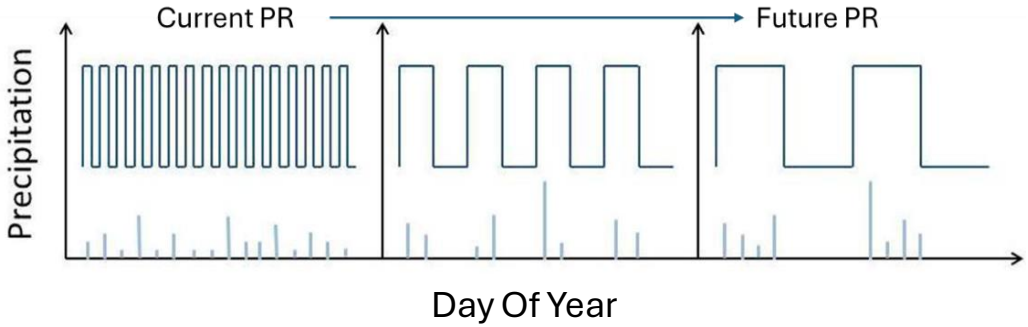
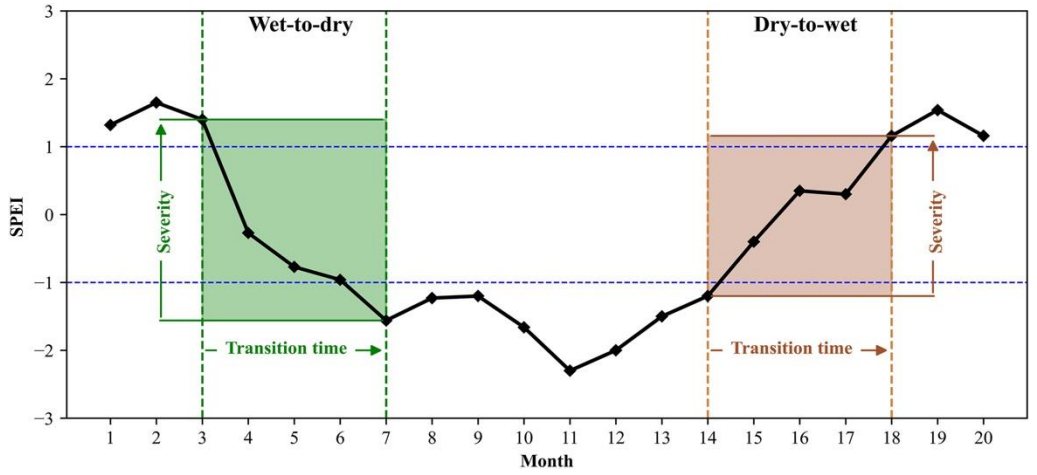
How do Changing Rainfall Patterns in a Warming Climate affect plant growth?

A Changing World of Rainfall: Climate change is profoundly transforming global precipitation patterns extreme downpours and prolonged droughts are becoming the new normal.

Stable Totals, Shifting Reality: Annual rainfall may stay constant, but its timing and distribution are changing, reshaping water, ecosystems, and agriculture.

A Chance to Shape the Future: This transformation offers a unique opportunity for researchers to understand, model, and design sustainable solutions for a climate-resilient world.



