Open PhD position 2026/2027

Institute of Experimental Botany
of the Czech Academy of Sciences

How plants protect reproduction from heat stress; from models to crops

Project Description

Introduction

Increasing frequency and intensity of high-temperature episodes represent a major challenge for global agriculture. Reproductive development is among the most heat-sensitive stages of the plant life cycle, with the male gametophyte being particularly vulnerable. Heat stress during pollen development, germination, or pollen tube growth often results in reduced pollen viability, impaired fertilization, and yield losses. Understanding the molecular mechanisms that confer pollen thermotolerance is therefore of critical importance.

In recent years, numerous regulatory factors involved in pollen heat stress responses have been identified in the model plant Arabidopsis thaliana, including transcription factors, RNA-binding proteins, and translational regulators. However, it remains largely unclear to what extent these regulatory mechanisms are conserved across species and how they have been adapted in crop plants with diverse reproductive strategies and ecological niches. Systematic comparative studies linking mechanistic insights from model systems to crop species are still lacking.

Aims

The main aim of this PhD project is to investigate adaptive **gene regulatory mechanisms** underlying **reproductive thermotolerance** and to compare these mechanisms between *Arabidopsis thaliana* and selected **crop species** (e.g. barley, tomato). The project will focus on regulatory modules that maintain reproductive fitness under heat stress and will seek to distinguish conserved regulatory principles from species-specific adaptations.

Specific objectives include:
(i) identification of key **gene regulatory modules** associated with **pollen heat tolerance**,
(ii) comparative analysis of their **activity in a model plant and crop species**,
(iii) functional characterization of selected **regulatory factors** involved in reproductive heat stress responses, and
(iv) formulation of transferable principles relevant for improving **crop reproductive resilience**.

The project will bridge fundamental regulatory biology with applied aspects of plant adaptation to climate change.

Methods and experimental approach

The project will combine model-based and crop-oriented approaches. Arabidopsis thaliana will serve as the primary experimental system, complemented by one or two crop species depending on material availability and collaborations. Transcriptomic and translatomic analyses of pollen under control and heat-stress conditions will be performed, followed by network and pathway analyses.

Functional assays will include pollen viability, germination, pollen tube growth, and fertilization efficiency under elevated temperatures. Selected candidate regulators will be subjected to functional analyses using genetic or molecular approaches appropriate for each species.

Expected background of the student

Applicants should have a basic background in plant molecular biology, genetics, or physiology, with an interest in stress biology and gene regulation. The ability to integrate data across regulatory levels and to work with multiple plant systems is important. Experience with omics approaches or bioinformatics is advantageous but not required.

Research environment, collaboration, and funding

The project will be conducted at the Institute of Experimental Botany of the Czech Academy of Sciences, within the Laboratory of Pollen Biology, in collaboration with Faculty of Science, Charles University, and international partners.

The PhD student will be co-funded by the supervisor through grant and institutional resources guaranteed by the host institution. Funding availability is secured and will not disadvantage the applicant during the admission process.

Suggested reading

- Agho C, Avni A, Bacu A, Bakery A, Balazadeh S, Baloch FS, et al. (2025) Integrative approaches to enhance reproductive resilience of crops for climate-proof agriculture. Plant Stress 15: 100704
- Bakery A, Vraggalas S, Shalha B, Chauhan H, et al. (2024) Heat stress transcription factors as the central molecular rheostat to optimize plant survival and recovery from heat stress. New Phytol 244: 51-64
- Chaturvedi P, Wiese AJ, Ghatak A, Záveská Drábková L, Weckwerth W, Honys D (2021) Heat stress response mechanisms in pollen development. New Phytol 231: 571-585, DOI: 10.1111/nph.17380
- Hafidh S, Honys D (2021) Reproduction Multitasking – the Male Gametophyte. Annu Rev Plant Biol 72: 581-614, DOI: 10.1146/annurev-arplant-080620-021907
- Rutley N, Poidevin L, Doniger T, Tillett RL, Rath A, Forment J, Luria G, Schlauch KA, et al. (2021) Characterization of novel pollen-expressed transcripts reveals their potential roles in pollen heat stress response in Arabidopsis thaliana. Plant Reprod 34: 61-78, DOI: 10.1007/s00497-020-00400-1
- Sze H, Klodova B, Ward JM, Harper JF, Palanivelu R, Johnson MA, Honys D (2024) A wave of specific transcript and protein accumulation accompanies pollen dehydration. Plant Physiol 195: 1775-1795

Application form: https://forms.gle/zxDLQjYW149rYd356

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