Increasing Water Use Efficiency of Irrigated and Dryland Cotton

MS Row Crop Short Course

5th Dec 2017, Starkville, TN

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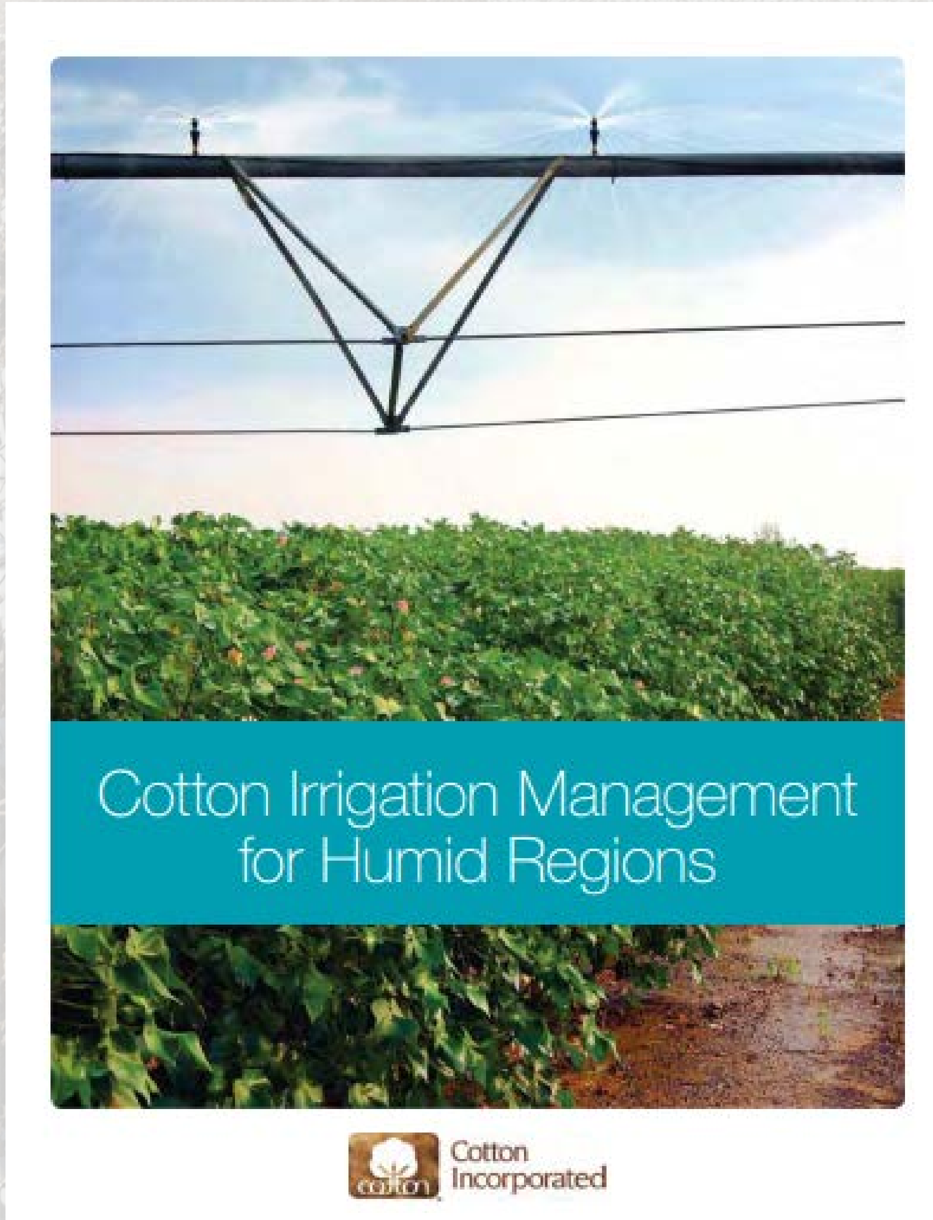
Take Home

- Cotton Agronomics
  - Cotton is an indeterminate, drought tolerant plant which does not like saturated soils
  - Increase infiltration, water holding capacity with cover crops
  - Target less frequent, more thorough irrigation events

- Scheduling
  - We have a number of tools to help us understand plant water status and guide our irrigation events
  - Still need boots on the ground to calibrate ALL of these instruments
  - Provide valuable insight on when to start, how long we can wait between events, and when to terminate

