SCIENCES & BIOENGINEERING SCIENCES

The Research Groups

Plant Genetics and Structural Biology Brussels

have the honor to invite you to the public defense of the PhD thesis of

Phuong Nguyen Nhu

to obtain the degree of Doctor of Bioengineering Sciences

Title of the PhD thesis:

New insights in molecular functions of the *Arabidopsis thaliana* dehydrin ERD14 during water deficit

Promotors:
Prof. Dr. ir. Geert Angenon
Prof. Dr. Peter Tompa
Co-promotors:
Dr. Tran Thanh Thu
Dr. Denes S. Kovacs

The defense will take place on

Thursday, August 19, 2021 at 14h00

The defense can be followed through a live stream. For more information contact Phuong.Nguyen.Nhu@vub.be

Members of the jury

Prof. Dr. Dominique Maes (VUB, chair)
Prof. Dr. Joris Messens (VUB, secretary)
Prof. Dr. Harry Olde Venterink (VUB)
Prof. Dr. Daniel Van Damme (UGent)
Prof. Dr. Dana Reichmann (The Hebrew University of Jerusalem, Israel)

Curriculum vitae

Phuong Nguyen Nhu graduated as a Bachelor of Biotechnology from the Cantho University (CTU, Vietnam) in 2008. She was immediately employed as lecturer in the Biology department, College of Sciences, CTU before receiving a VLIR-UOS scholarship to obtain a Master of Science in Molecular Biology at the Vrije Universiteit Brussel in 2013. After returning to Vietnam for a year, she started her PhD study that focused on the role of ERD14 in drought stress responses. So far, her PhD research led to 1 first author publications and 3 co-author publications in international peer reviewed journals. She also presented her work at several (inter)national conferences and academic meetings.

Abstract of the PhD research

Among several groups of proteins protecting plants from the severe effects of abiotic stresses, chaperones play an important role in maintaining proteins in their functional conformations and preventing the aggregation of non-native proteins. Different proteins belonging to the Late embryogenesis abundant (LEA) family, were shown to act as chaperones and improve resistance to osmotic-, cold-, and heat stress. As a member of this LEA group, ERD14 (Early response to dehydration 14) – an *Arabidopsis* dehydrin and disordered protein – plays an important role in plant protection, especially in drought stress. Studies showed that induction of ERD14 by dehydration occurs after 1 hour and increases to a maximum after 10 h while cold stress induction peaks at 10 h after start of cold exposure. Acting like a chaperone, ERD14 can protect several model substrates including lysozyme, alcohol dehydrogenase, firefly luciferase, and citrate synthase against enzymatic activity loss or protein aggregation due to high temperature. This dehydrin not only shows ability to revert the negative effects of dehydration stress *in vitro*, it also responds to adverse conditions *in planta* such as drought and salinity, for example, when it is overexpressed in *Arabidopsis*. However, few studies show in which way ERD14 improves plant stress tolerance, especially under water loss conditions. Therefore, it is necessary to unravel the molecular mechanisms of ERD14 in drought stress responses.

The physiological evaluation of ERD14 overexpression plants showed an increase in drought stress tolerance in comparison with ERD14 knockout and wildtype plants. As the first response to water loss, the relation between ERD14 and stomatal movement has been investigated. Interactome analysis, stomatal evaluation and colocalization of ERD14 and potential targets like LHCB2 suggested the effects of ERD14 on stomatal closure to some extent. Besides, the stress causes the disruption of cellular homeostasis and leads to the increase of ROS in plants, which then results in oxidative stress. This is an unavoidable secondary stress to the plant. Interestingly, ERD14 overexpression plants accumulated much less H_2O_2 than other lines under drought. Further investigation of the molecular function of ERD14 in ROS detoxification, showed its ability to protect and activate enzymes like catalase and glutathione transferase Phi9.

Moreover, to counter the effects of oxidative stress and reduce cell damage, autophagy is a crucial way to remove the damaged components and help to recover materials for cell growth. In plants, autophagy which involves lysis and degradation in the vacuole, plays an important role in cell survival under stress conditions, while inhibition of this process can induce a switch from vacuolar programmed cell death (PCD) to necrosis. In order to get insight into the influence of ERD14 in oxidative stress response, it is necessary to study the relation of ERD14 and the autophagy machinery. Our results showed that liquid-liquid phase separation of ERD14 relates to the formation of stress granules, which are membrane-less organelles that can play a role in stress response and can be eliminated by the autophagy machinery. Colocalization experiments and testing the autophagy component ATG8 showed a strong connection of ERD14 and autophagy in oxidative stress response.

In general, we have established that *Arabidopsis* ERD14 can help plants to protect themselves from the adverse effects of water deficit via multiple molecular mechanisms.