Scaling relations between leaf and plant water use efficiencies in rainfed Cotton – Role of environmental and biophysical parameters

Scan for Abstract

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Research motivation

Water Use Efficiency (WUE) is a key ecohydrological trait, defined as the ratio of carbon assimilation to water losses, and can be represented at various spatial scales. Inspite of huge cultivation and water use, crop water productivity (0.46 kg of lint/m³) of Indian Cotton is far below the world averages (0.95 kg of lint/m³). Effective quantification and scaling relations in WUE helps in understanding the carbon-water exchanges for effective management of resources and improving the yield.

Research Objectives

- Establish scaling relations between leaf (WUE_L) and plant (WUE_P) WUE in rainfed Cotton.
- Identify optimal time-window and leaf position to measure and upscale WUE_L.
- Understand the role of various environmental and biophysical factors on WUE_L and WUE_P dynamics.
- Assess the contribution of canopy positions to whole-plant carbon and water fluxes.

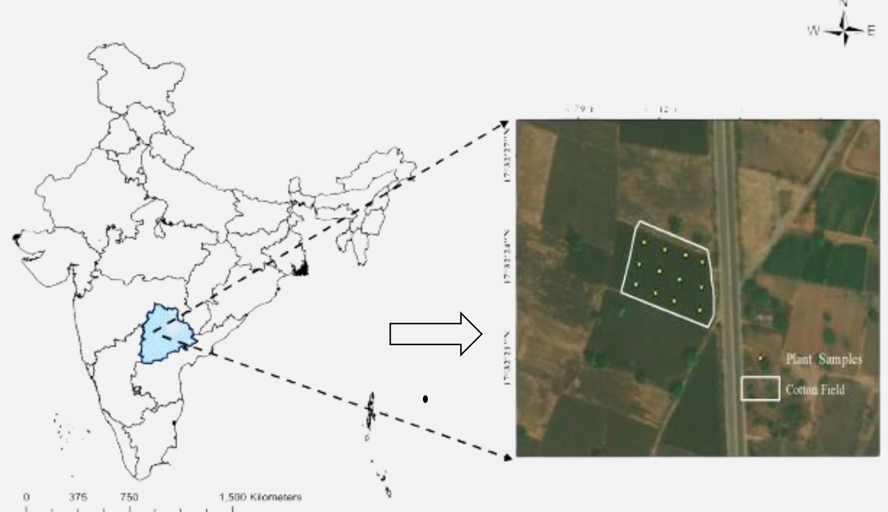


Fig 1: Geographical location of the study area

Methodology

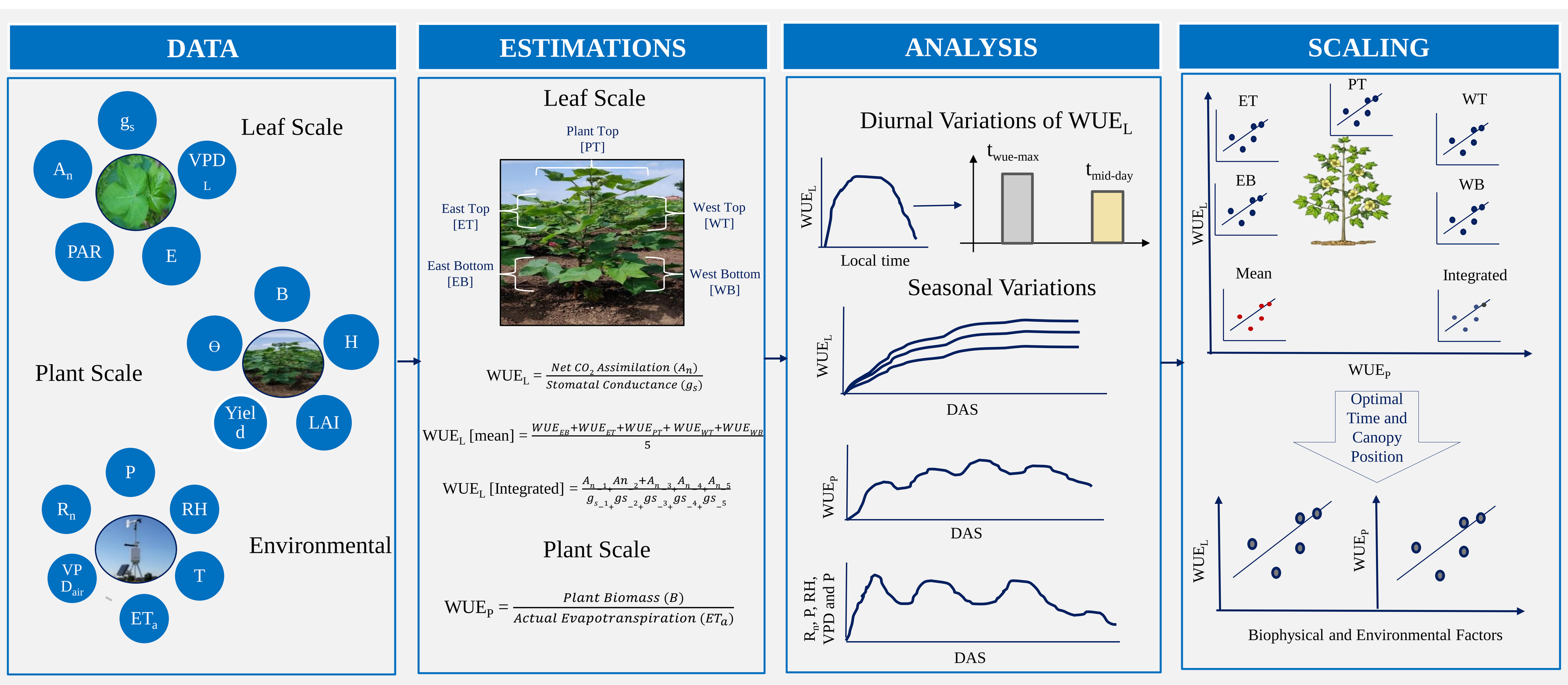
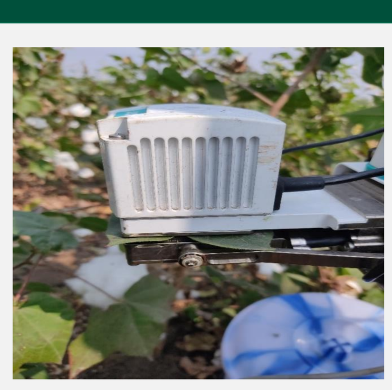


Fig 2: Flowchart illustrating the methodology followed in this research to quantify and upscale WUE_L

Field experimentation [Data collection]




