Real-Time Assessment of PEG-Induced Hydric Stress in Sunflowers Using Spectral Data and ASCA

Ingi Abdelmeguid[1,2], Daphné Heran[2], Maxime Ryckewaert[3], Ryad Bendoula[2]

[1] Department of Botany and Microbiology, Faculty of Science, Helwan University, Cairo, Egypt
[2] ITAP, Univ Montpellier, INRAE, Institut Agro, Montpellier, France
[3] AGAP Institut, CIRAD, INRAE, Institut Agro, Univ de Montpellier, Montpellier, France

Context & Objective

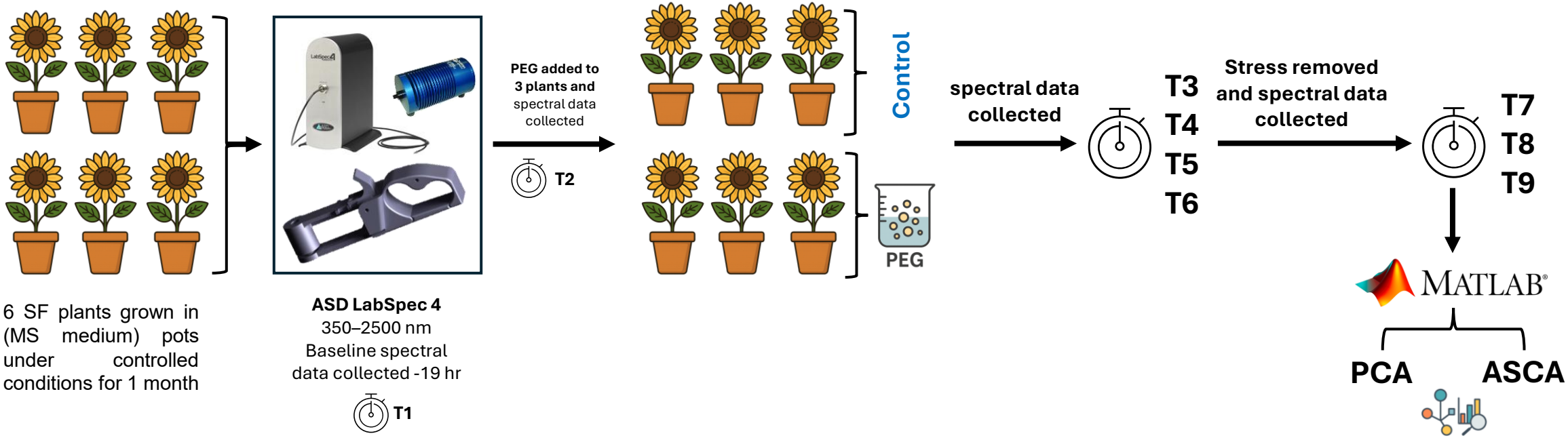
Hydric stress (drought stress) is a major constraint on crop growth and physiology.

PEG (polyethylene glycol) is an osmotic agent used to simulate drought by limiting water availability in the root zone without damaging plant tissues.

