Gembloux Agro-Bio Tech
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Long-term field study of the photosynthetic performance and acclimation potential of *Lolium perenne* L. facing combined environmental constraints in a temperate managed grassland

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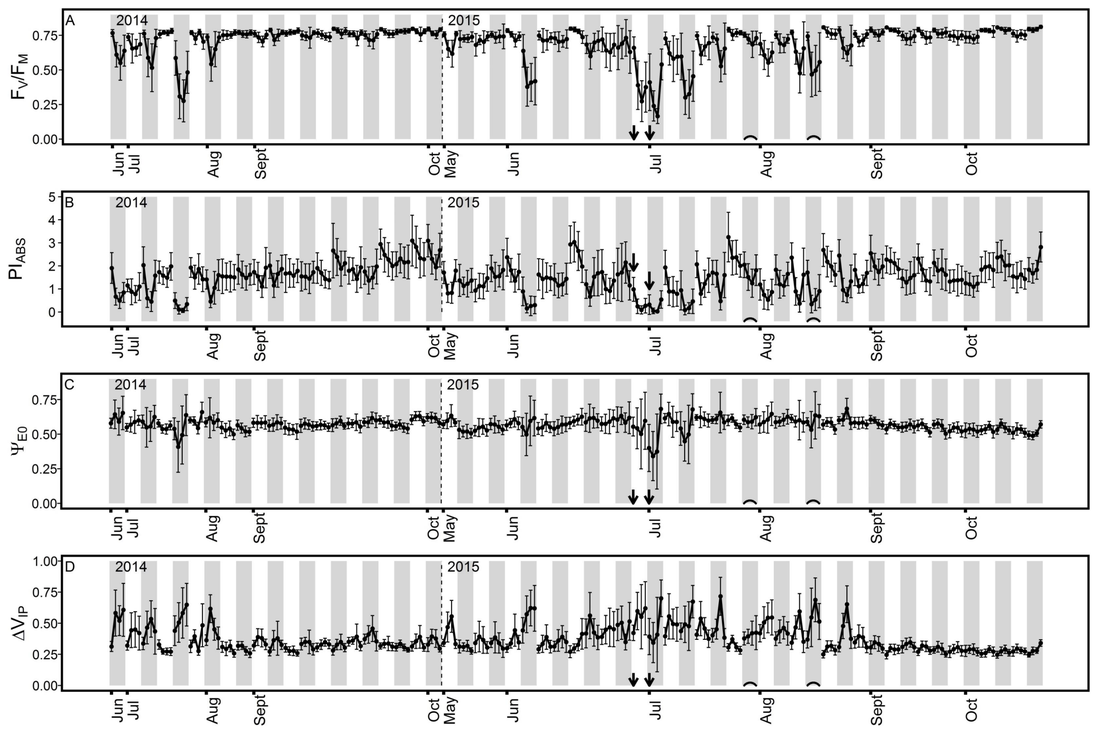
- The photosynthetic apparatus is able to trigger protective mechanisms favouring its **acclimation u**nder stressful conditions. However, its response to long-term environmental constraints in field condition remains understudied.
- Analysis of the **chlorophyll *a* fluorescence** (ChlF) using the JIP-test has been used to investigate the physiological aspects of photosynthesis. During **two years**, frequent ChlF measurements were performed on **perennial ryegrass (*Lolium perenne* L.)** in a **temperate managed grassland** to the study the response of the photosynthetic apparatus to environmental constraints. Measures of ChlF were performed at 4 time periods per day. ChlF data were analyzed along with meteorological data measured on-site.

I. *L. perenne* population shows a decreased photosynthetic performance in summer



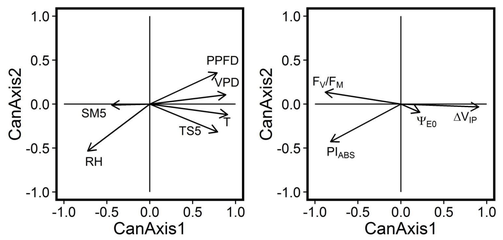
Variation of ChlF parameters in the 2014 and 2015 study periods. The average value (n = 21-24) ± SD for each of the four measurement time periods (11:00, 13:00, 15:00 and 17:00) is represented. Grey bars separate the different days of measurements. Arrows indicate the first and the third day of a heat wave.

