Institute of Agricultural Sciences in the Tropics (Hans- Ruthenberg-Institute) Water stress Management (490g)

Hyperspectral estimation of pigments composition in wheat canopy layers under heat and drought field conditions

Geckem Dambo[1],Ilaria Parente[1], Alejandro Pieters[1], Carlos A. Robles-Zazueta[2], Francisco Pinto[2], Matthew Reynolds[2], Folkard Asch[1]

[1]University of Hohenheim, [2]International Maize and Wheat Improvement Center (CIMMYT)

Introduction

- Drought and heat stress have become the most significant factors limiting wheat productivity.
- Use of fast non-destructive remote sensing gadgets to detect changes in plant pigment composition would help in the selection of wheat genotypes that are tolerant to drought and heat stresses.
- Thus, spectral indices related to leaf pigments are used as proxies to indirectly estimate plant tolerance to drought and heat stress.

Conclusions

- Our results indicated that proxy of PRI, PSSRa and ARI indices varied among the enviromental conditions, wheat genotypes and leaf positions.
- However, the effect was more pronounced under heat stress condition.
- PRI and ARI indices could be used to predict wheat biomass under varied conditions.

Results and Discussion

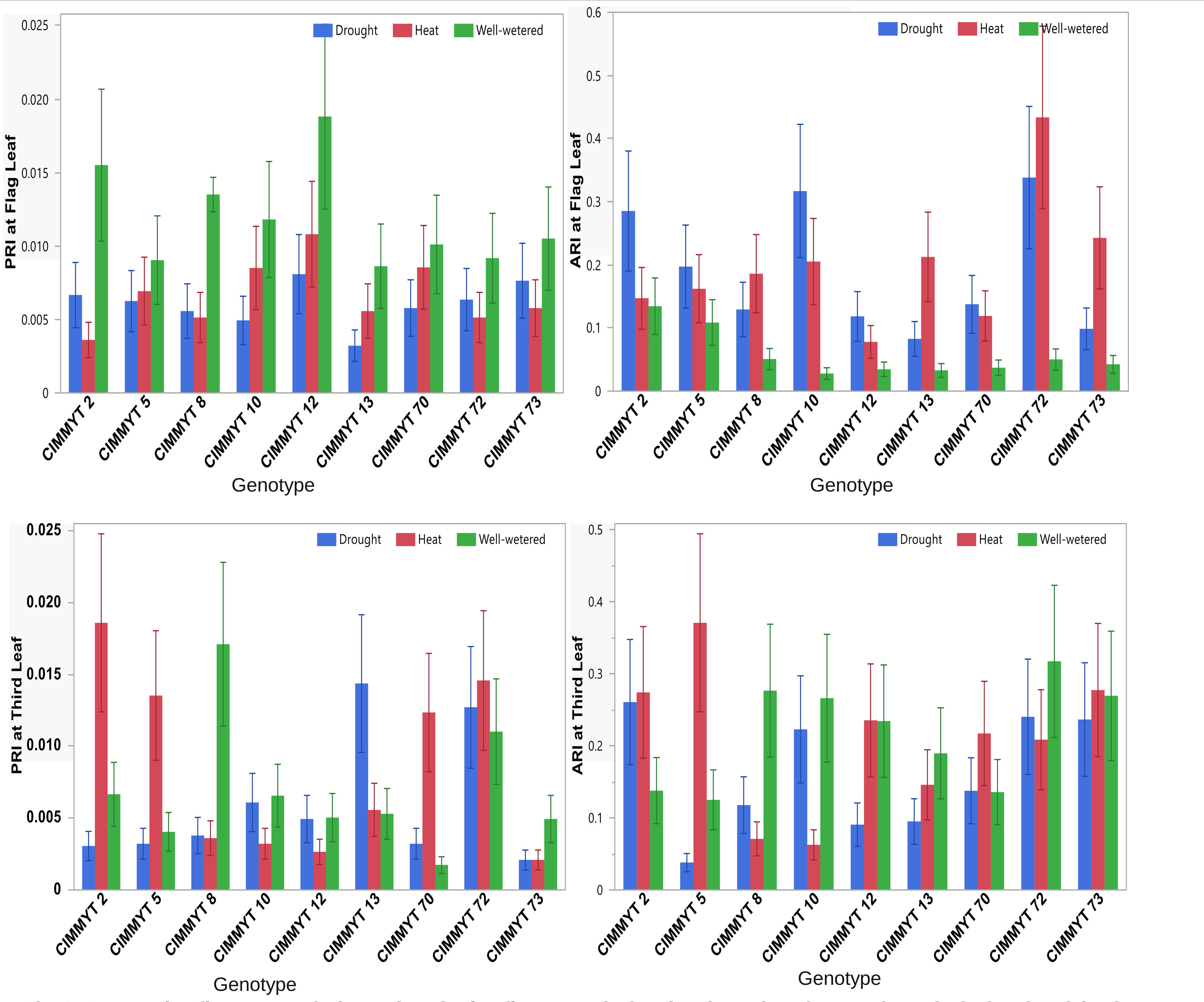

Fig 1. Spectral reflectance of photochemical reflectance index (PRI), and anthocyanin ratio index (ARI) in the flag and third leaf under heat, drought, and well-watered wheat genotypes.

•Lower Photochemical Reflectance Index (PRI) values in HS and WD in most leaves and higher values in WW suggest a higher de-epoxidation state of the xanthophyll cycle under stressful environments.

•Significant increases in the anthocyanin ratio index (ARI) indices in flag leaves under HS and WD compared to WW.

•Some genotypes showed higher values of PRI and ARI in the third leaf under WD and HS

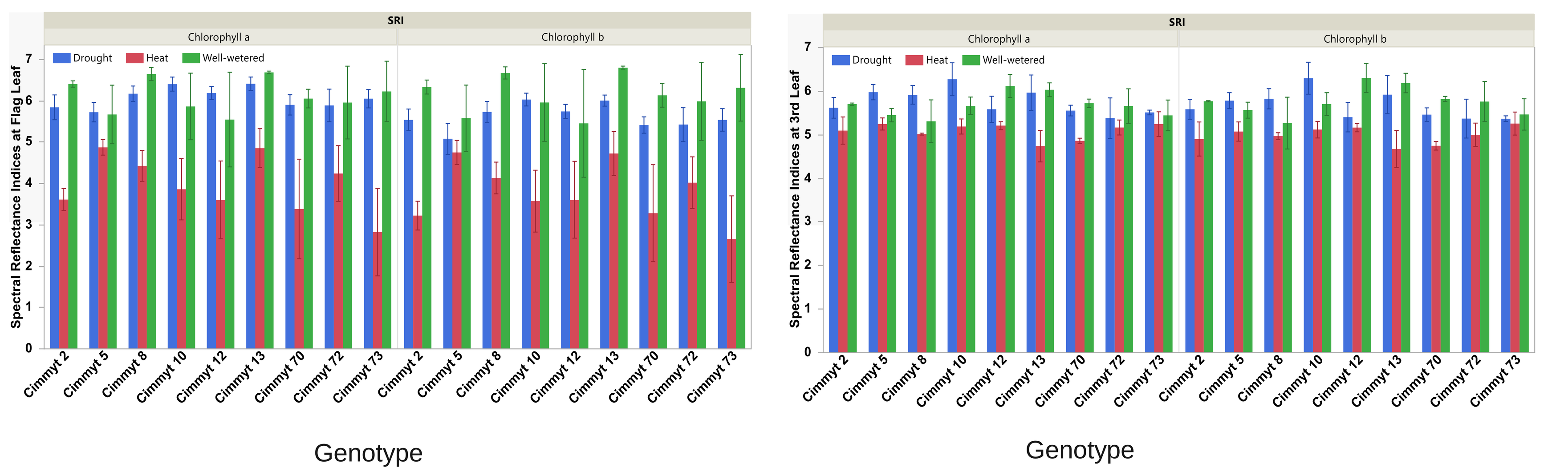

Fig 2: Spectral reflectance indices for chlorophyll a, and b in the flag and third leaf under heat, drought, and well-watered wheat genotypes.

•Spectral reflectance indices related to chlorophyll a and b decreased in the flag leaf under HS compared to WD and WW. While in the third leaf, the values were almost stable.