WUE dynamics

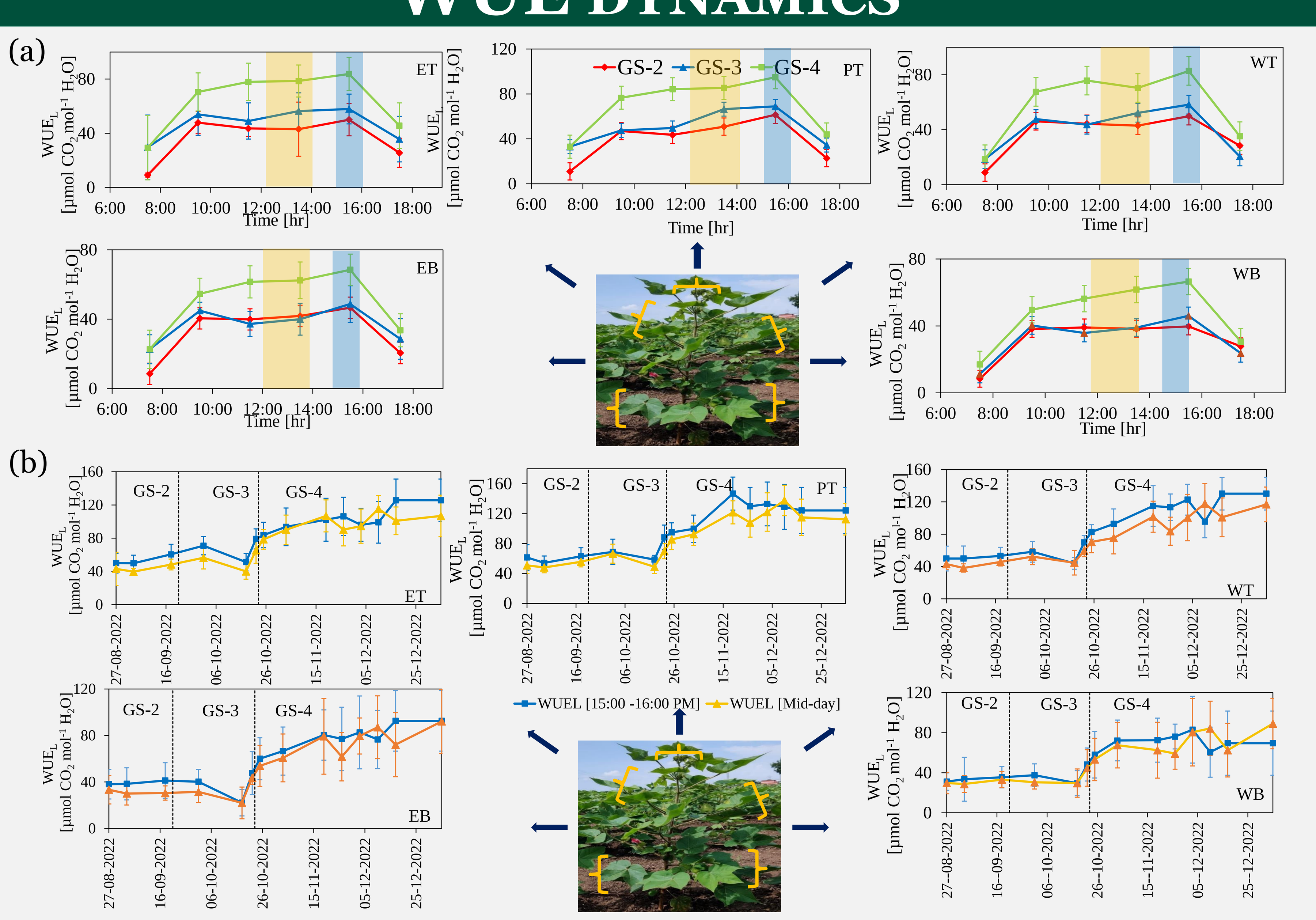


Fig 3: Diurnal (a) and seasonal (b) variations in WUE_L across five canopy positions during different growth stages of rainfed Cotton.