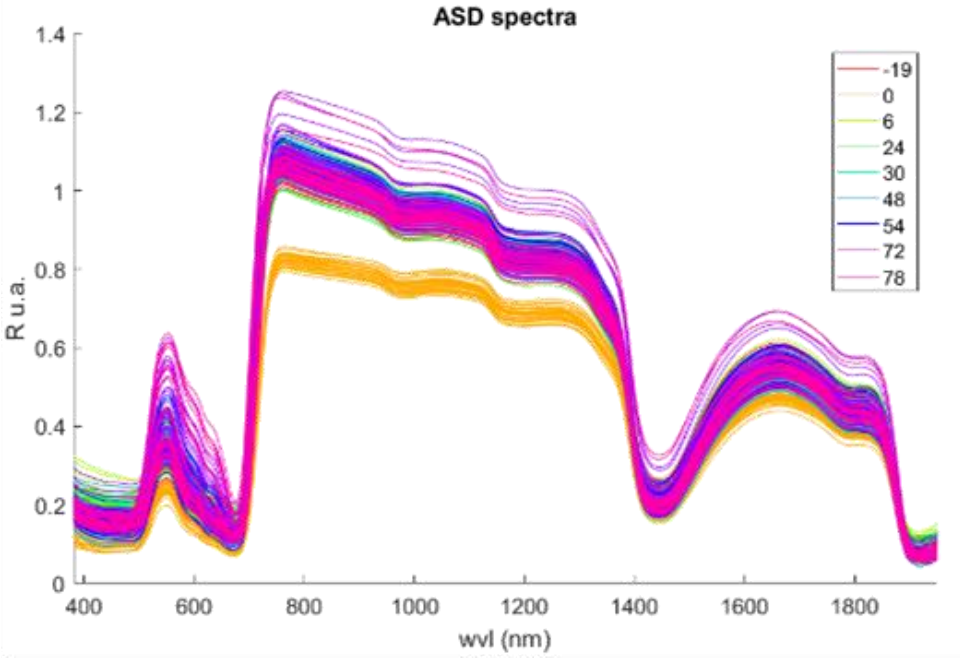
Multivariate methods like PCA and ASCA help untangle the effects of treatment, time, and their interaction in spectral data.

- To monitor real-time spectral responses of sunflower plants to PEG-induced hydric stress and recovery.
- Apply ASCA to distinguish treatment and time effects for improved interpretation of stress dynamics.

Materials & Methods



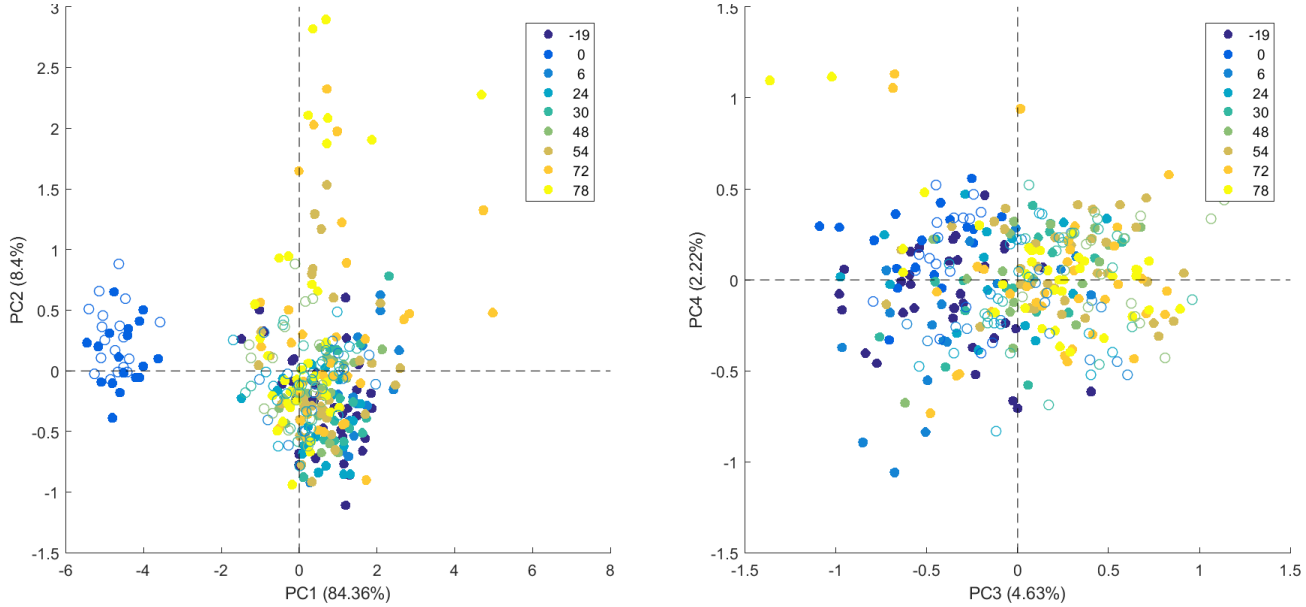
N samples	324
Spectral range	350–2500 nm
Spectral resolution	1 nm
N spectral variables	2150
Y	PEG
Repetition per treatment	3*2*3*9 = 162



Raw spectral data collected using the ASD spectrometer

- Greater dispersion observed at T2 (0 h) .
- Likely due to environmental or handling variation.

