Evaluation of drought effects on field-grown spring wheat canopies *via* spectral reflectance indices

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Introduction

High-throughput phenotyping of wheat lines using hyperspectral indices provides an effective approach to accelerate breeding for drought resilience, allowing the detection of changes in canopy characteristics and leaf composition, supporting the identification of genotypes with improved tolerance to drought stress.

In this study we compared the changes of spectral reflectance indices (SRIs) commonly linked to crop yield and biomass, in field grown wheat lines developed by CIMMYT, subjected to drought stress.

Figure 1: Canopy-level measurements of wheat using an ASD FieldSpec spectroradiometer

Conclusions

- SRIs showed significant variation ($p<0.05$) among tested lines and in response to WD.
- WD activated photoprotection (PRI) and antioxidant defence mechanisms (ARI).
- Due to the close association between SRIs and yield under WW and WD conditions, drought-resilient and drought sensitive wheat lines can be identified and further characterised.

Results and Discussion

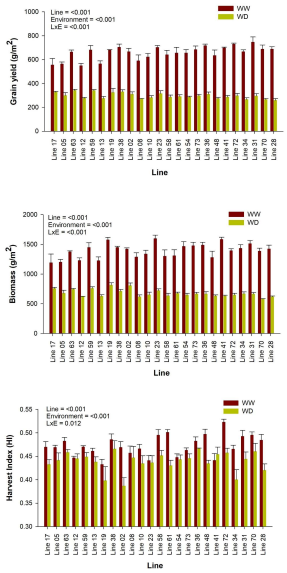

Figure 2: Grain yield, biomass, and harvest index in 24 wheat lines grown under well-watered (WW) and water deficit (WD) conditions

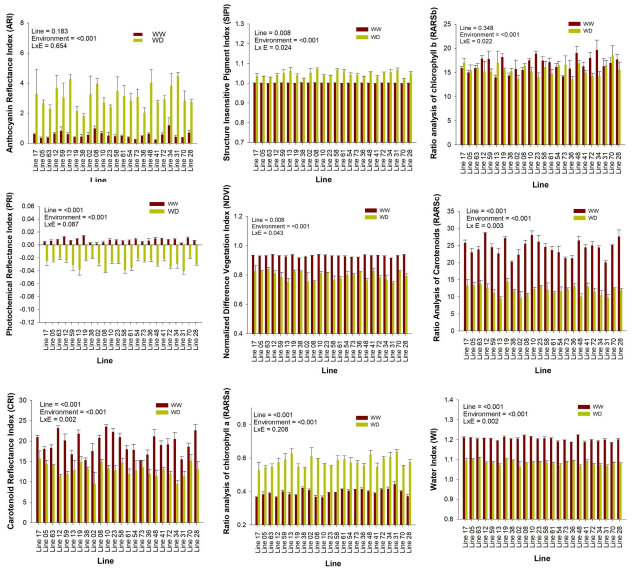

Figure 3: Several spectral reflectance indices measured at the canopy level in 24 wheat lines grown under well-watered (WW) and water deficit (WD) conditions

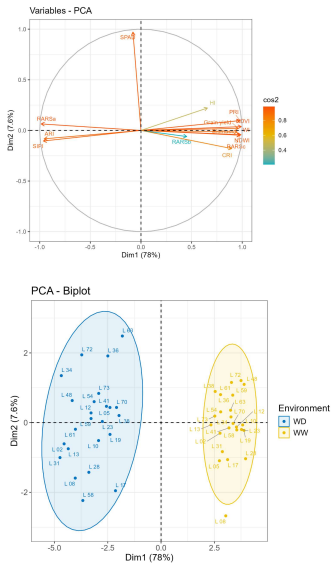

Figure 4: Multivariate analysis of several spectral reflectance indices (SRIs) and agronomic traits in 24 wheat lines grown under well-watered (WW) and water deficit (WD) conditions

- Grain yield and biomass were decreased by 46%, 48% under water deficit (WD) compared to well watered (WW) conditions.
- The harvest index was 7% higher in WW than in WD.

- Lower Photochemical Reflectance Index (PRI) values under WD, which could be attributed to an increased de-epoxidation state of the xanthophyll cycle and thus, energy dissipation.
- A significant increase in Anthocyanin Reflectance index (ARI) under WD, which acts as an antioxidant defense, contributes to photoprotection.
- The Water index (WI) values are decreased under WD, due to intensified WD conditions.

- PC 1 and 2 explained the 85.6% and segregated the two environments (WW and WD).
- SRIs (PRI, NDVI, CRI, RARSc, RARSb, WI, and NDWI) showed a strong positive and significant association with grain yield and biomass.

Materials and Methods

Twenty-four spring wheat lines from the Best Physiological Traits + Parents (BESTPT+PDS) panel were cultivated at CIMMYT's Campo Experimental Norman E. Borlaug (CENEB) field station in Ciudad Obregón, Sonora, Mexico, during the 2023/2024 growing season under well-watered (WW) and water deficit (WD) conditions. The canopy-level spectral reflectance data were measured at the early reproductive stage using an ASD FieldSpec spectroradiometer. The spectral data were processed with ViewSpec Pro software, and several spectral reflectance indices were calculated using R Studio.