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Integrative Genomic and Transcriptomic Analysis of GASA Gene family in Sunflower Reveals Their Regulatory Role in Drought Stress Response

Muhammad Awais Ahmed[1], Muhammad Arshad Javed[1], Javaria Tabassum[1], Muhammad Asad Ullah[1]

[1]Department of Plant Breeding and Genetics, Faculty of Agricultural Sciences, University of the Punjab, Lahore, Pakistan

Abstract

Climate change has an outstanding impact on world agriculture. It increases both the frequency and severity of drought, reducing crop yield and compromising food security. Sunflower (*Helianthus annuus*), being a valuable oilseed crop suffers considerably by drought sress. Therefore, it is imperative to determine the genetic component that regulates its tolerance in water deficit environments in order to facilitate the production of drought-tolerant cultivars. *The GASA (Gibberellic Acid-Stimulated Arabidopsis)* gene family is known to be involved in hormone signaling, stress adaptation and growth regulation, but it's functional characterization lacks in sunflower. In the current study, we employed an integrative approach to screen and characterize the *GASA* gene family in sunflower and their roles under drought stress. Genome-wide analysis identified 27members of *HaGASA* gene family, unevenly distributed on eleven chromosomes. Phylogenetic analysis grouped the genes into five subfamilies supported by conserved motifs and structural homology with Arabidopsis, peanut, and soybean *GASA* genes. Analysis of cis-regulatory elements revealed drought and stress-responsive element enrichment with hormone and growth-related regulatory motifs. Based on transcriptomic data in the NCBI database, *HaGASA* gene expression in ten genotypes of sunflower was screened under drought. Fourteen genes exhibited differential expression under stress indicating a significant role in drought tolerance. Organ-specific expression analysis revealed *HaGASA2, HaGASA11, HaGASA17, HaGASA19, HaGASA21,* and *HaGASA26* to be dominantly expressed in the stem. This study emphasizes the *HaGASA* gene family's role in improving sunflower drought stress tolerance as well as gives preliminary insight into the genetic and regulatory processes of *HaGASA* genes that could help breed drought-tolerant sunflower varieties.

Keywords: *GASA, expression analysis, sunflower, drought*