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Trehalose-driven drought tolerance: Uncovering biochemical and physiological resilience in bread wheat genotypes

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Abstract

Drought is a major challenge to wheat production in arid regions like Oman, where limited water availability and high temperatures severely affect crop growth and food security. This study explored how trehalose, a natural sugar known for protecting cells during stress, contributes to drought tolerance in 20 bread wheat genotypes. Plants were grown under three levels of soil moisture – 80 %, 60 %, and 40 % of soil water holding capacity – to simulate mild, moderate, and severe drought stress, respectively. Data were collected at the flowering stage, when wheat is most vulnerable to water shortage. The results revealed clear differences among genotypes in how they responded to drought. Genotypes that accumulated higher levels of trehalose were better able to retain water in their leaves, preserve chlorophyll, and limit oxidative damage, even under the most severe drought conditions. These high-trehalose genotypes also showed greater antioxidant enzyme activity (SOD, CAT, POD), helping them neutralize harmful reactive oxygen species. Importantly, they maintained higher shoot biomass and leaf area, indicating healthier growth under stress. These findings highlight trehalose as a powerful indicator of drought resilience. Genotypes with strong trehalose accumulation not only survive better under water deficit but also maintain key physiological functions that support growth and yield. This study provides valuable insights for breeding programs focused on improving drought tolerance, offering a pathway to develop climate-smart wheat varieties suited for arid environments like Oman.

Keywords: Chitosan, drought tolerance, food security, nano-trehalose, osmoprotection, photosynthesis, sustainable agriculture

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