Evaluation of drought tolerance candidate genes in cotton

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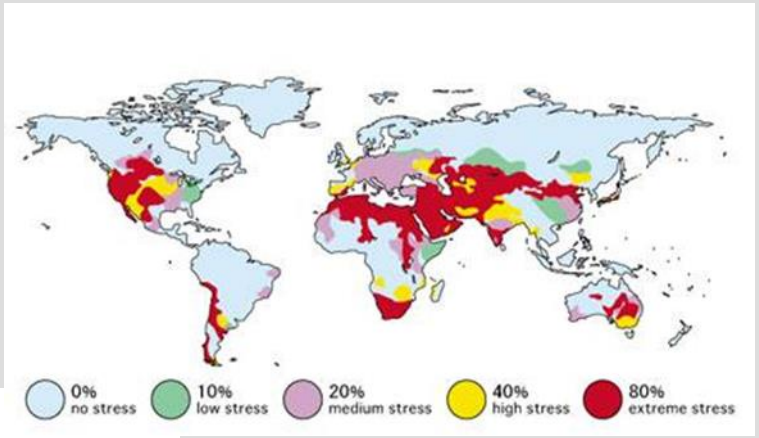
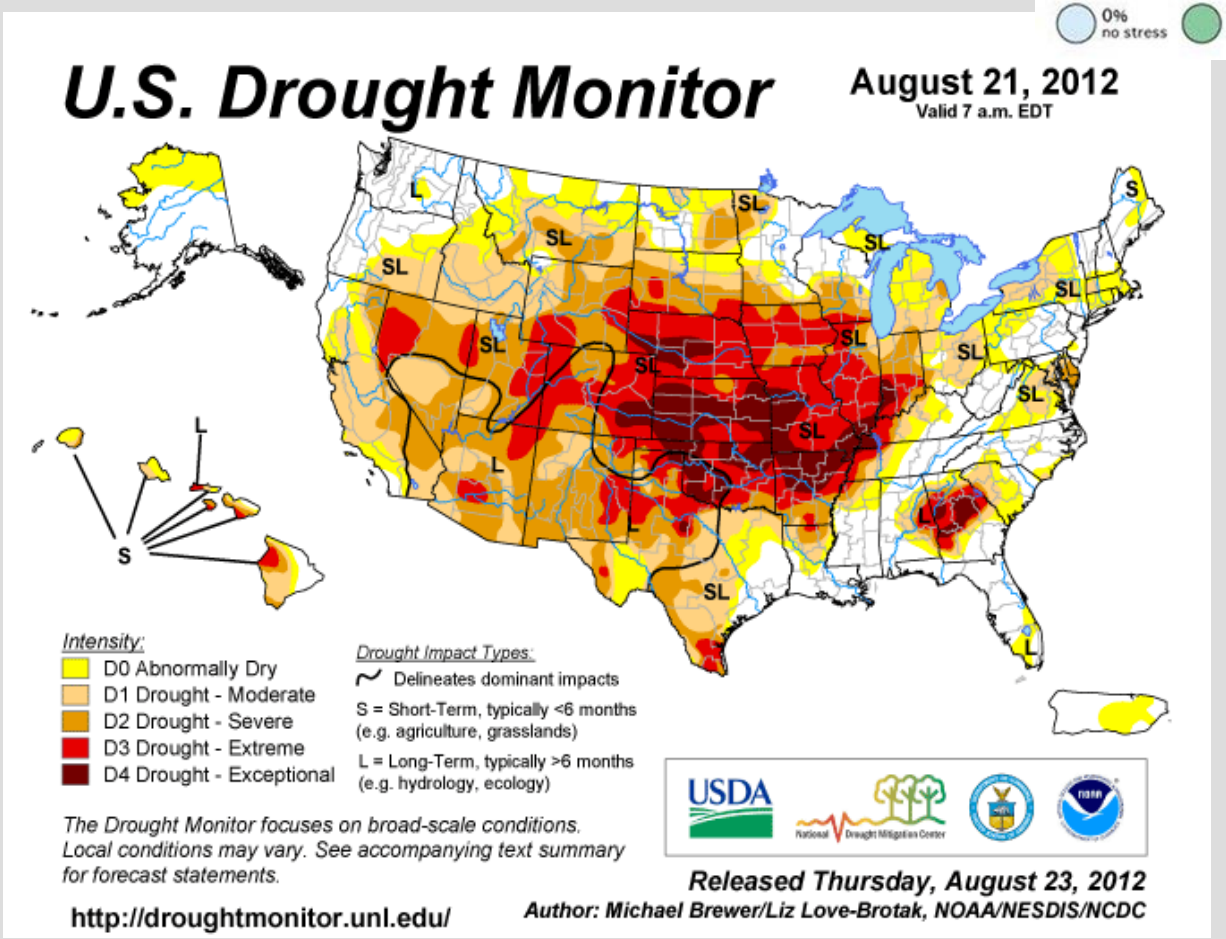
Drought:



