2020 SC Water Resources Research Report

Title: Identifying intrinsic mechanisms of water sensing and transport in cotton and soybean root.

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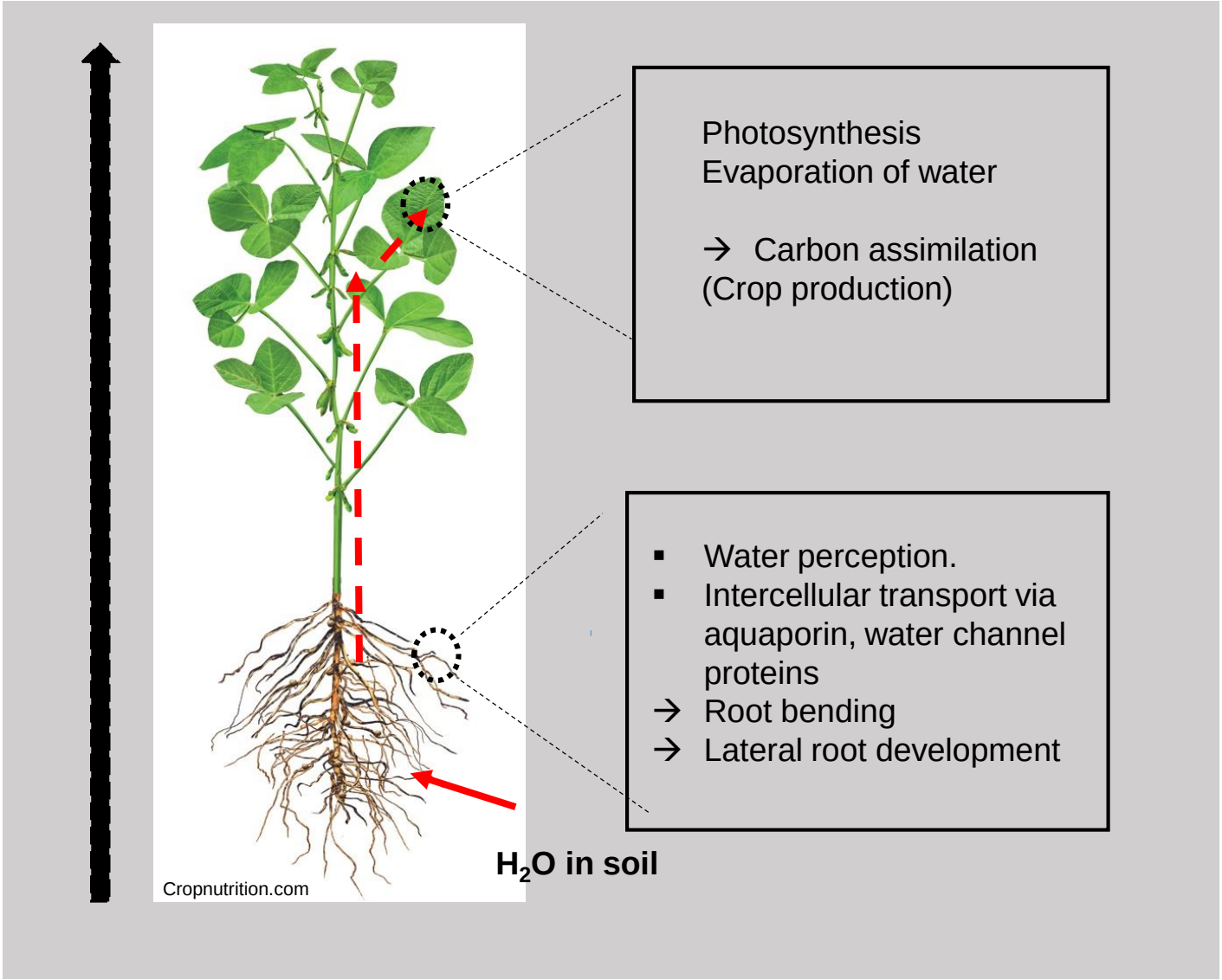
- Objective 1. Investigate mechanisms of water perception and transport in cotton and soybean root system.
- Objective 2. Evaluate water perception traits of cotton and soybean cultivars differing in slow wilting under drought.

Cotton, Soybean, and drought stress

- Crops such as cotton and soybean is vulnerable to drought and production is greatly affected by drought.
- Plants have genetic mechanisms by which perception and transport of water are regulated.
- Traits that govern these intrinsic processes may affect resilience to drought in roots.

