Identification of a biostimulant enabling pollen protection and preventing yield loss under heat stress

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Context

The project **ST POL** aimed to:

2 years

- Establish a comprehensive study protocol for thermal stress
- Evaluate a potential correlation between pollen quality and fruit development in order to predict yield at early stage
- Identify biostimulant able to alleviate plant thermal stress by maintaining good pollen quality

Experimental design

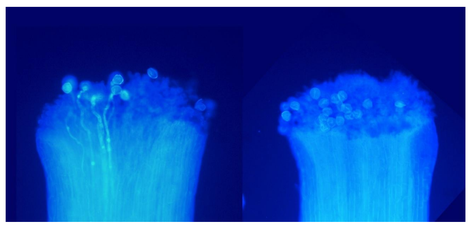
Dwarf tomato and spring wheat

From 8h photoperiod at 40°C to 16h photoperiod at 32°C

Species	Duration	Photoperiod	Day Temperature	Night Temperature
Dwarf Tomato	96h	16h	32°C	26°C
	36h	12h	38°C	30°C
	8h	8h	40°C	Room Temperature
Spring Wheat	48h	16h	35°C	25°C
	48h	16h	35°C	30°C
	8h	8h	40°C	Room Temperature

Samplings of flowers and leaves

- **Stress markers**
  - Electrolytes leakage
  - Proline content
  - MalonDiAldehyde content
  - Acid Abscissic content



In situ Pollen Germination. Left : control dwarf tomato flower; Right : 38° C heat stress dwarf tomato flower

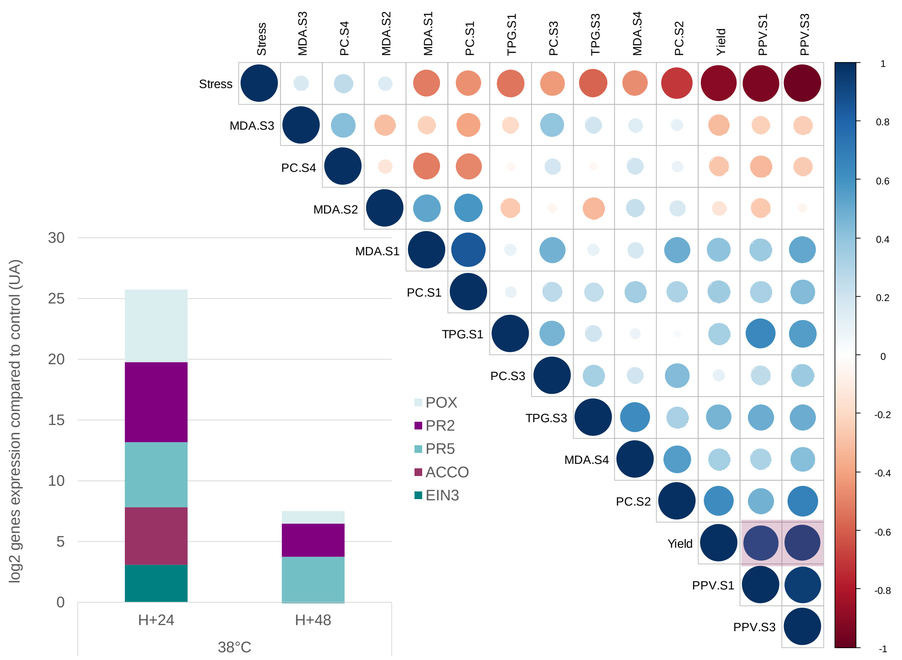
- **Plant stress genes expression** (qPCR)
- **Pollen quality**: number of grain and viability (Imaging Flow Cytometry)
- **Yield**