WUE scaling relations

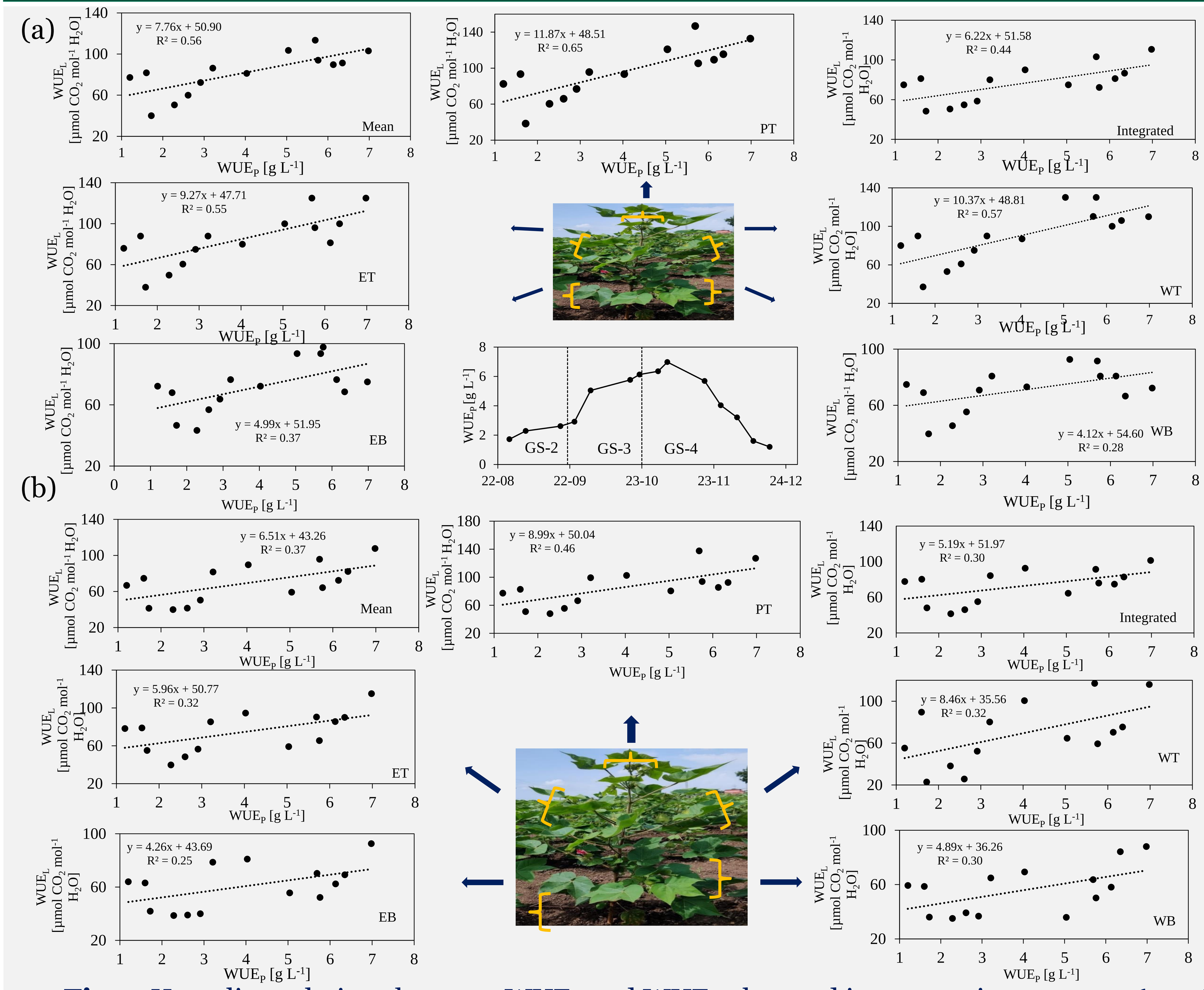


Fig 4: Upscaling relations between WUE_L and WUE_P observed in t_{max_wue} i.e. 15:00 – 16:00 (a) and t_{midday_wue} i.e. 12:00 – 13:00 (b) time windows