Water perception and transport in plants



- Water transport in the plant is an passive process driven by difference of water potential gradient.
- Water perception can trigger root bending toward water, lateral root initiation, and root development.
- Water transport is facilitated by water channel proteins, called Aquaporins.

Approaches:

Crop growth (four replicated field plots)

Drought

Irrigation

Fast wilting (NC-Roy)

Slow wilting (NO4-9646)

Photo credit: Tommy Carter, 2014

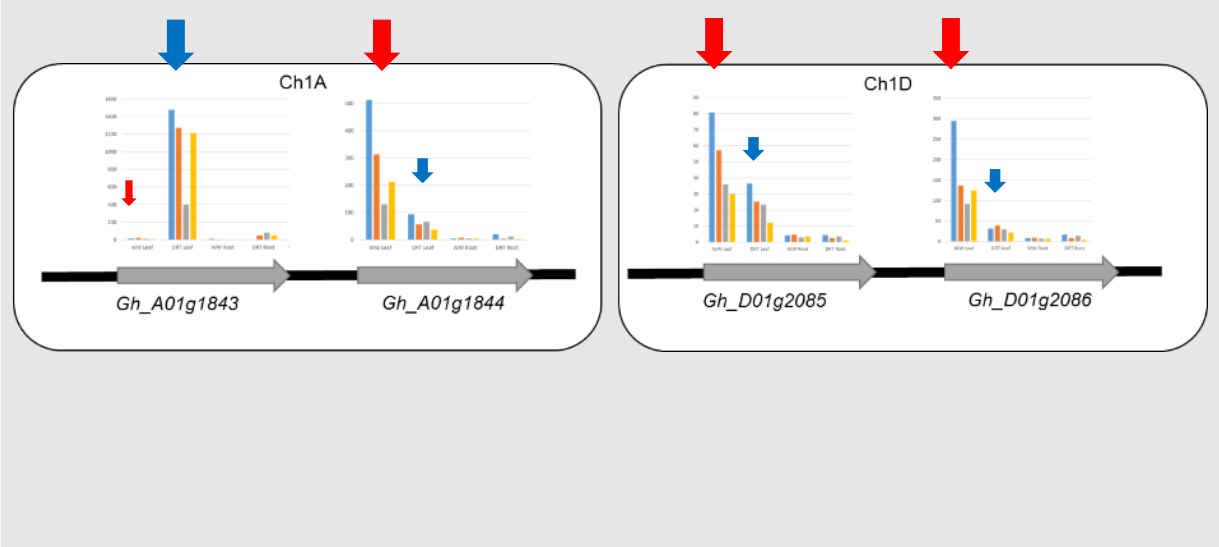
Measurement

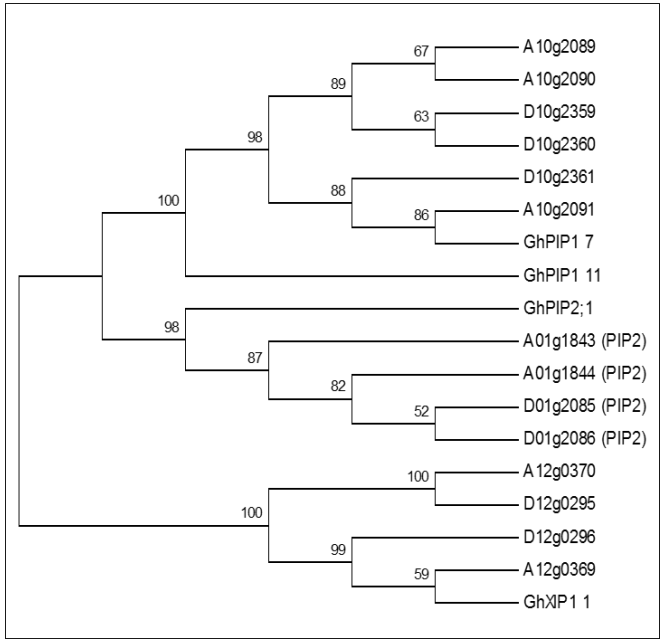
- Visual scoring of wilting
- Water applied
- Physiology
- Gene activities
- Crop yield

Research in progress:

- In four replicated plots, soybean and cotton tissues (leaf and root) were collected un different developmental stages under two different water conditions in 2019 Summer → Tissues will be analyzed for those aquaporin genes and water sensing-related MIZ genes.
- For the functional study, a cotton MIZ gene was isolated and has been used to complement Arabidopsis mutants that have defects in water sensing characteristics. → Under progress
- Aquaporin and MIZ genes are identified in cotton and soybeans for expression analsis