Unfilled circles = *PEG-treated plants*
Filled circles = *plants without PEG*



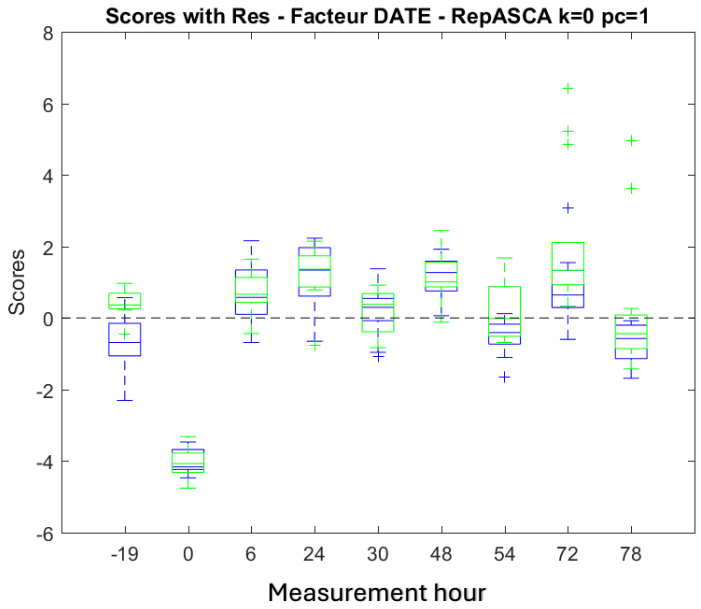
PCA score plots showing spectral variance over time

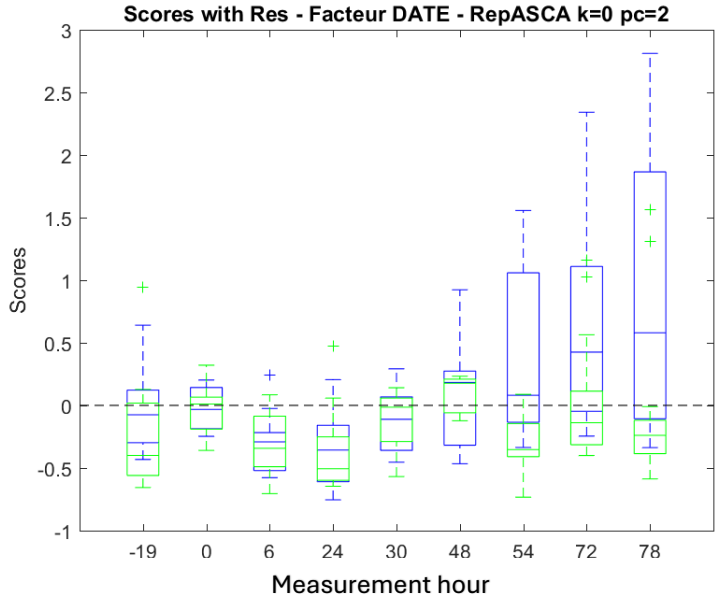
- PC1 highlights a distinct dispersion of T2 (0 h) spectra, characterized by strong negative scores.
- This separation is insufficient to clearly distinguish the effect of PEG treatment from time progression alone.