Take Home


Cotton Irrigation Management for Humid Regions
Cotton Incorporated

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Outline

- Overview of Water Management
  - Cotton water use
  - Rainfall patterns and atmospheric demand
- Increasing WUE with Covers
- Increasing WUE with Sensors
- Increasing WUE through variety selection

Crop Water Use

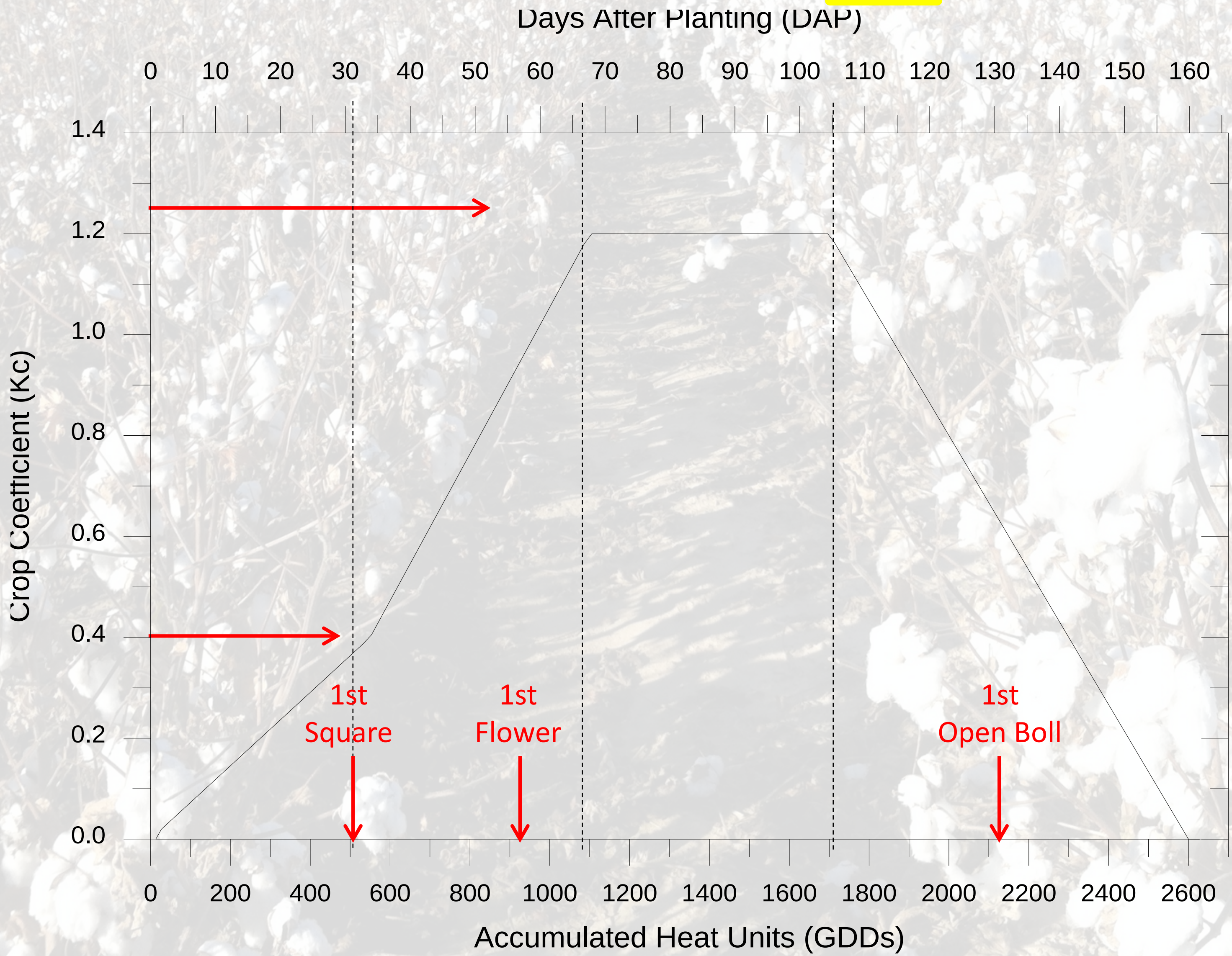
- Framework for understanding crop water use:
  - Crop Coefficient approach for estimated evapotranspiration (ET):

$$ETc = ETo \times Kc$$

  - Where:
    - ET_C = estimated crop ET
    - K_C = crop coefficient
    - ET_O = Penman-Monteith reference ET (FAO-56)