Cotton aquaporin genes responding to water deficit stress

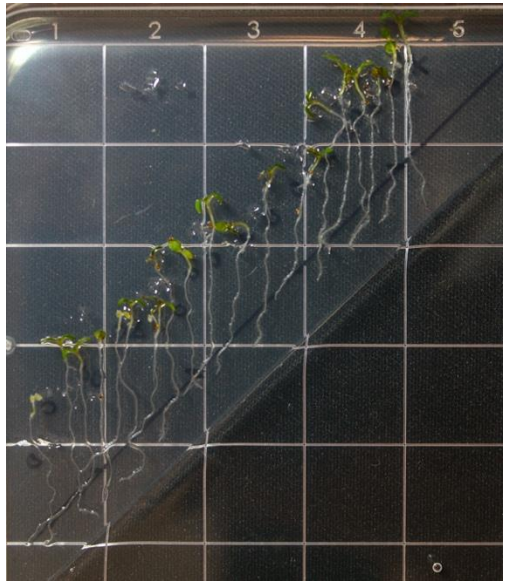




Aquaporin gene expression under water deficit stress. Four *G. hirsutum* (marked in differently colored columns) lines were grown in the 5 gallon soil pots in the greenhouse. Plants were divided into two groups, one with well-watered (WW) and the other withholding water for 16 days before sampling to apply drought stress (DRT). Under stress condition, only *Gh_A1g1843* is highly induced among tandem repeat AQP members across all 4 cultivars examined. All WW pots were in the range of 0.4-1.8% pot wet weight change, while the weight of all DRT pots declined to ~50% of the initial pot weight.

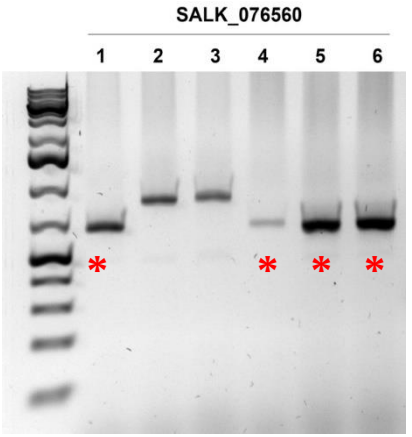
Functional identification of cotton water perception genes (Gh*MIZ*) using a model plant

A. Wild type CONTROL

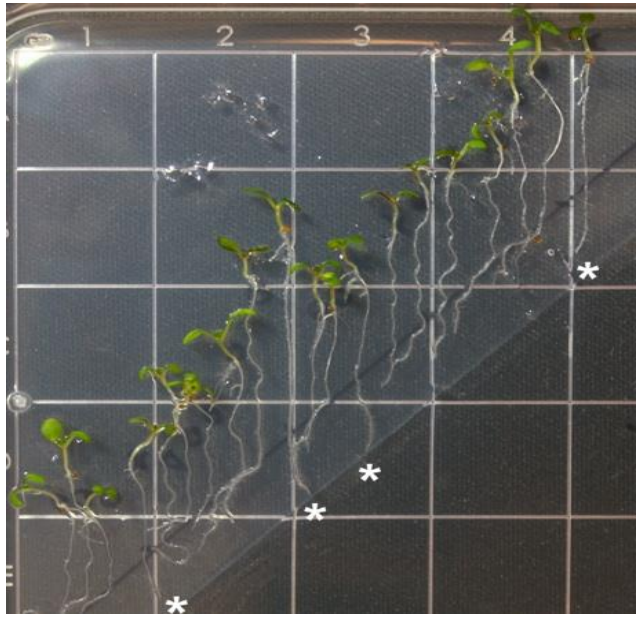


Position of root tip
of 4-day-old seedlings

14.8% sorbitol



B. Loss-of function mutant selectoin



The loss-of function mutants in B (*) are supposed to fail to bend away from the low water content agar provided by14.8% sorbitol, while in A, all wild-type normal control plants are properly bended by hydrotropism.
Loss of function plants will be used to analyse GhMIZ gene by complementation and rescue experiments by Dr. Kwak (LIU).

Outcomes

- Better understanding of cotton and soybean water sensing and transporting systems

  → Help develop varieties with drought resilience that can leads to higher yield potential.

Thank You!