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"Reconcile land system changes
with planetary health"

Harnessing radiation use efficiency using spectral reflectance indices for climate-resilient wheat improvement in cimmyt international nurseries

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Abstract

Wheat is essential for global food security, with an average annual genetic gain in yield of 1 %, while the global demand increases by 1.7 % annually. Heat and drought, further threaten yields, with 10–12 % losses per 1°C rise above wheat's optimum temperature window and 7–8 % losses for 5 % reduction in rainfall, as observed in Northern Israel. The availability of novel wheat nurseries in combination with field trials in target environments (drought-prone and heat-prone locations world-wide) provides an opportunity to evaluate and phenotype a wide set of germplasm to accelerate breeding for drought and heat resilience. A recent study has shown that radiation use efficiency (RUE), defined as the biomass accumulated per unit of absorbed radiation, drive yield gains in the CIMMYT Elite Spring Wheat Yield Trial (ESWYT) over a 14-year line release period under irrigated conditions. RUE is a complex trait, but previous studies have shown that it can be accurately predicted using Spectral Reflectance Indices (SRI). This study evaluates RUE in elite wheat genotypes across three latest CIMMYT international wheat nurseries specific to targeted environments: 45 ESWYT for irrigated-high yielding conditions, 32 Semi-Arid Wheat Yield Trial (SAWYT) for drought-prone environments, and 23 Heat Tolerant Wheat Yield Trial (HTWYT) for high temperature environments. RUE was estimated from 40 days after emergence to initiation of booting period (E40InB) and initiation of booting to 7 days after anthesis period (InBA7) using this SRI model to validate its efficacy under stress conditions. Results show that heat and drought stress had little effect on RUE at InBA7, although higher RUE at E40InB was found in irrigated conditions over drought and heat. The higher RUE at InBA7 under heat stress may be attributed to increased pigment concentration as a response to late heat, potentially skewing SRI-based RUE estimates. However, under drought, slightly elevated RUE values at InBA7 than in irrigated might be associated with an increased photosynthetic capacity and higher chlorophyll content at that stage. Further regression analyses with biomass-derived RUE, physiological traits, and yield will assess the possibility for further corrections to the SRI model for predicting RUE under stress conditions.

Keywords: Climate change, Drought and heat, Food security, High-throughput phenotyping, Remote sensing

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