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"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

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

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Abstract

Wheat productivity is challenged by increases in air temperature and water deficit. Photoprotective leaf pigments play a significant role in preventing the negative impacts of these stresses. Reflectance indices have the potential to rapidly and non-destructively estimate leaf pigment composition allowing characterisation of heat and drought resilient wheat. A total of nine elite wheat genotypes developed by CIMMYT showing different resilience to drought and heat stress were grown in the field in Cd. Obregón, Mexico during the 2021/2022 growing season. The genotypes were evaluated under three different treatments, water deficit (WD), well-watered (WW) and heat stress (HS). The WD treatment was irrigated only twice during the growing season, whereas the WW treatment was irrigated throughout at regular intervals. The HS was achieved by adjusting the sowing date from December (used for WW and WD) to late February. Spectral reflectance for Anthocyanin Ratio Index (ARI), Photochemical Reflectance Index (PRI), Pigment specific simple ratio of chlorophyll a (PSSRa), Pigment specific simple ratio of chlorophyll b (PSSRb) and Pigment specific simple ratio of carotenoids (PSSRc) were used to estimate leaf pigment composition at the initiation of booting. The results showed a significant increase in the indices related to ARI in the flag leaves under HS and WD compared to WW. Lower PRI were observed in HS and WD in most leaves measured, while leaves from WW showed higher values, suggesting a higher de-epoxidation state of the xanthophyll cycle under stressful environments. PSSRc, PSSRb and PSSRa also decreased in the flag leaves in HS and WD. These results showed that reflectance indices associated to photoprotective mechanisms (ARI and PRI) were activated by HS and WD. However, HS and WD decreased reflectance indices associated to Chlorophylls and carotenoids, suggesting stress induced pigment degradation. The highest impact of HS and WD was observed in the flag compared to older leaves, which indicates that the light environment plays a modulating role on stress response of pigment composition in wheat.

Keywords: Leaf pigments, photochemical reflectance index (PRI), spectral reflectance indices (SRI), xanthophyll cycle pigments

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