TOWARD CLIMATE-RESILIENT COTTON: MOLECULAR DRIVERS, ABSCISSION ZONE DYNAMICS, AND TRANSLATIONAL BREEDING STRATEGIES

A molecular, physiological, and translational breeding perspective for heat-resilient cotton improvement

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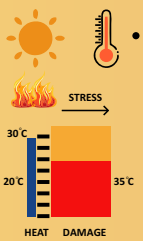
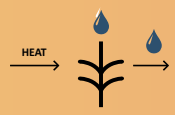
CLIMATE-INDUCED HEAT STRESS



- Heat stress during flowering and boll development severely reduces boll retention.
  - ✓ Photosynthesis
  - ✓ Hormonal balance
  - ✓ Cellular stability



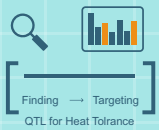
- Result: Premature boll abscission → major yield losses.

MOLECULAR DRIVERS & ABSCISSION ZONE DYNAMICS

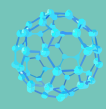
- Heat triggers activation of the abscission zone (AZ).
- Ethylene and ABA biosynthesis increases. Auxin transport decreases, destabilizing AZ homeostasis.
- ROS accumulation and HSPs regulate cell death and AZ differentiation. Stress-responsive transcription factors coordinate the shedding signal.

TRANSLATIONAL BREEDING STRATEGIES

- Integrating QTL mapping, transcriptomics, and CRISPR/Cas9.
- Identifying and modifying AZ-specific genes to improve thermotolerance.
- Gene–hormone network modeling to predict resilient phenotypes.
- Multi-omics pipelines accelerate trait introgression and ideotype development.



EMERGING & AGRONOMIC INTERVENTIONS



- Nanotechnology-enabled delivery of stress modulators to AZ.
- Exogenous plant growth regulators (PGRs) to stabilize hormonal crosstalk.
- Precision irrigation to minimize heat load and maintain turgor.
- Agronomic–molecular integration for holistic stress mitigation.

PROPOSED FUTURE FRAMEWORK

AZ-specific Gene ID → Hormone-network Modeling → CRISPR Editing → Trait Validation → Field-level Integration → Climate-resilient Cultivar Release

A multi-layered strategy integrating molecular profiling, regulatory networks, translational genomics, and precision agriculture. Aimed at delivering next-generation climate-resilient cotton varieties adapted to extreme agro-climatic conditions.

Designed by: Muhammad Akasha HameedMinhas