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Opportunities to Enhance Seed Cotton Yield through various Biotechnological Approaches under water deficit Conditions

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Abstract

Earth is blessed with a huge quantity of water reservoir, but yet it's a limiting factor for crop production. Emission of greenhouse gases is a dark reality of industrialization. The huge cause of this emission is the burning of fossil fuels which leads to the global warming. It is a destructive and alarming situation for agriculture economies especially for crop husbandry. Cotton is a C3 crop and is sensitive to abiotic stresses, a little change from its optimal temperature, moisture and water content can affect its yield, growth and biomass. The objective of this review is to examine various biotechnological methods and their potential to increase seed cotton yield under water deficit conditions. It includes techniques like genetic engineering, molecular breeding, physiological interventions, and omics technologies. Genetic engineering has shown promising outcomes in improving cotton resistance to water stress, including the insertion of drought-tolerant genes, stimulation of stress-responsive genes, and modified hormone signaling mechanisms. Similar to this marker-assisted selection in molecular breeding, gene editing methods like zinc-finger nucleases (ZFNs), transcription activator-like (TAL) effector nucleases (TALENs), CRISPR technology, RNAi interference, somaclonal variations and Omics technology which includes genomics, transcriptomics, proteomics, metablomics, glyomics and phenomics are those biotechnological approaches that make it possible to precisely manipulate the genetic makeup of cotton plants, offering better management of desired characteristics. In addition, plants respond well to drought stress by application of biofertilizers, hydrogel and nanoparticles. The detrimental effects of water stress on seed cotton yield can be reduced by these interventions, which support the regulation of physiological processes, uphold cellular homeostasis, and improve stress tolerance mechanisms in cotton plants. In conclusion, integrating biotechnological techniques into cotton farming has the potential to significantly improve productivity, profitability, and resilience to water stress, guaranteeing sustainable cotton production for the next generation.

***Key words**: Abiotic stress, Genetic engineering, Genome editing, Omics technologies.*