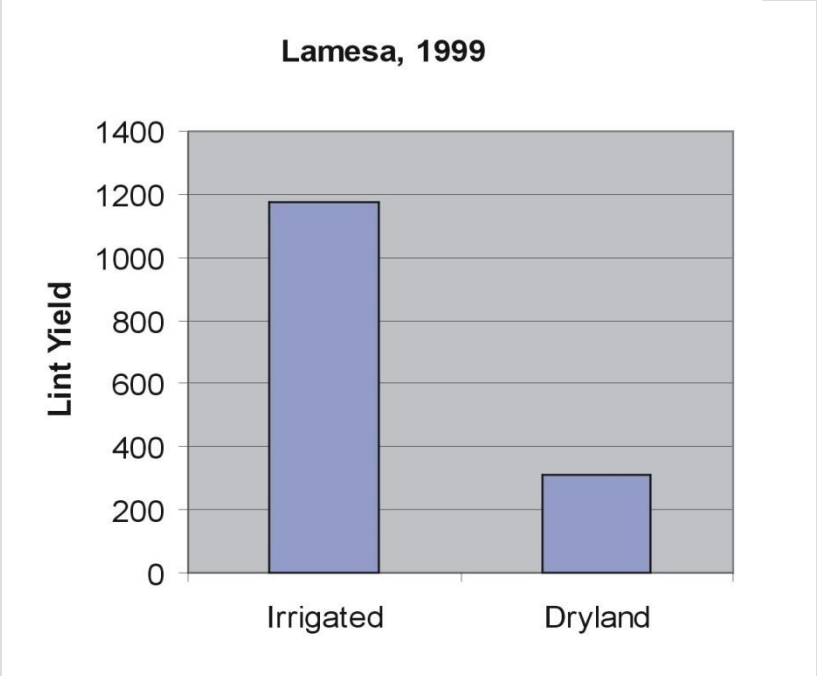


Abiotic stresses result in 70% to 80% average crop losses (Boyer, 1976)