Crop Water Use

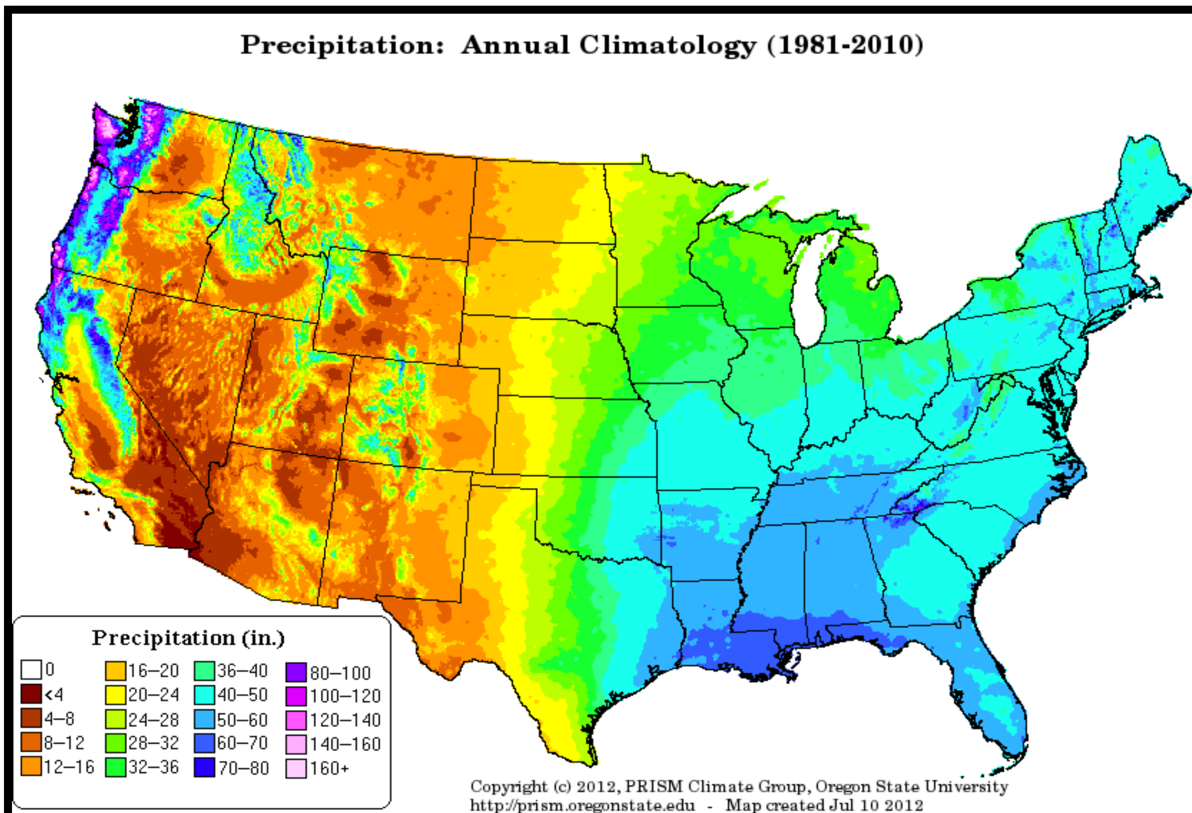
$$ET_c = ETo \times Kc$$



Environmental Demand

$$ET_c = ETo \times Kc$$

- 40 -50 in. per year in dry, hot environments
- 20-30 in. per year in humid, moderate environments