External drivers on WUE

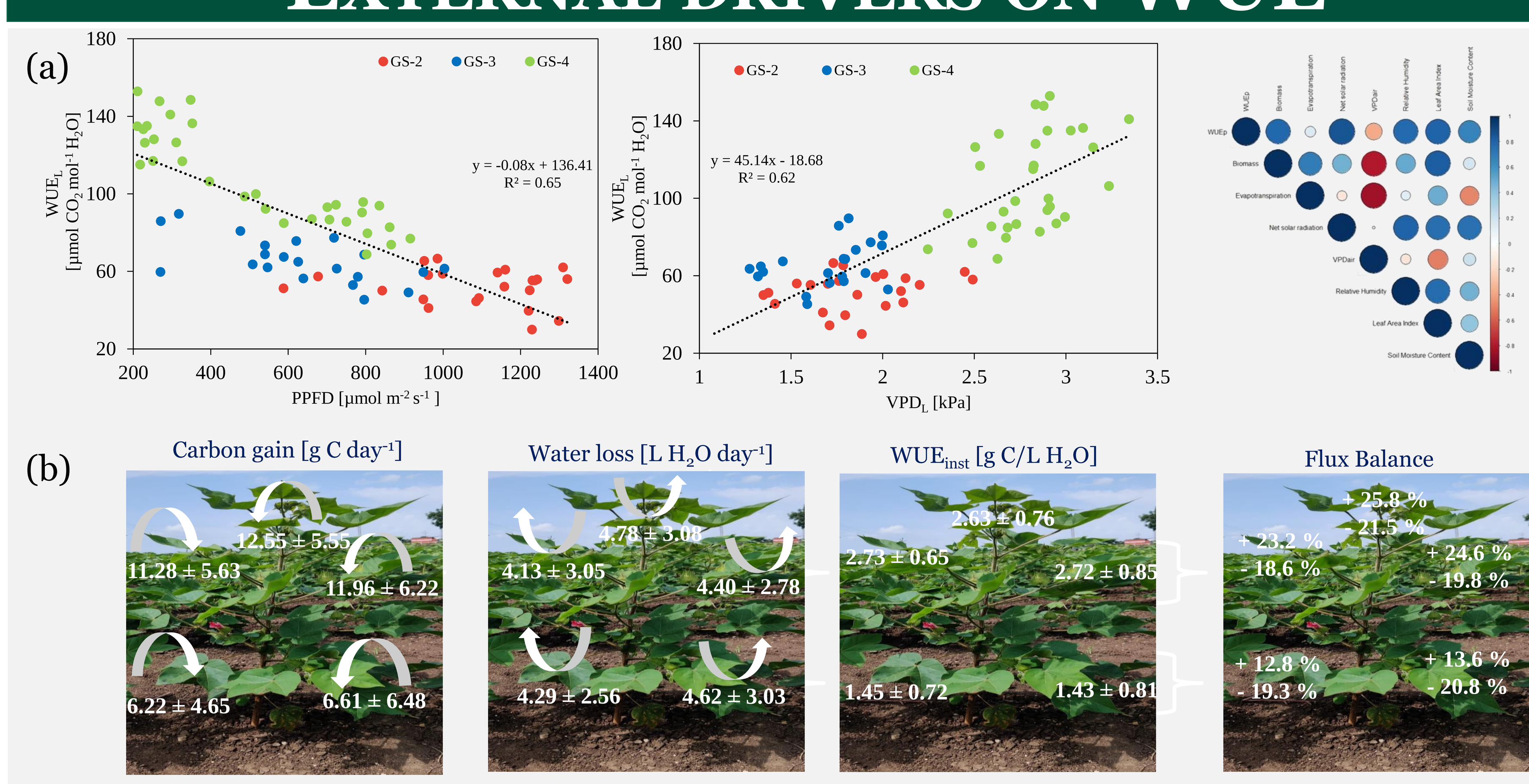


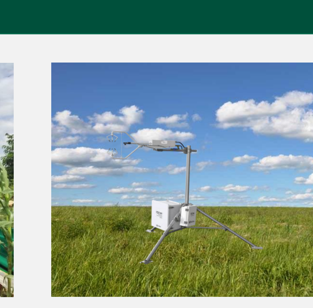
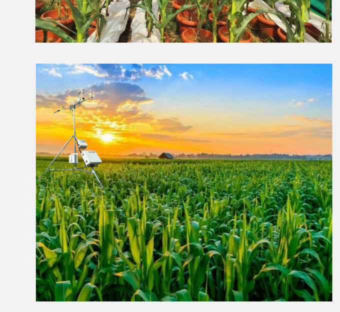
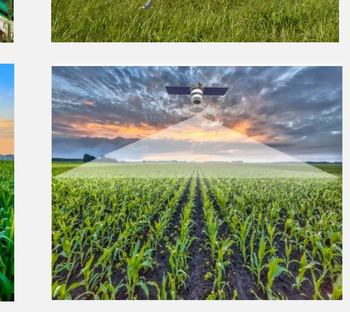
Fig 5: Association between PPFD and VPD_L on WUE_L and Correlation matrix between various external drivers with WUE_P (a); distribution of carbon gain, water loss, and their ratio WUE_L fluxes (b) within the canopy.

Conclusions

- Plant Top [PT] canopy position and time corresponding to maximum WUE_L [t_{max_wue}] i.e., 15:00 to 16:00 hours are the optimal canopy position and optimal time window to measure WUE_L.
- WUE_L was significantly influenced by the measured PPFD [r = 0.80] and VPD_L [r = 0.78] whereas the WUE_P was influenced by R_n [r = 0.85] and RH [r = 0.77].

Future steps

- Multi scale characterization of WUE of Maize crop.
- Investigate the WUE scale issues under Indian –agro climatic conditions.
- Investigate the role of climate and biophysical drivers on various scales of WUE dynamics.
- Development of WUE model for estimating ecosystem WUE using observed eddy-covariance flux datasets.

Research accomplishment

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