Remote Sensing based Evaluation of heat tolerance in Tropical Bread Wheat using Spectral Reflectance Indices

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Introduction

- Heat stress is a major constraint to wheat productivity in tropical regions.
- Remote sensing through spectral reflectance indices (SRIs) enables rapid, non-destructive monitoring of canopy greenness, pigments, and water status.
- This study evaluates selected SRIs at booting, flowering, and milk stages to characterize their variation and assess their potential as indicators of heat stress tolerance in tropical bread wheat.

Conclusions

- SRIs showed clear stage-dependent responses under heat stress.
- The milk stage gave the strongest separation among genotypes.
- NDVI-1, EVI, PRI, and ARI were reliable indicators of canopy stress.
- NWI-1 and OSAVI differentiated maturity groups effectively.
- Combined use of indices enables rapid screening of heat-tolerant wheat in tropical environments.

Results and Discussion

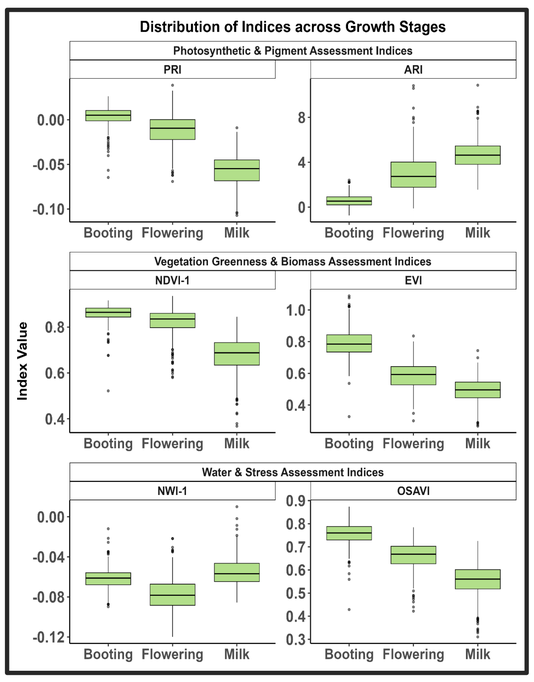

Figure 1: Variation of SRIs across growth stages

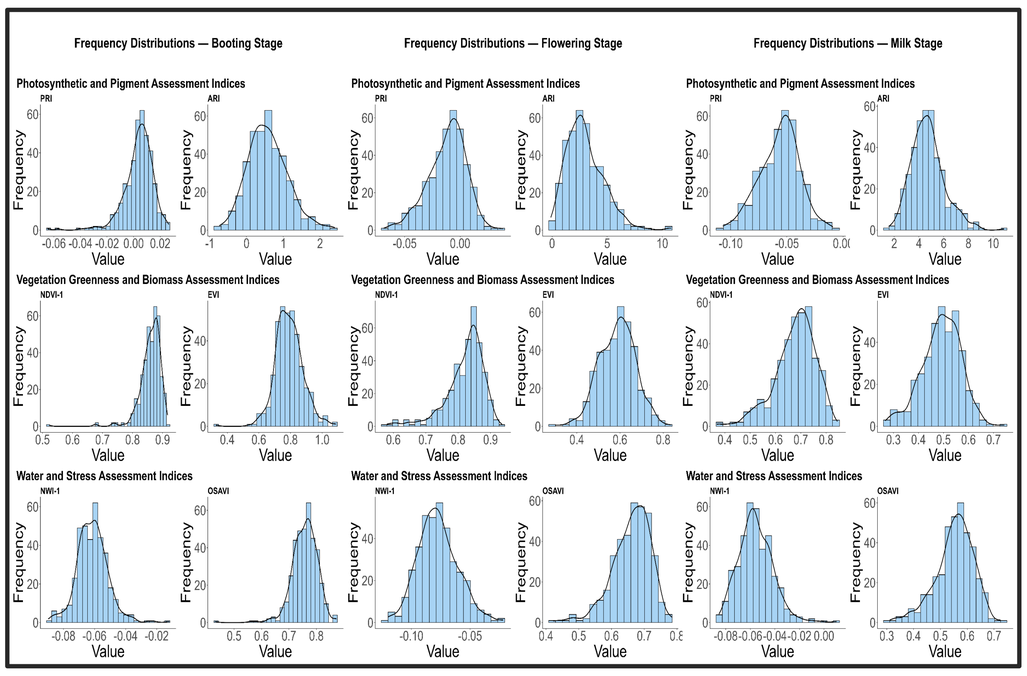

Figure 2: Frequency distribution of SRIs across growth stages

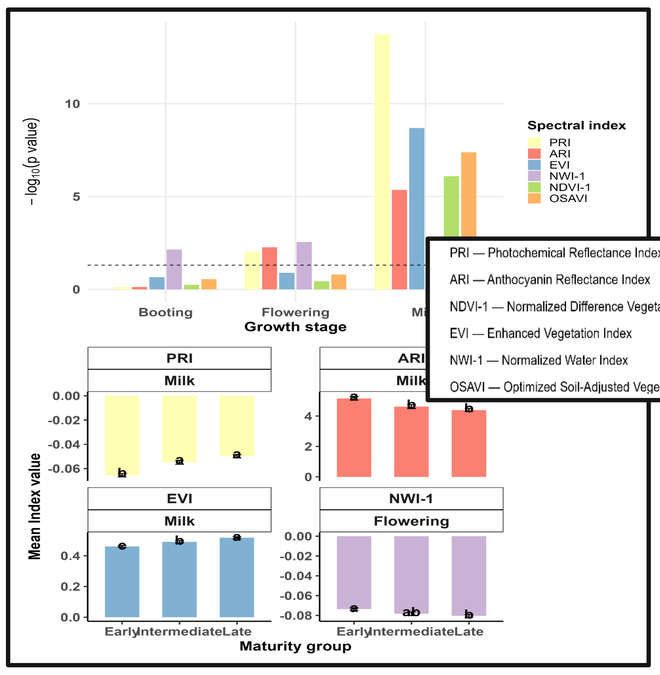

Figure 3: ANOVA of SRIs. Top: −log10(p) values across stages. Bottom: Key SRIs with means ± SE; Tukey letters show significant maturity-group differences.

- **Pigment and greenness SRIs indicated progressive pigment loss and canopy senescence from booting to milk.**
- **Water SRIs showed stable to variable responses, reflecting genotypic differences in stress tolerance.**
- **PRI declined steadily, while ARI increased, showing pigment loss and anthocyanin buildup.**
- **NDVI-1 stayed high until flowering but dropped at milk; EVI declined across all stages, reflecting canopy senescence.**
- **NWI-1 dropped until flowering but slightly recovered at milk; OSAVI remained stable, indicating diverse water retention capacity among genotypes.**
- **The milk stage showed the strongest discrimination among genotypes.**
- **Early maturing lines had higher NWI-1 values at flowering, indicating better canopy water status.**
- **Late maturing lines expressed higher EVI at milk stage, reflecting prolonged greenness and delayed senescence.**

Materials and Methods

A panel of 380 wheat genotypes (CANPBY-23) was evaluated under heat stress at CENEB, CIMMYT (Obregón, Mexico) in 2022–2023. Trials followed an alpha-lattice design with two replications (1.6 m² plots). Canopy spectra were recorded at booting, flowering, and milk stages using a FieldSpec HandHeld 2 (325–1075 nm), and indices of greenness, pigments, and water status (NDVI-1, EVI, PRI, ARI, NWI-1, OSAVI) were derived.

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