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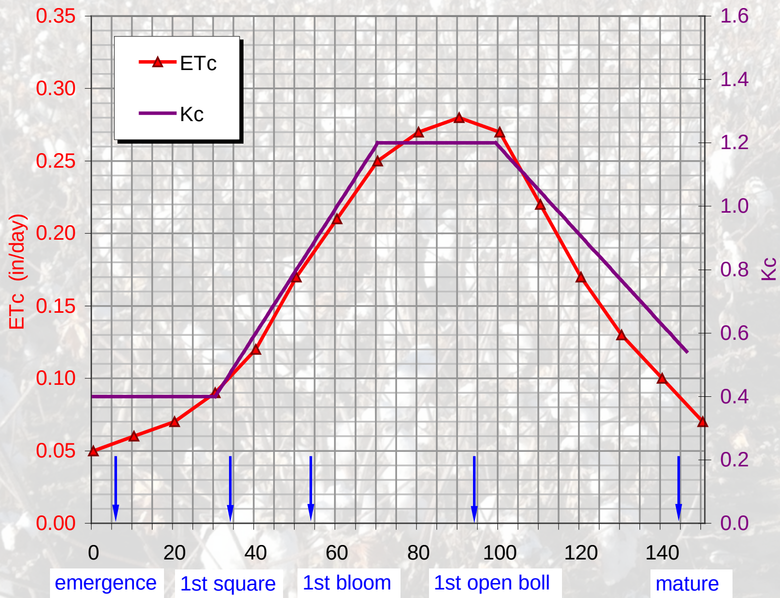
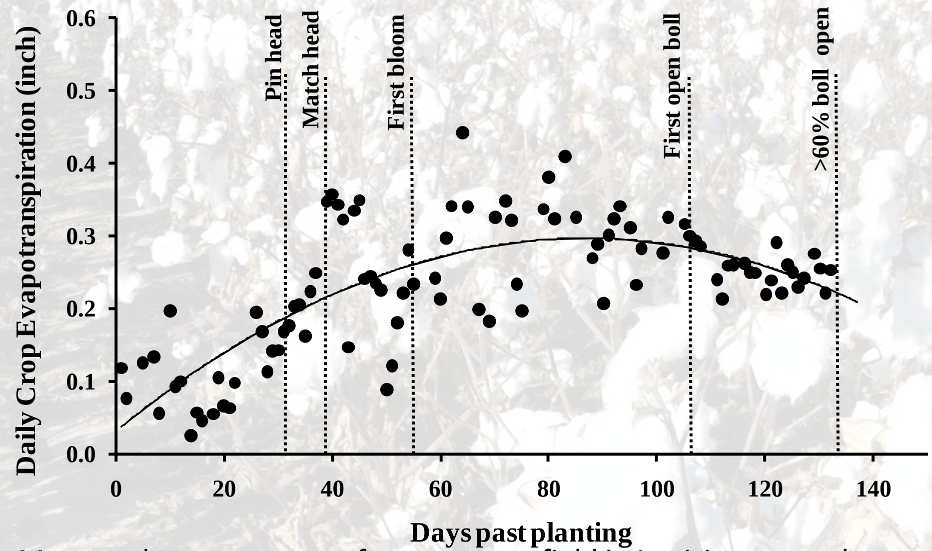
Crop Water Use

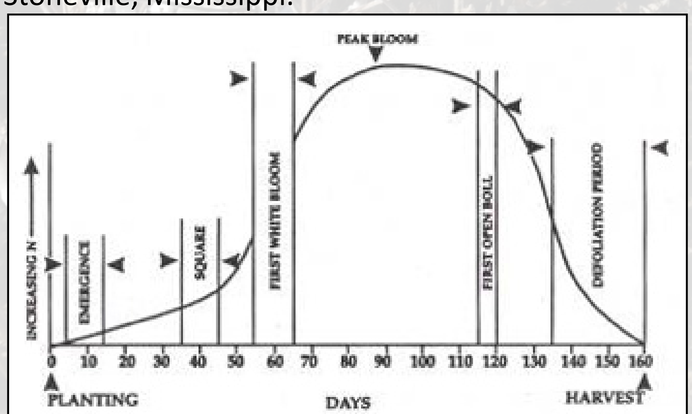
$$ET_c = ETo \times Kc$$

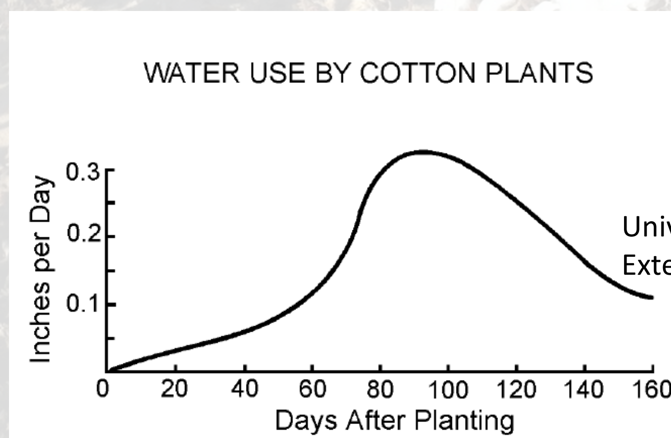


Water use and crop coefficient function for cotton in Stoneville, Mississippi.