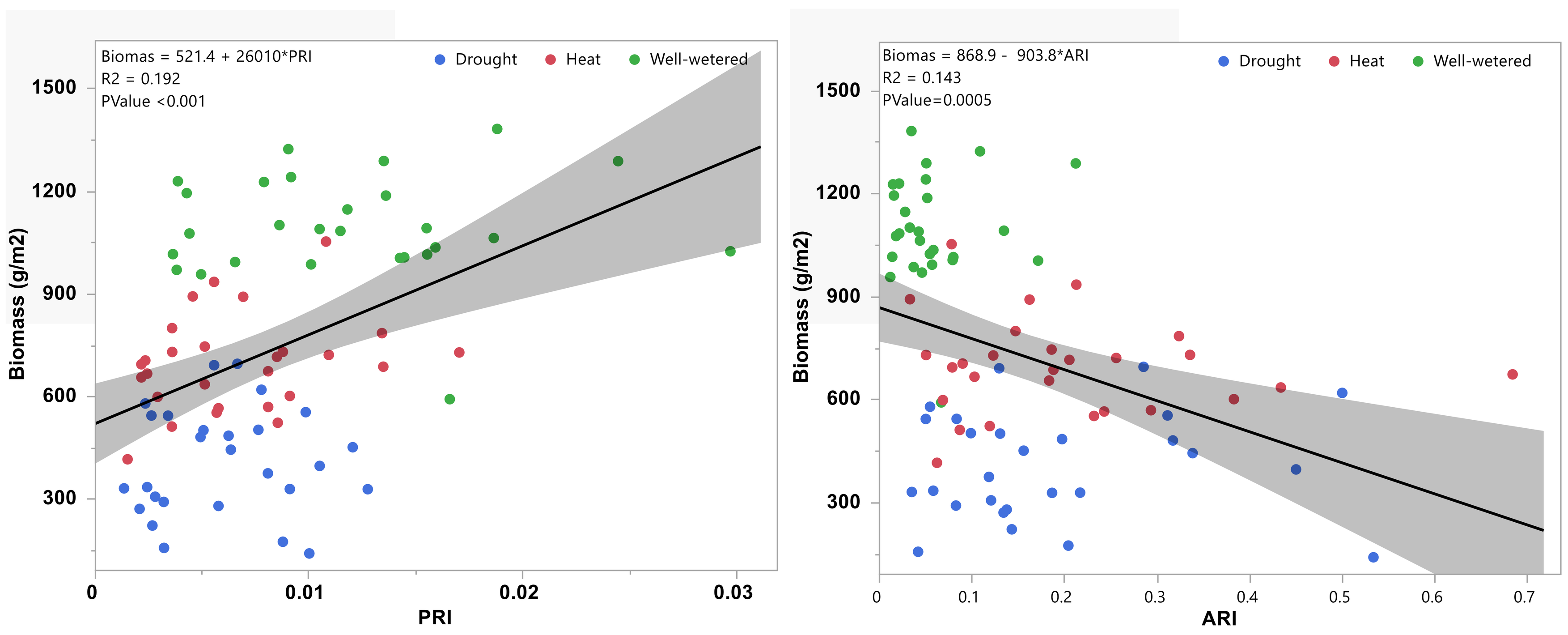

Fig 3: Relationship between PRI, and ARI with the wheat biomass across various conditionswheat genotypes.

•PRI had a positive relationship with the wheat biomass implying that increasing PRI values increases the biomass.

•However, ARI had a negative correlation with the wheat biomass suggesting biomass decreases with increasing ARI.

Materials and Methods

Step 1: Experimental setup

Nine wheat genotypes were grown in the field in. Obregon, Mexico during the 2021/2022 growing season under three treatments, **drought stress (DRT), heat stress (HS) and Well-Watered (WW).**

Field Spec 4 Hi-Resolution, portable spectroradiometer

Step 2: Spectral data acquisition

Spectral reflectance data for leaf pigments were collected at initiation of booting in the spectral range of 350-2500nm

Spectral indices related to PRI ARI, PSSRa, PSSRb and PSSRc were estimated.

Step 3: Spectral data processing

$$ARI = \left(\frac{1}{R550} - \frac{1}{R700}\right)$$

$$PRI = \left(\frac{R531 - R570}{R531 + R570}\right)$$

$$PSSRa = \left(\frac{R800}{R675}\right)$$

$$PSSRb = \left(\frac{R800}{R650}\right)$$

$$PSSRc = \left(\frac{R800}{R470}\right)$$