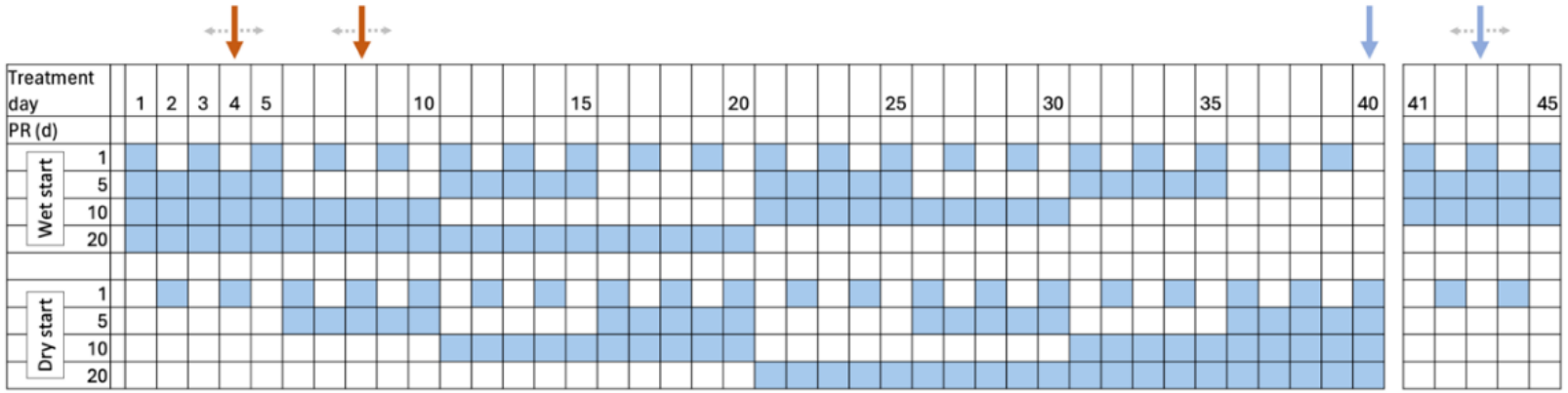


Experiment Setup - Watering Regimes

•**Simulated Rainfall Scenarios:** An advanced watering protocol recreates four precipitation regimes from daily watering to 20-day drought or flooding to mimic real-world extremes.

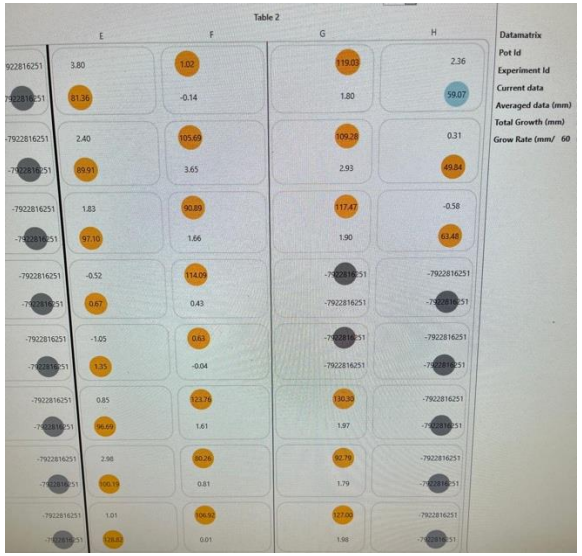
•**Precise Moisture Control:** Continuous soil water monitoring ensures accurate replication of conditions from drought to flooding.

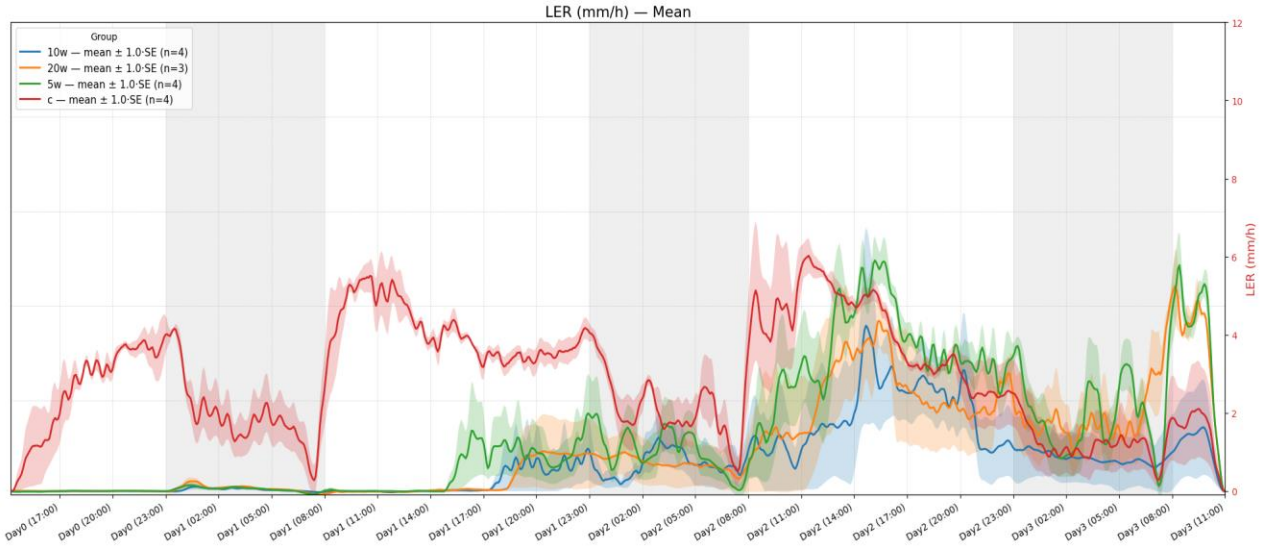
•**Adaptive Irrigation System:** Water input dynamically adjusts according to plant evapotranspiration, enabling realistic and responsive experimental conditions.