- Low F_V/F_M midday values in summer are indicative of a **down-regulation of photochemical activity of PSII** during this period.
- Low PI_{ABS} values in summer indicate an **increase in energy dissipation (e.g., through silent reaction centres)**.
- **The increased PSI efficiency** in summer, indicated by high ΔV_{IP} midday values, suggests an increase in photochemical deexcitation.
- **A decrease in electron transport efficiency beyond Q_A** (ψ_{E0}) was observed during important stressful climatic events.
- **F_V/F_M recovered** from repeated photoinhibition at the end of both years.

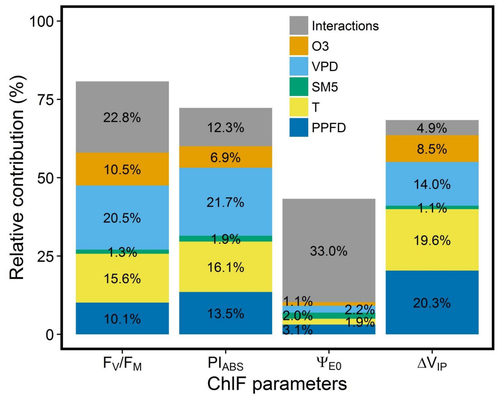
	Chlorophyll fluorescence parameters description
F_V/F_M	Maximum quantum yield of the PSII
PI_{ABS}	Performance Index : representation of the energy conversation from photons absorbed by PSII to the reduction of intersystem electron acceptors
Ψ_{E0}	Efficiency of the electron transport beyond Q_A
ΔV_{IP}	Efficiency with which an PSII trapped electron is transferred beyond the PSI acceptor side

(**Strasser R et al. 2000.** In : Yunnus M, Pathre U and Mohanty P (eds) Probing photosynthesis : mechanism, regulation and adaptation. Taylor and Francis, London, 445–483 ; **Oukarroum A et al. 2009.** Physiologia Plantarum 137 : 188–99.)

II. Combined environmental constraints impact the different photosynthetic processes



Canonical correlation analysis. PPFD, photosynthetic photon flux density. **VPD**, vapour pressure deficit. **T**, air temperature. **TS5**, soil temperature. **RH**, relative air humidity. **SM5**, soil moisture.

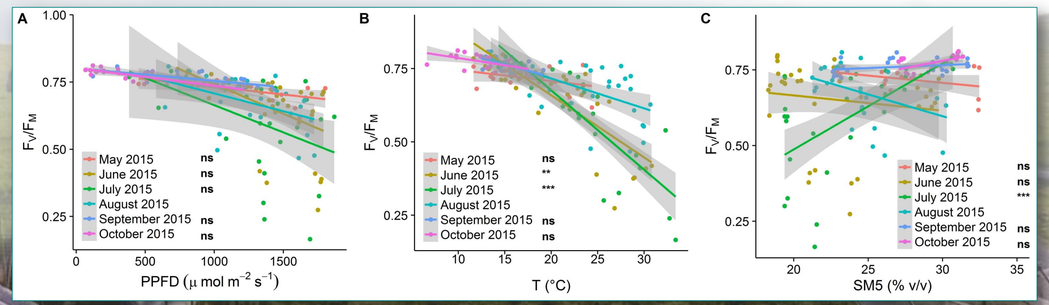


Relative contribution of meteorological parameters and their second-order interactions in the variation of ChlF parameters.

- Combined environmental constraints were associated with a down-regulation of PSII (F_V/F_M), high energy dissipation (PI_{ABS}) and high efficiency in PSI activity (ΔV_{IP}).
- Environmental conditions had a **low influence on electron transport** efficiency beyond Q_A (ψ_{E0}).
- **Soil moisture had a low influence** on photosynthetic processes.
- **Combined stresses** had a large impact on photosynthetic processes.
- The electron transport efficiency beyond Q_A (ψ_{E0}) was **the most influenced by stress combination**.

III. Photosystem II shows an increased thermotolerance at the end of the summer

- F_V/F_M exhibited a **less steep decrease to increasing air temperature in August** compared with previous months, suggesting a stronger PSII thermotolerance.
- Sensitivity of PSII to sun irradiance between months was similar.
- PSII was more susceptible to low soil moisture in July, probably because of the occurrence of a heat wave a few days before this period of low soil moisture.



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