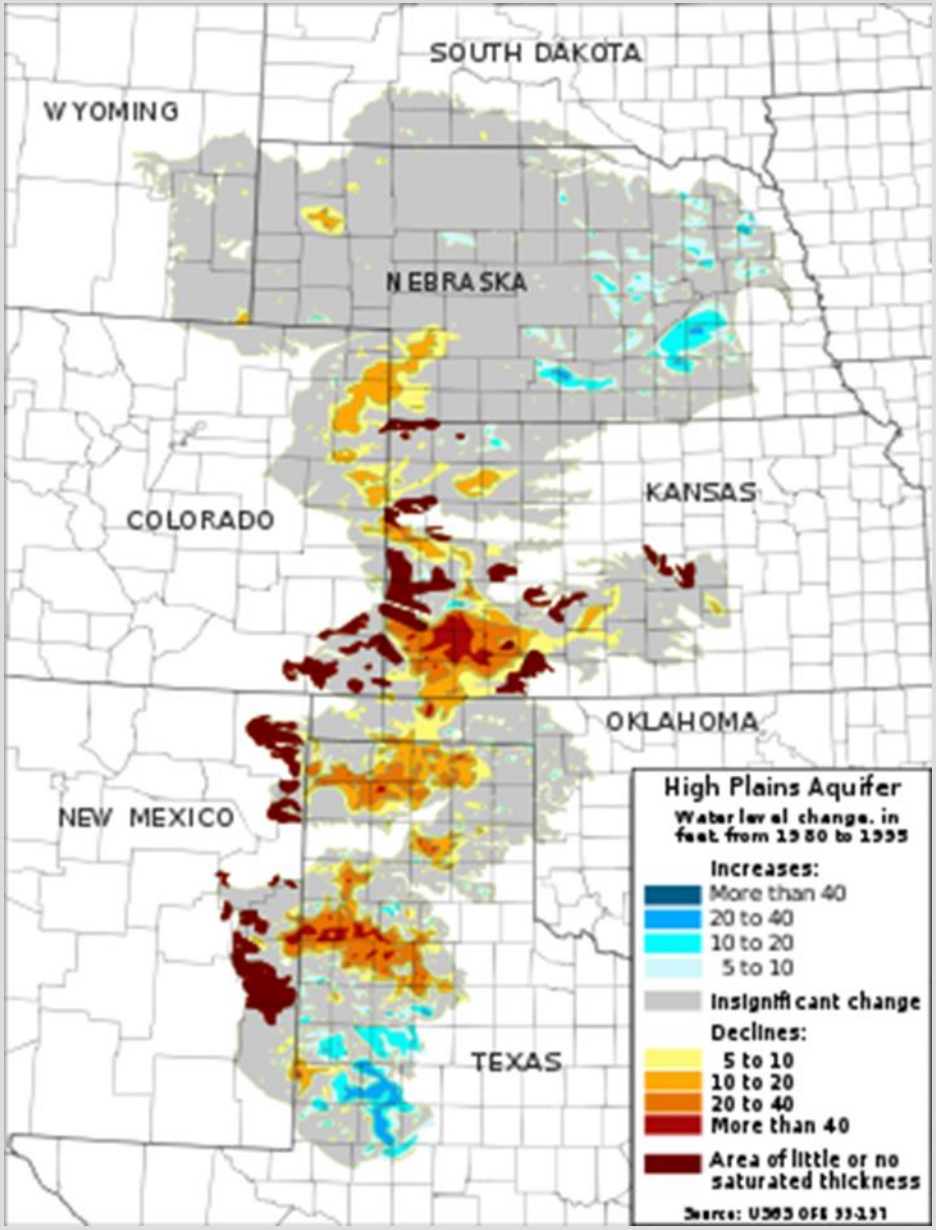
Water is the primary limiting factor in