Measurements

Leaf length tracking (LLT) system





- **Leaf elongation rates** will be monitored with high temporal resolution using an **automated leaf tracking system** that records instantaneous growth every five minutes.

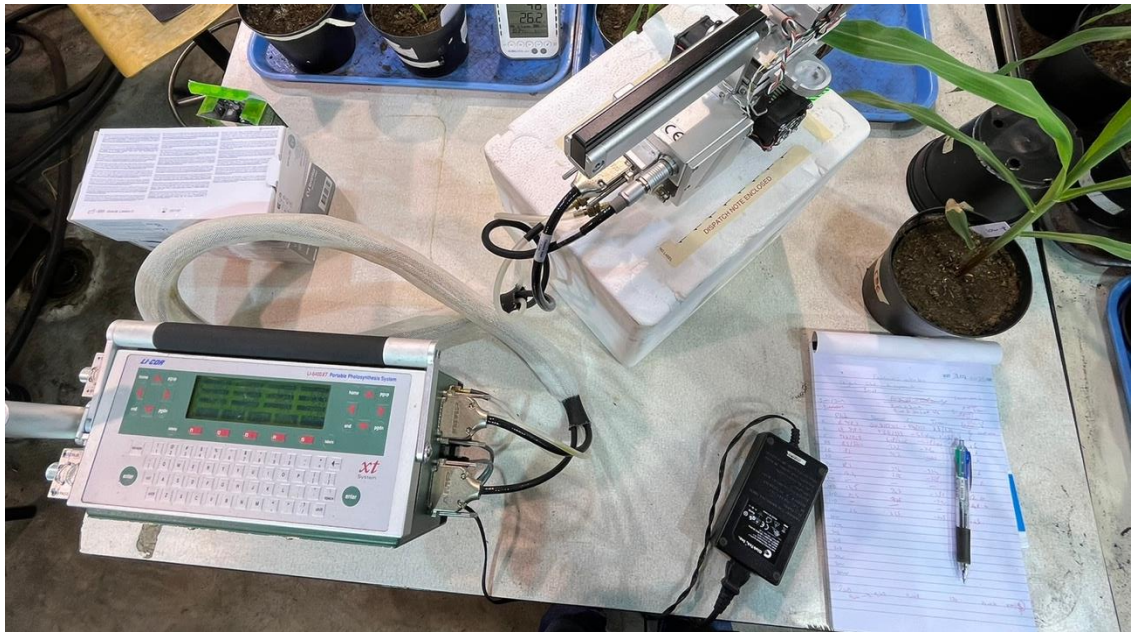
- This approach will enable **real-time** monitoring of **growth dynamics** during **wet-to-dry and dry-to-wet transitions**.

- The resulting data will allow for precise quantification of stress responses, **recovery kinetics**, and **transitional growth behavior** under fluctuating environmental conditions.