Measured crop water use from a cotton field in Louisiana over the growing season.

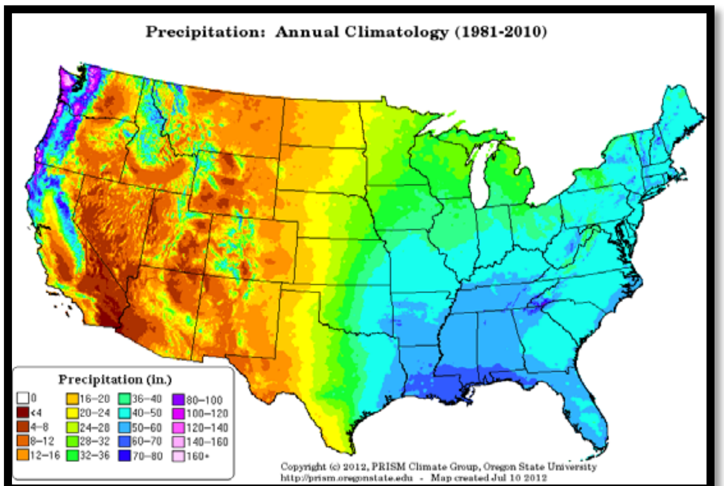


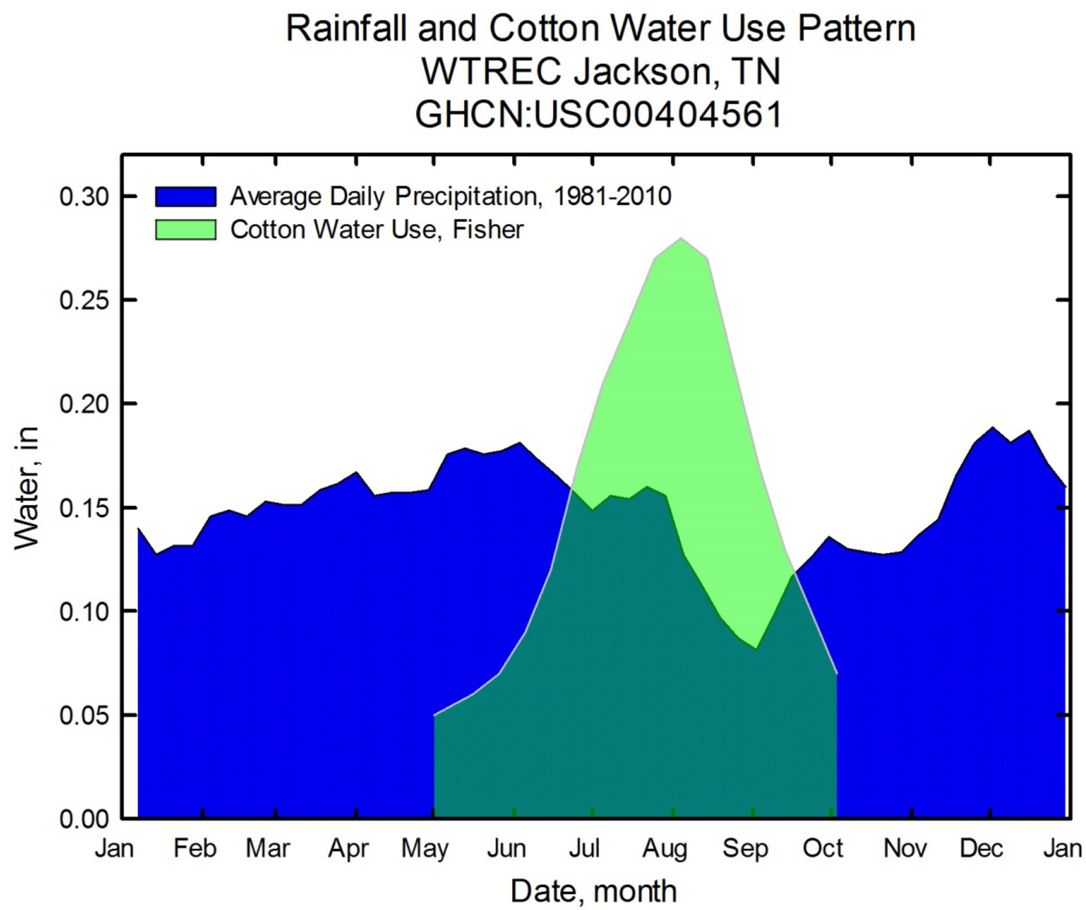


University of Georgia Extension publication.

Environmental Demand

- Discrepancy between rainfall pattern and crop demand





Meeting Crop Demands

Meeting Crop Demands

1. Agronomic Components
    1. Yield
    2. Stand establishment
    3. Herbicide activation
    4. N movement
    5. Canopy development
    6. Earliness
    7. Potential to fertigate

2. Economic Components
    1. Increase land value
    2. Utilize inputs in a timely manner