agricultural productivity, world-wide.

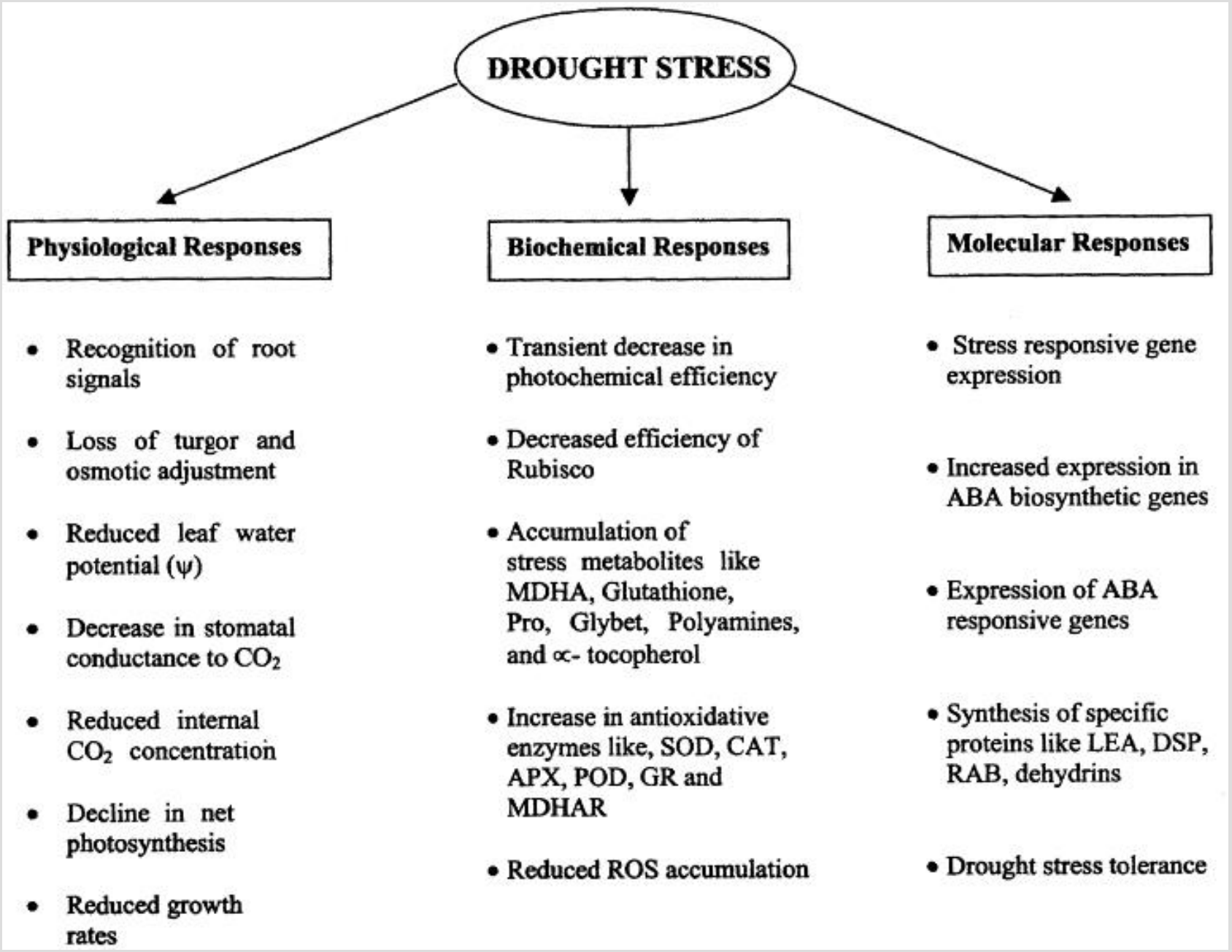
Irrigation:

- 90% of fresh water used in the U.S. is for irrigation.
- On average, an irrigated West Texas cotton crop yields 75% more than a dryland crop.
- Is irrigation of cotton in the western U.S. sustainable?



- The Ogallala Aquifer the largest single water-bearing structure in North America
- Covers 174,000 square miles of the Great Plains.
- Estimated to contain 3.2 billion acre-feet of water.
- Conservative estimates suggest it will be depleted by 2020.

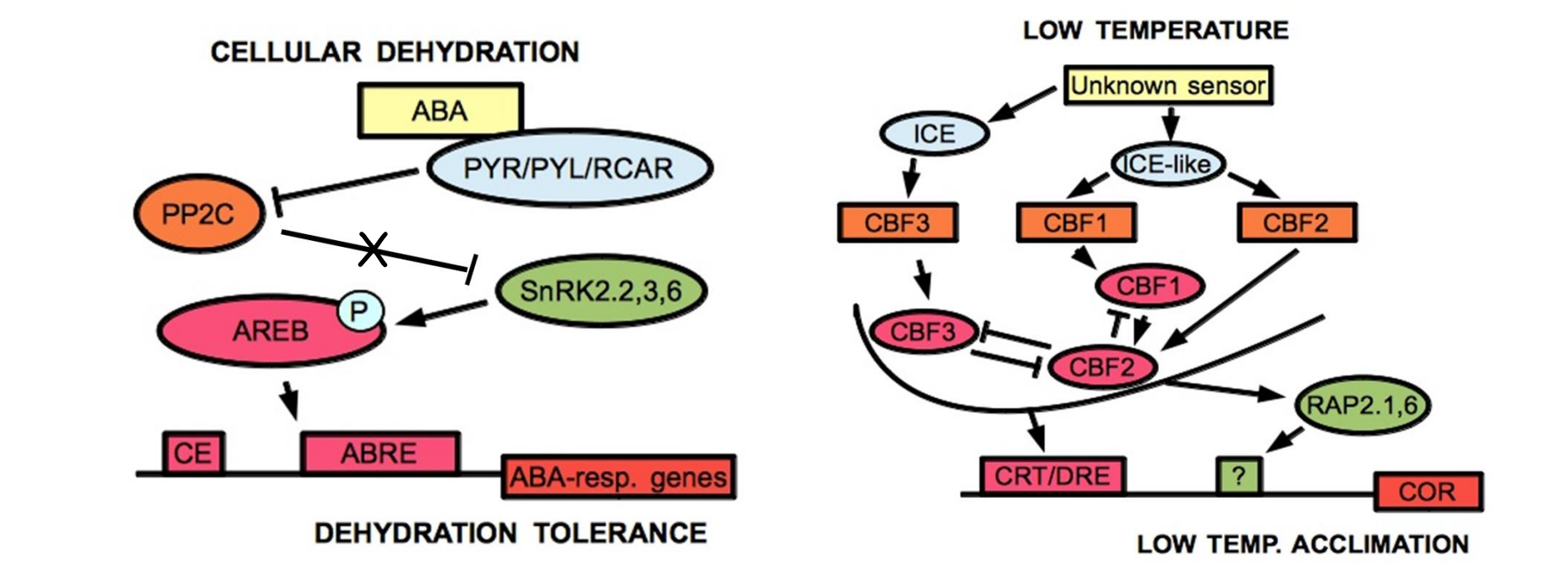



DROUGHT STRESS
Physiological Responses
Recognition of root signals
Loss of turgor and osmotic adjustment
Reduced leaf water potential (ψ)
Decrease in stomatal conductance to CO_2
Reduced internal CO_2 concentration
Decline in net photosynthesis
Reduced growth rates
Biochemical Responses
Transient decrease in photochemical efficiency
Decreased efficiency of Rubisco
Accumulation of stress metabolites like MDHA, Glutathione, Pro, Glybet, Polyamines, and ∝- tocopherol
Increase in antioxidative enzymes like, SOD, CAT, APX, POD, GR and MDHAR
Reduced ROS accumulation
Molecular Responses
Stress responsive gene expression
Increased expression in ABA biosynthetic genes
Expression of ABA responsive genes
Synthesis of specific proteins like LEA, DSP, RAB, dehydrins
Drought stress tolerance

Can we find a magic pill (gene)?

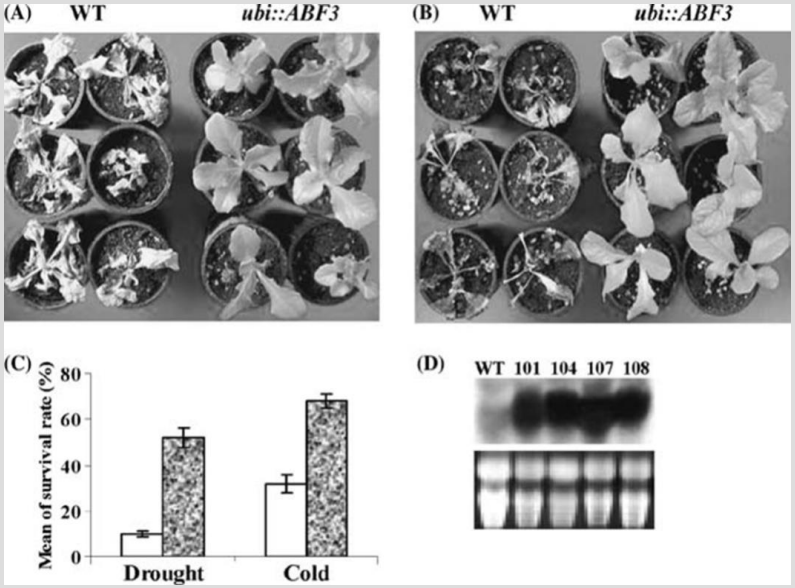
- Protective factors
  - Antioxidants
  - Dehydrins
  - Osmotic regulators
- Ion regulators
  - Na^+/H^+ pumps
- Regulatory factors
  - Transcription factors
  - Protein kinases
  - Ubiquitin ligases