Photosynthesis and Photosystem Efficiency Measurements

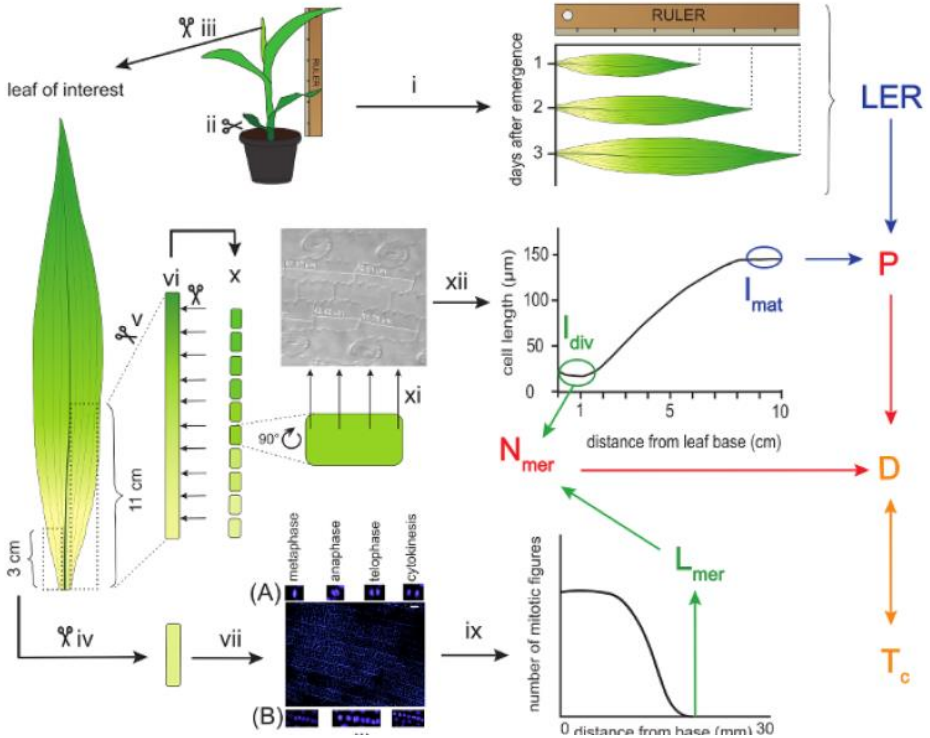
Gas exchange parameters: including photosynthetic rate (A), stomatal conductance (gs), and respiration rate will be measured using a LI-COR 6400 portable photosynthesis system (LI-COR Inc., Lincoln, NE, USA).

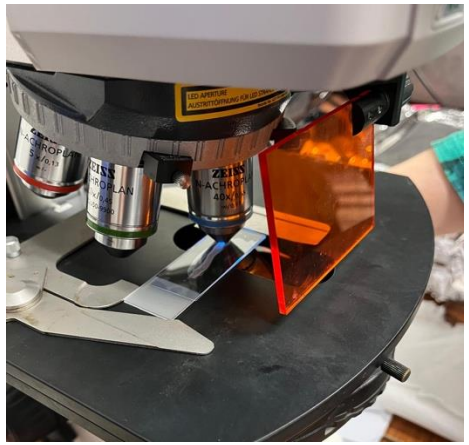
Chlorophyll fluorescence parameters including maximum quantum yield of PSII (Fv/Fm) and photochemical quenching (qP) will be recorded to evaluate photosystem II efficiency and potential photoinhibition under variable water availability.

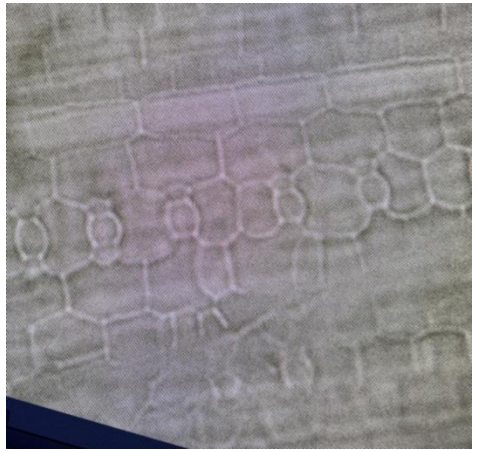


Kinematic Analysis of Cell Division and Expansion

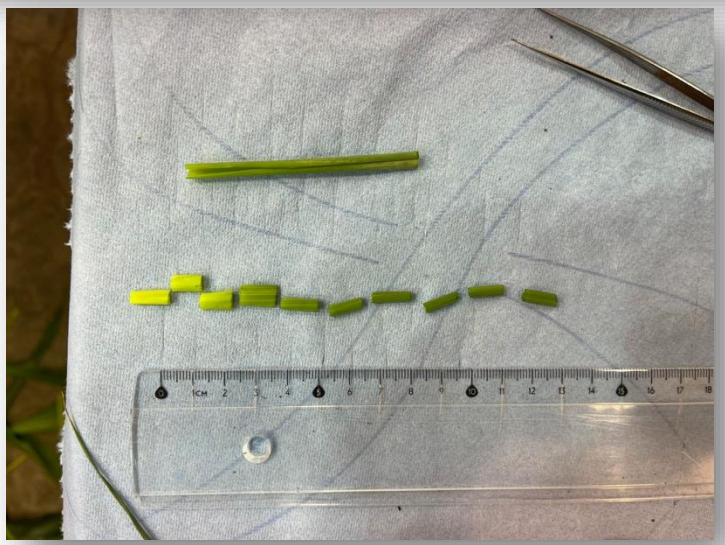
Performing kinematic analysis allows researchers to uncover the cellular basis of plant growth, linking visible organ development to underlying processes of cell division and elongation, and revealing how these processes are altered under **changing precipitation regimes**.