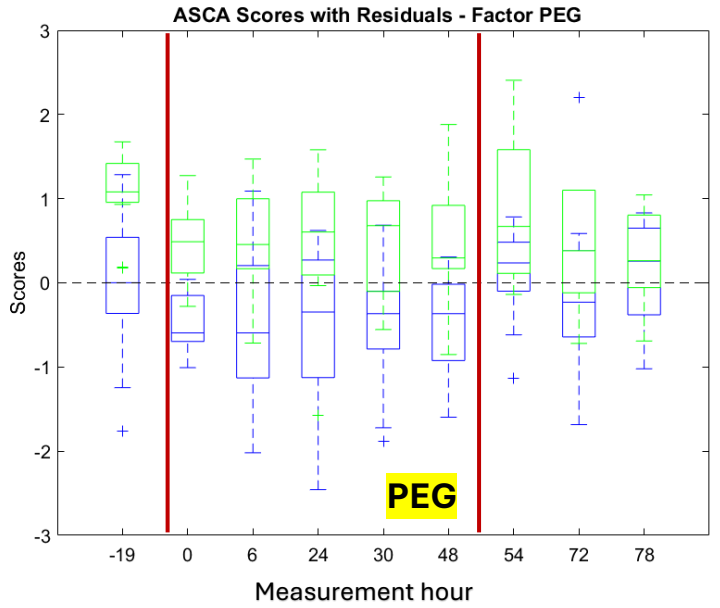
ANOVA–Simultaneous Component Analysis (ASCA) Results Summary- Factors defined:

- **Date** (measurement time points)
- **PEG** (treatment: stressed vs control)

Green = control plants
Blue = PEG-treated plants







Factor: Date

Factor: PEG

- **PC1:** Captures global dynamics across all time points
- **PC2:** Reflects stress progression over time

- Clear separation between PEG-treated *(blue)* and control *(green)* plants from 0 to 48 h.
- Recovery phase (T7:54 to T9:78): Score distributions begin to converge

ASCA allowed us to distinguish treatment and time effects, offering valuable insight into the temporal dynamics of plant responses under PEG-induced hydric stress.

Choosing an appropriate data analysis method is essential for making sense of complex spectral datasets in stress monitoring.

Currently working on a publication that builds on this study, exploring advanced methods like Rep-ASCA to better account for plant-to-plant variability and improve the robustness of interpretation.

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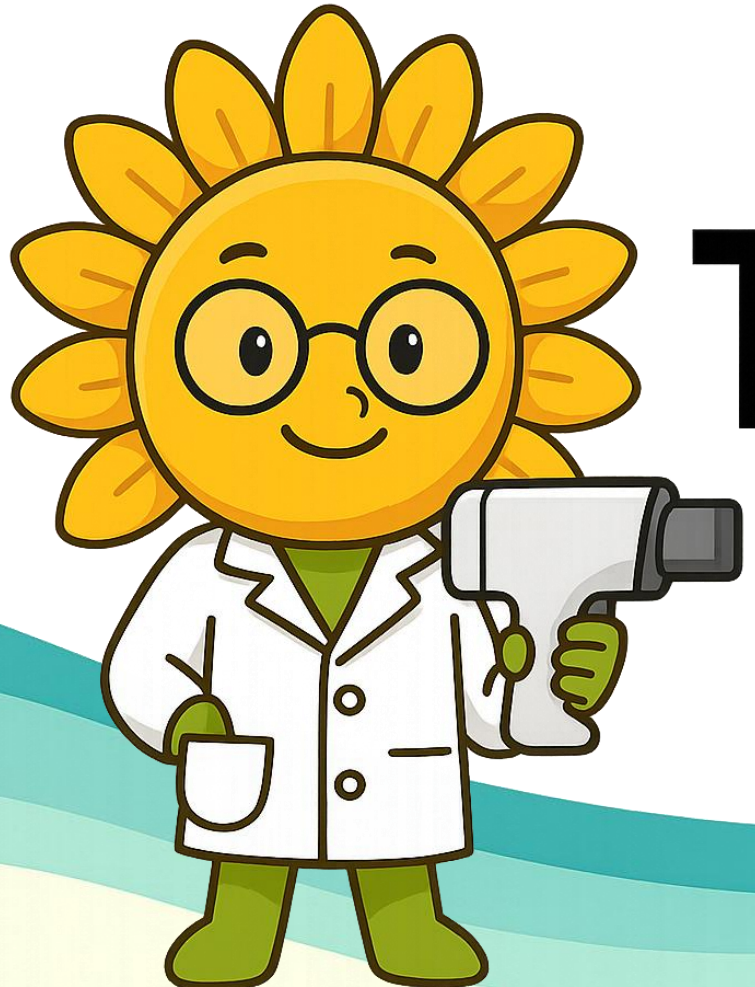

Thank You