ABA-dependent and independent signaling

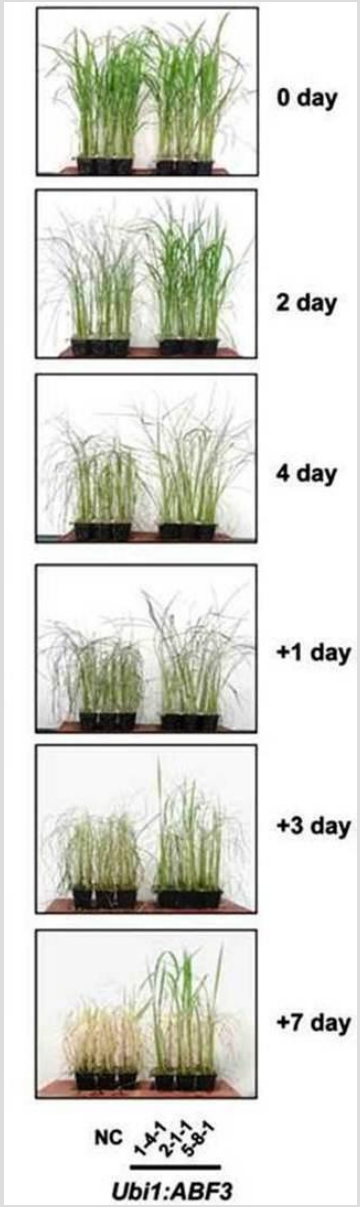


Constitutive expression of AtABF3 leads to stress tolerance:

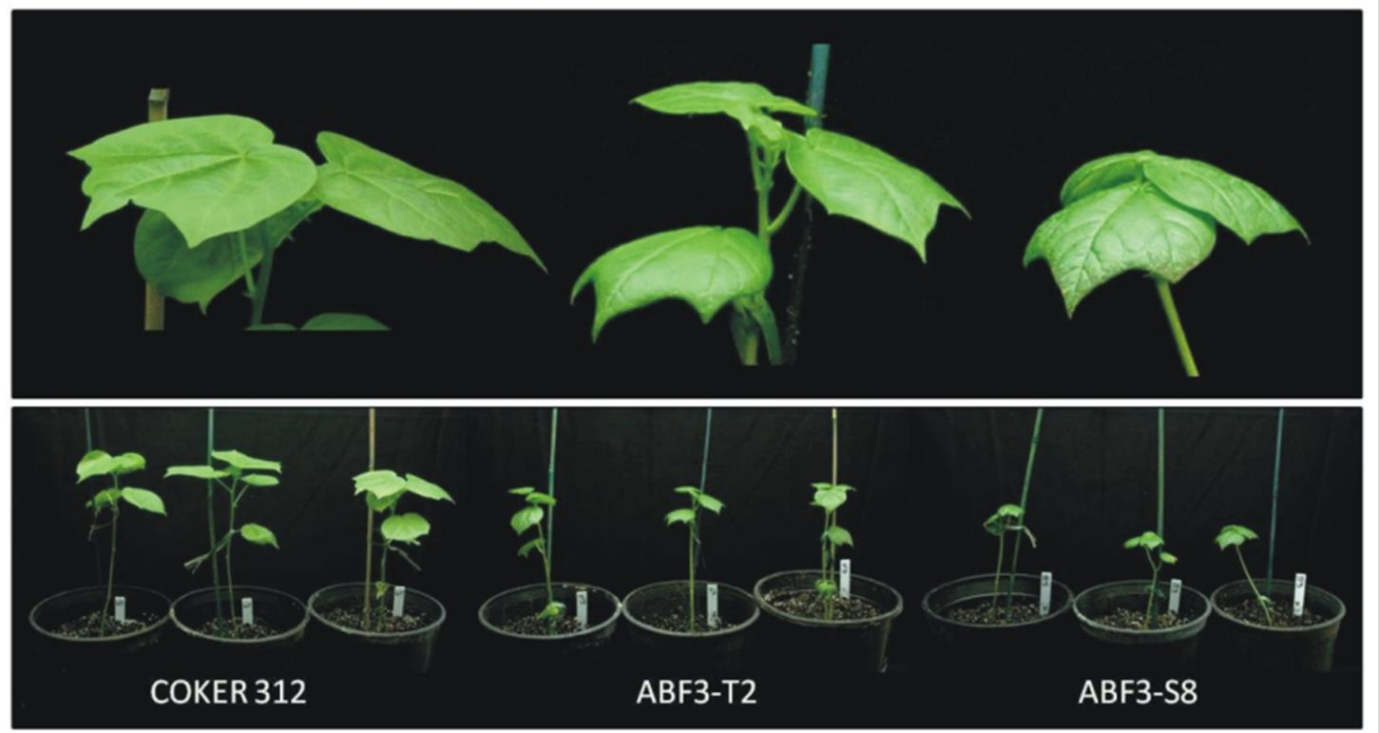
Kim et al., (2004) *Plant Biotech Journal* 2: 459–466

