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"Reconcile land system changes
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Evaluation of drought effects on field-grown spring wheat canopies via spectral reflectance indices

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Abstract

Wheat productivity is significantly constrained by climate change–induced drought stress, often compounded by high irradiance, resulting in inhibition of photosynthesis and a consequent reduction in yield. Spectral reflectance indices (SRIs) have the potential to assess plant physiological traits, including leaf pigments that can be used as proxies to assess plant responses to drought stress rapidly and non-destructively. This study aimed to identify genotypic variation among 24 spring wheat Lines in response to water-deficit (WD) conditions using SRIs and to evaluate their association with crop performance. The experiment was conducted during the 2023/2024 growing season at CIMMYT's field station in Ciudad Obregón, Sonora, Mexico. SRIs for Anthocyanin Reflectance Index (ARI), Carotenoid Reflectance Index (CRI), Ratio Analysis of Carotenoids (RARSc), Structure Insensitive Pigment Index (SIPI), Photochemical Reflectance Index (PRI), Normalized Difference Vegetation Index (NDVI), Ratio Analysis of Chlorophyll a (RARSa), Ratio Analysis of Chlorophyll b (RARSb), Water Index (WI), Normalized Difference Water Index (NDWI) were used to assess plant physiological status at early reproductive and maturation stages. ARI values increased under WD conditions across both growth stages, indicating higher anthocyanin accumulation, contributing to photoprotection and antioxidant defense. A reduction in PRI under WD reflected increased xanthophyll cycle de-epoxidation and thus, an excess of energy dissipation, while CRI and RARSc values were higher under WW conditions, suggesting possible inhibition of carotenoid biosynthesis under WD. NDVI values consistently declined under WD due to reduced green biomass, whereas SPAD values showed small variation across environments and limited contribution to principal component analysis. Chlorophyll index, RARSa increased under WD in most Lines. WI and NDWI significantly decreased under WD. On average, grain yield and biomass were reduced by 46 % and 48 % under WD, respectively. In conclusion, the SRIs (PRI, NDVI, CRI, RARSc, RARSb, WI, and NDWI) exhibited a stronger positive and significant correlation with grain yield and biomass, while ARI, SIPI, and RARSa showed a negative association across growth stages and environments. Two Lines were identified as drought-adapted,

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while the other two Lines could be identified as drought-sensitive. Overall, SRIs proved reliable for identifying high-yielding, drought-resilient lines, supporting their use in breeding for water-limited conditions.

Keywords: And stress resilience , climate change, Photochemical Reflectance Index, remote sensing, Water Index