

Article

Multi-Trait Index-Based Selection of Drought Tolerant Wheat: Physiological and Biochemical Profiling

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Abstract: Drought is a detrimental abiotic stress that severely limits wheat growth and productivity worldwide by altering several physiological processes. Thus, understanding the mechanisms of drought tolerance is essential for the selection of drought-resilient features and drought-tolerant cultivars for wheat breeding programs. This exploratory study evaluated 14 wheat genotypes (13 relatively tolerant, one susceptible) for drought endurance based on flag leaf physiological and biochemical traits during the critical grain-filling stage in the field conditions. Measurements included six physiological, seven gas exchange, six photosystem II, six stomatal, three reactive species, seven metabolomic solutes, and two biomass traits. All parameters were significantly influenced by drought, with varying genotypic responses. Hierarchical cluster analysis (HCA) categorized genotypes into three drought tolerance groups based on trait performance. Seven genotypes in Cluster 2 (BARI Gom 26, BARI Gom 33, BD-631, BD-600, BD-9910, BD-9889, BD-637) exhibited superior drought tolerance, characterized by minimal changes in physiological traits and biomass accumulation, reduced oxidative stress markers, and increased accumulation of osmoprotectants. The innovative multi-trait genotype-ideotype distance index (MGIDI) further ranked wheat genotypes in regard to drought tolerance, identifying BARI Gom 33, BARI Gom 26, BD-9889, and BD-600 as top performers. Notably, all these top-ranking genotypes belonged to Cluster 2, previously identified as the highest-performing group in the HCA. The identified genotypes with superior drought tolerance offer valuable genetic resources for enhancing wheat productivity in water-limiting environments. Traits related to photosynthetic activity, biomass gain, leaf conductance, water stress, and osmoprotection showed high selection differentials and heritability in MGIDI analysis, indicating their potential as selection targets for drought-tolerant wheat. Overall, the strategic approaches have yielded novel insights into genotype screening that can be directly applied to deepen our understanding of drought tolerance mechanisms in wheat.

Keywords: *Triticum aestivum* L.; photosynthesis; drought; osmoprotectants; hierarchical cluster analysis; plant breeding



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1. Introduction

Wheat (*Triticum aestivum* L.), a staple cereal crop in global agriculture, supplies essential carbohydrates to 35% of the world's population. However, wheat production declines