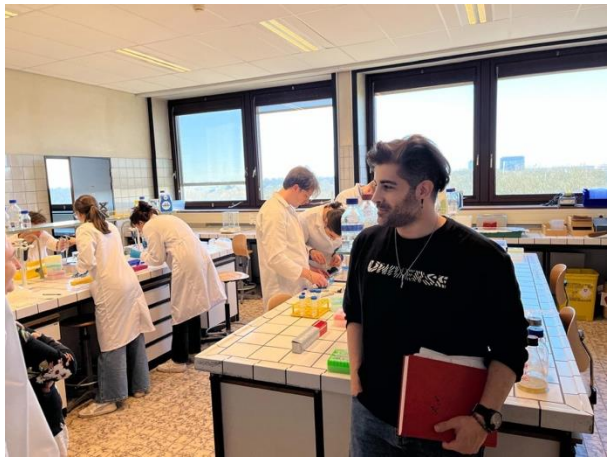
Plant Harvest and Sampling



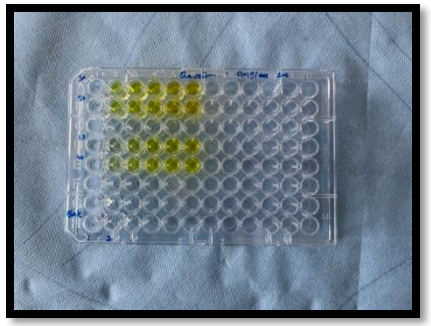
- Plant harvesting and subsequent sample preparation for transcriptomic and biochemical analyses will be conducted within the **IMPRES group's collaborative research environment**.

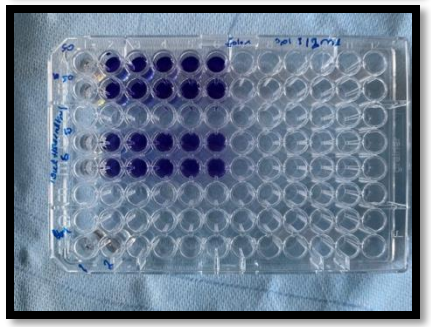
- The group's integrated workflow connects all experimental phases from plant growth to harvest and biochemical analysis providing an inspiring, hands-on environment for students to develop both technical and analytical skills.

- The laboratory fosters a strong culture of teamwork, where **members at all levels from professors to PhD students actively support one another** by sharing expertise, technical skills, and constructive feedback.



Analysis and Interpretation





Transcriptomic analysis will provide genome-wide insights into the regulation of stress-responsive genes, enabling the identification of molecular pathways associated with biochemical and metabolic shifts.

To assess the physiological and biochemical adjustments of plants to changing precipitation regimes, a comprehensive set of **biochemical and metabolic analyses** will be performed.

These will include the quantification of **antioxidant enzyme activities** (such as superoxide dismutase, catalase, and peroxidase) as well as **non-enzymatic antioxidants** (flavonoids, phenolics, and FRAP assays).

In addition, **carbohydrate metabolism** will be examined through the determination of soluble and insoluble sugars, while **hormonal profiling** (e.g., abscisic acid, auxins, cytokinins) and **primary metabolite analyses** will provide further insight into the regulation of stress adaptation and recovery.

Measurements

Analysis and Interpretation

The obtained results will be continuously evaluated through **biweekly laboratory meetings**, where team members collectively discuss experimental progress, data interpretation, and emerging research directions.

In addition, **individual meetings with the supervising professor and experts** will provide deeper scientific insights and methodological guidance.

The IMPRES group's collaborative culture promotes active engagement at every research stage.