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Leaf pigment composition in wheat (*Triticum aestivum* L.) exposed to water deficit and heat stress

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Abstract

Photoprotective pigments play a significant role in preventing negative effects of excessive light absorption on plant metabolism by preventing oxidative stress. Climate change-driven episodes of water deficit and heat spells would exacerbate such negative effects of excess light. However, information on the response of pigments composition in wheat leaves to abiotic stresses is scarce. We investigated the carotenoid and chlorophyll (Chl) composition at heading stage in flag leaves of sixteen elite spring wheat genotypes alongside with reflectance spectra measured by a canopy-level portable spectroradiometer. Field trials were carried out in Cd. Obregón, Mexico during two consecutive seasons (2021/2022 and 2022/2023) comprising three environments, namely Water Deficit (WD), Heat Stress (HS), and Well-Watered (WW) conditions. WD was irrigated only twice during the growing season, whereas WW was irrigated throughout at regular intervals. HS was achieved by adjusting the sowing date from December (WW and WD) to late February 2022 and 2023, management was as in WW. Carotenoids and Chls were determined by HPLC and spectrophotometry, respectively. WD and HS significantly affected transpiration rate, stomatal conductance, quantum yield of photosystem II, pigment related reflectance indices, and pigment composition. Genotypic differences were detected in pigment composition, SPAD values, transpiration, and stomatal conductance but not in reflectance indices. Carotenoids increased and Chl decreased under WD and HS, indicating activation of defensive mechanisms against stress such as non-photochemical quenching. To summarise the response of the genotypes and to identify key parameters associated to the response, a principal component analysis (PCA) was carried out. PCA segregated the three environments. PCA1 and PCA2 explained >80 % of total variation. Yield and plant performance variables were highly and negatively correlated to PC1, whereas carotenoids concentrations were highly but positively correlated with PC1. WD and HS were associated to high scores on PC1, and WW was associated to negative scores on PC1. Our results suggest that photoprotective mechanisms related to carotenoid composition are activated by drought and heat stress in wheat. Hyperspectral reflectance using pigment related indices could not detect genotypic differences in pigment composition. However, genotypic differences could be identified through laboratory analyses, which is promising for selection purposes.

Keywords: Chlorophyll, drought, heat, photoprotection, photosystem II, pigments, stomatal conductance

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