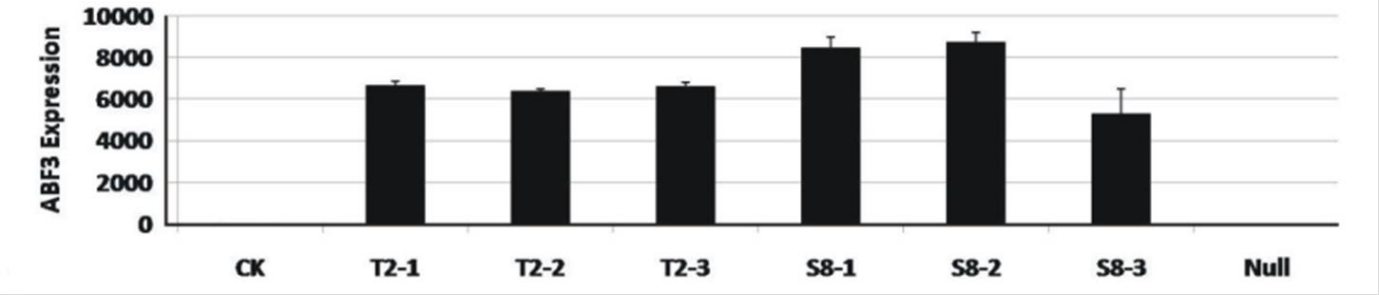


Vanjildorj et al., (2005) *PCT and O Culture* 83: 41–50

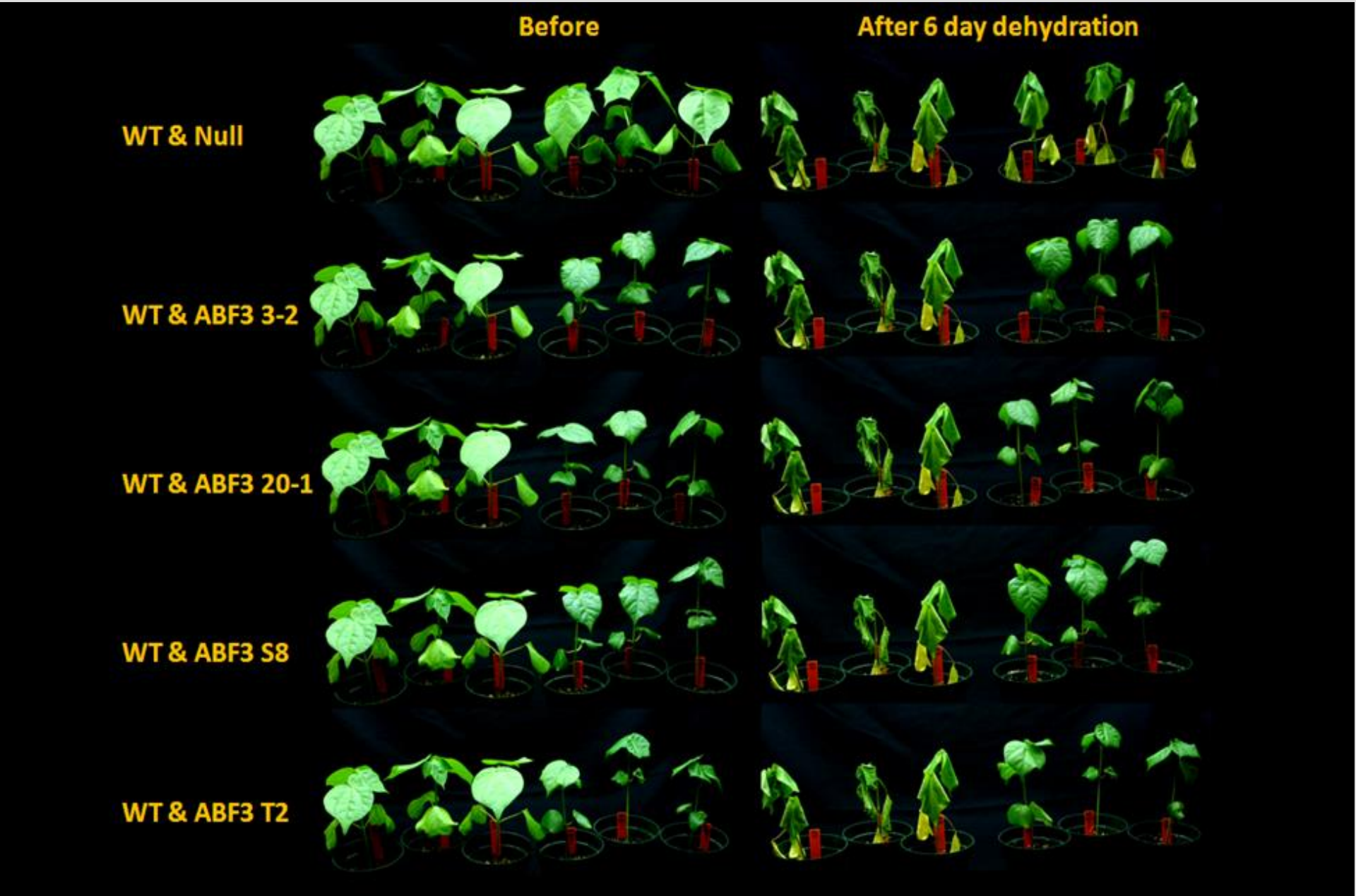


Phenotype of *35S::ABF3* Cotton:



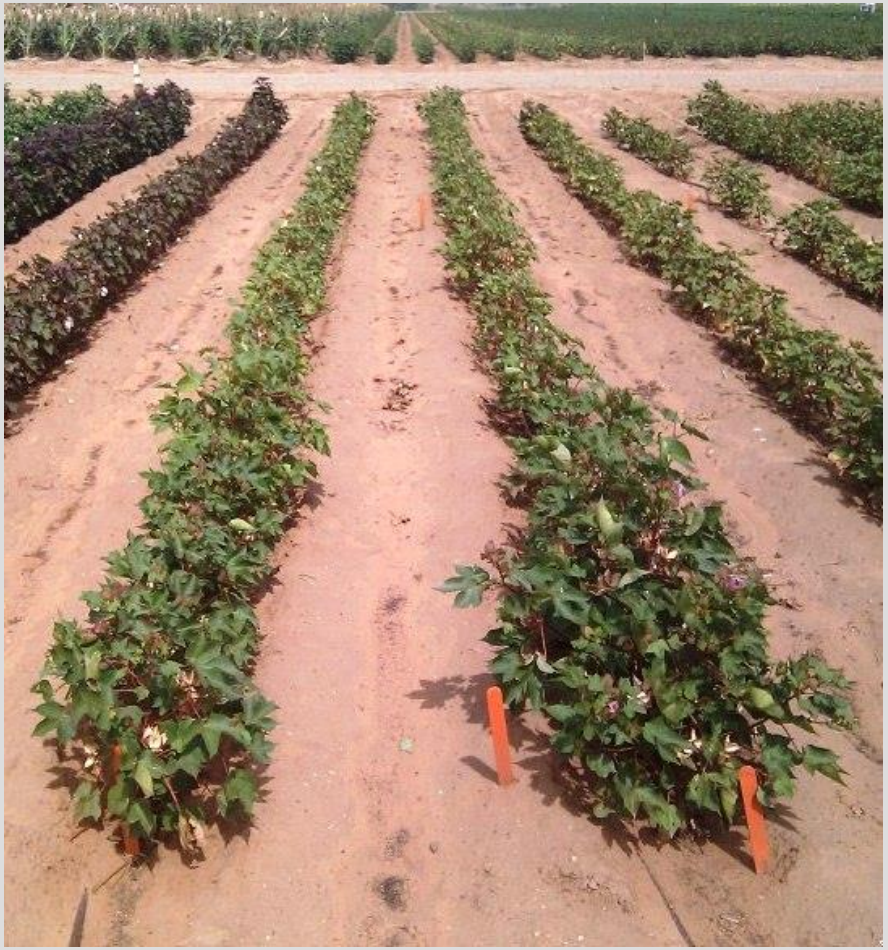


Delayed wilting in *35S::ABF3* Cotton:



Field evaluation of *AtABF3* cotton:

p35S::AtABF3



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Constitutive expression of AtABF3 in cotton :

- ABF3 influences plant responses to water deficit:
  - Reduced transpiration
  - Delayed wilting
  - Delayed development (greenhouse)
- Effects of ABF expression on field performance:
  - Various event-specific responses
  - Some lines show enhanced yield under water stress.
- Can ABF3 performance be improved?
  - Stress responsive promoters
  - Native cotton homologs

Acknowledgements:

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