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Climate-smart strategies: Improving cotton resilience through superior leaf phenotyping

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Abstract

Climate change and resource scarcity are the major challenging drivers to focus on developing climate-resilient crops. Under climate change, combating erratic temperature fluctuations is an arduous challenge. Cotton (*Gossypium hirsutum*) is an economically important oilseed crop for its textile fibre but the heat stress is a major constraint in lowering its yield by devastating crop at the early and terminal reproductive stages. Cotton is a major cash crop in Pakistan with 80 % livelihood depending on agriculture. There is a dire need to mitigate environmental calamities by exploring innovative phenotyping strategies to develop climate-resilient cotton. The present study aimed to explore the early stress establishment and tolerance through superior leaf anatomical and physiological traits to sense stress signals. For this purpose, Relative cell injury of 50 cotton genotypes was measured at seedling stage resulted in categorisation of 20 contrasting genotypes with low RCI 14 % as heat tolerant and heat sensitive between 70 to 100 RCI%. This coreset of 20 cotton genotypes were investigated under two temperature regimes: control and heat-stressed (>45°C) using a chamber) at different developmental stages. Leaf physiological traits including net photosynthesis, stomatal conductance, transpiration rate and photosynthetic water use efficiency and chloroplast showed significant differences in contrasting genotypes at seedling and reproductive stages. These traits were efficient in heat tolerant genotypes as compared to heat susceptible cotton genotypes. A biplot analysis indicated significant variation in yield related traits and fiber quality traits. Further, scanning electron microscopy (SEM) results indicated difference in leaf stomatal density and sizes of heat tolerant and heat sensitive genotypes, correlated efficient stomatal conductance with net photosynthesis rate under heat stress treatment. Moreover, the size and thickness of trichomes were high in heat tolerant genotypes as trichomes play diverse role in plant acclimation toward thermo-switches. The traits under study suggested that these are the efficient indicators in selecting heat tolerant genotypes. Utilizing these non-destructive trait study in breeding programmes has the potential to improve heat stress tolerance and overall plant performance. In future studies, these phenotypic plasticity parameters will promote cotton cultivation under harsh weather conditions that will uplift country economy and livelihood.

Keywords: Abiotic stress, anatomical structure, gossypium hirsutum, physiological parameters

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