Results

Tomato

38-30°C

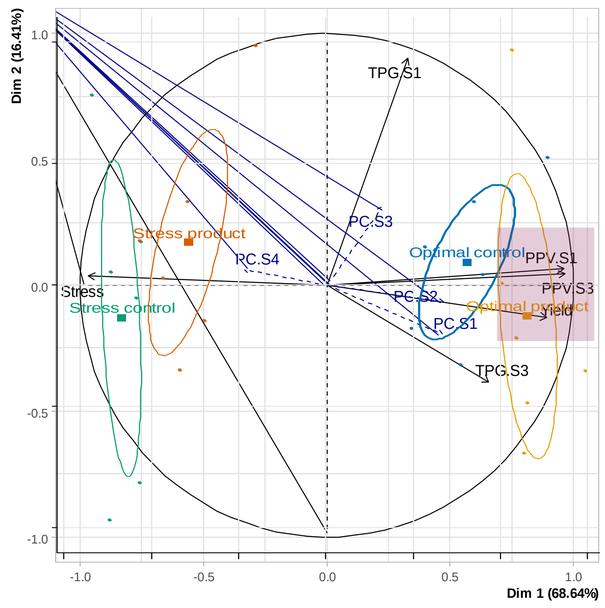
-51% of pollen viability



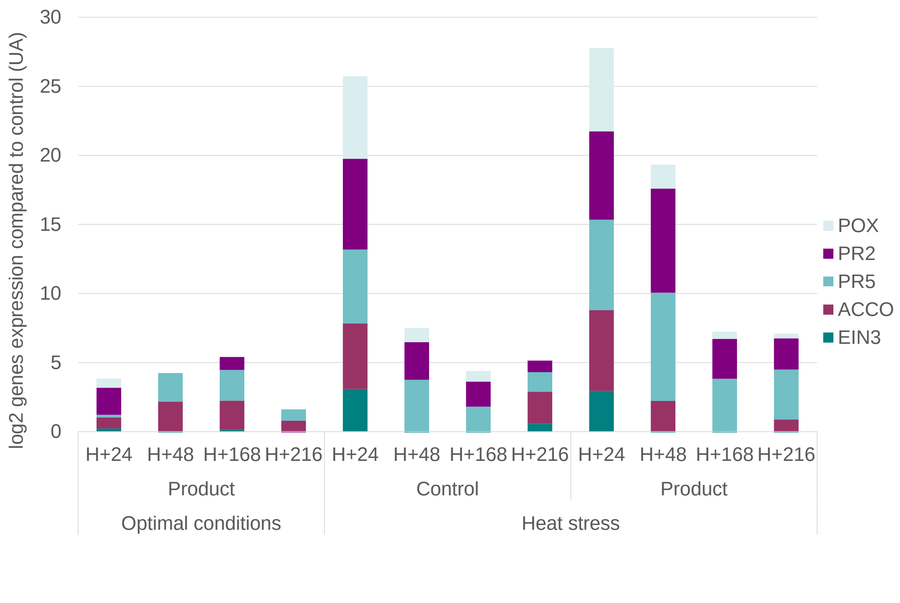
Correlation matrix [-1;1] - each variable is represented by a code : Yield; Total Pollen Grains (TPG); Percentage of Pollen Viability (PPV); Electrolyte Leakage (ECL); Proline Content (PC); MalonDiAldehyde (MDA); Acid Abscissic (ABA); 1st sampling (S1); 2nd sampling (S2); 3rd sampling (S3); 4th sampling (S4) – Histograms of the main genes overexpression compare to optimal control (qPFD® INRAE license): Glucanase pathway (PR2); Osmotin pathway (PR5); Oxidative stress pathway (POX); Ethylene pathway (EIN3 and ACCO)

Positive correlations (up to 0.9) were observed between pollen viability and final yield. The percentage of viable pollen decreased depending on the maximum temperature reached and the stress duration. For all heat stresses Pollen viability was also negatively correlated to proline and MalonDiAldehyde content. No link was found between electrolyte leakage and final yield in dwarf tomato. 24h after heat stress Four genes were overexpressed linked to glucanase, osmotin and ethylene pathways.

38-30°C + biostimulant product



PCA results - each variable is represented by a code : Yield; Total Pollen Grains (TPG); Percentage of Pollen Viability (PPV); Proline Content (PC); 1st sampling (S1); 2nd sampling (S2); 3rd sampling (S3); 4th sampling (S4)



Histograms of the main genes overexpression compare to optimal control (qPFD® INRAE license): Glucanase pathway (PR2); Osmotin pathway (PR5); Oxidative stress pathway (POX); Ethylene pathway (EIN3 and ACCO)

Under optimal conditions, the application of a biostimulant product had no effect on pollen viability but resulted in a 34% increase of the yield (cf. PCA biplot).

An overexpression of osmotin pathway gene was observed 48H after stress application, with a persistence up to 168H (cf. histograms).

Under heat stress conditions (38°C), the application of a biostimulant product induced a 57% average increase in pollen viability and a 35% increase in final yield (cf. PCA biplot).

Compared to the stress control, biostimulant application enhanced the overexpression of ACCO and PR5 genes 24H after stress. Persistent overexpression was also observed for glucanase pathway gene, osmotin pathway gene and ethylene pathway gene up to 216H after stress application (cf. histograms).

Spring wheat

After a 40°C heat stress, a positive correlation (0.3) was observed between pollen viability and final yield. The percentage of viable pollen decreased depending on the maximum temperature reached and the stress duration. For all heat stresses, the final yield was also negatively correlated to electrolyte leakage. For the two strongest stress the final yield was also negatively correlated to proline and MalonDiAldehyde content. Finally, the 40°C heat stress also highlighted an increase of Abscissic Acid in the aerial part. 48h after heat stress, two genes were overexpressed linked to phenylpropanoids pathways.

Contact

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