaptation, acclimatization or even death (Gaspar et al. 2002). Several reports conclude that effects of heat stress and mechanisms for their thermotolerance occur at various levels which includes morphological, anatomical, physiological, biochemical and molecular (Larkindale and Vierling 2008; Mittler et al. 2011).

Arabidopsis thaliana (L.) Heynh. is a well-known plant model organism to study intense genetic, biochemical, cellular, molecular and physiological traits due to its several contrasting features (Sivasubramanian 2015). Various studies on *A. thaliana* reported that Heat Shock Factors (HSF)

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