RÉPUBLIQUE FRANÇAISE
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INRAE

PEERSIM

EXPLORATORY PROJECT

2021-2023

Predicting plant response to combined stresses

(CO_2 and Heat)

Coordination
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Multi-Stress
Experiment design
Multi-omics
Integration
Plant Biology

INRAE units involved
IPS2
MIA Paris Saclay
MIAT

Context and challenges

Plants are constantly threatened by biotic and abiotic stresses, especially in the current context of climate change. The complexity of the stress response involves different levels of biological organisation, from genomes to metabolites. The study of multiple stresses shows that the impact of combined stresses is different from the sum of the impacts of individual stresses. How then can the impact of combined stresses be predicted by knowing only the impact of single stresses?

This conclusion is based on studies comparing lists of differential genes/metabolites subjected to individual stresses with the same lists subjected to combined stresses. However, these analyses are based on too few biological replicates (typically 3 in RNA-seq), which are insufficient to produce a robust and meaningful analysis, and only identify about 20% of the genes that are differentially expressed under the two stress conditions. This may partly explain the discrepancies observed between single and multiple stress conditions.

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Goals

The Peersim project proposes to effectively re-evaluate the prediction of combined stresses from individual stresses, by conducting an experiment combining 2 stresses: CO_2 and heat, with numerous replicates (~20).

Beyond the biological relevance of this dataset in the context of climate change, the project will allow progress on three essential points for the study of plant response to combined stresses:

1. Effectively quantify the extent to which the impact of combined stresses is different from the sum of the impacts of individual stresses, and assess the possibility of predicting the actors of the response to combined stresses and their interactions.
2. Develop and propose meaningful experimental designs.
3. Develop and evaluate recent analysis and integration methodologies.

Research units involved and partnerships

INRAE scientific division	INRAE research units	Expertises
Plant biology and breeding	IPS2	Bioinformatics, Biostatistics, Segmentation, Chloroplast biology, Transcriptomics, Metabolism and plant adaptation to climate change
Mathematics, computer and data sciences, digital technologies	MIA Paris Saclay	Statistics and gene network inference
	MIAT	Data integration, network analysis