Tropentag, September 10-12, 2025, hybrid conference

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Remote sensing-based assessment of heat stress tolerance in tropical bread wheat using spectral reflectance indices

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Abstract

Heat stress poses a critical challenge to wheat production in tropical regions, especially under increasing climate change. Conventional phenotyping for heat tolerance is often labour-intensive, time-consuming, and subjective. Spectral reflectance data in remote sensing offers an efficient, non-destructive method for evaluating physiological traits and crop responses to environmental stress. This study investigates Spectral Reflectance Indices (SRIs) to assess heat stress tolerance in tropical bread wheat, focusing on 380 genotypes from CIMMYT's Candidates for Selection (CANPBY) panel. Genotypes were sown in late February 2023 at CIMMYT's Ciudad Obregón station, Mexico, to ensure exposure to temperatures exceeding 35 °C during grain filling. Canopy-level spectral reflectance was measured using a handheld spectroradiometer from late tillering to physiological maturity. Various SRIs—NDVI, PRI, TCARI, OSAVI, SIPI, ARI, NWI4, EVI, MTCI1, and RARSc—were evaluated for their predictive capability regarding agronomic traits, mainly grain yield. Correlation analysis revealed strong associations between indices such as NDVI, EVI, OSAVI and grain yield, highlighting their utility as non-destructive proxies for heat tolerance. Boxplot analyses showed significant genetic diversity in agronomic performance and spectral responses under heat stress. Combining spectral data with traditional phenotyping enhances identification of heat-tolerant genotypes, supporting breeding for wheat resilience in heat-stressed environments. This approach underscores remote sensing's potential in advancing genetic improvement for heat tolerance, though genotypic variation in phenology may confound trait expression. Further evaluation of spectral dynamics across growth stages is needed to assess genotypic variation in phenology and heat stress responses.

Keywords: Climate change, heat tolerance, remote sensing, *Triticum aestivum*

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