    3. Minimize risks
    4. Improve sustainability of operation

3. Additional Components
    1. Reduce pressure from regulators
    2. Better public perception of cotton production

Water and Cotton

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Water and Cotton

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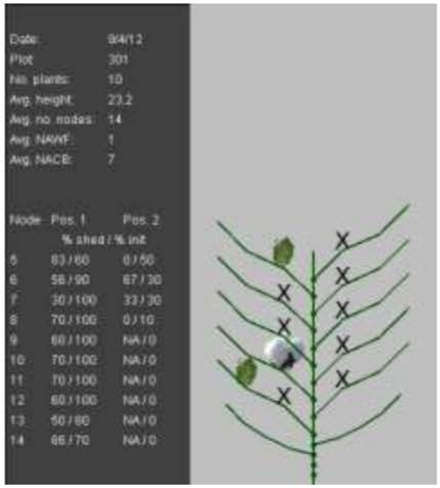
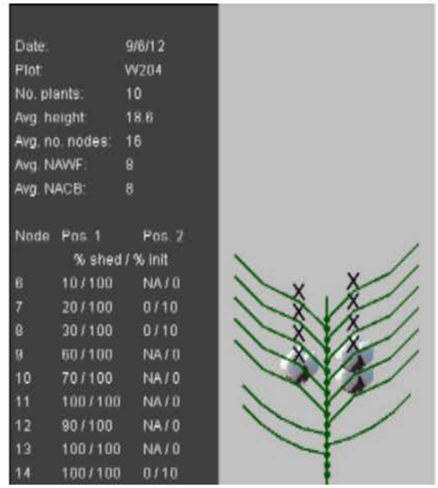
2012 Surface Drip Study

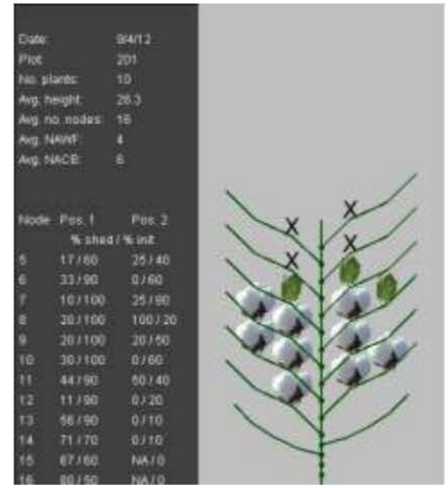
Shallow/sandy soil



rainfed - 506 lb/A

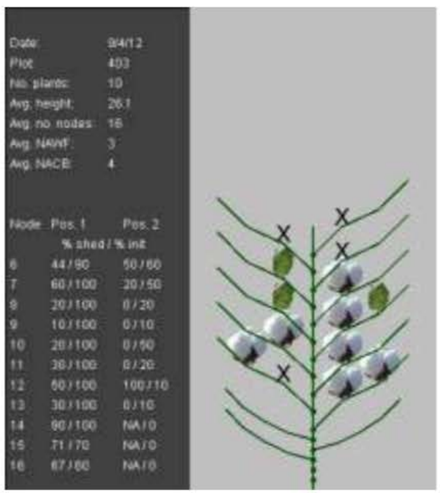


1"/wk - 703 lb/A

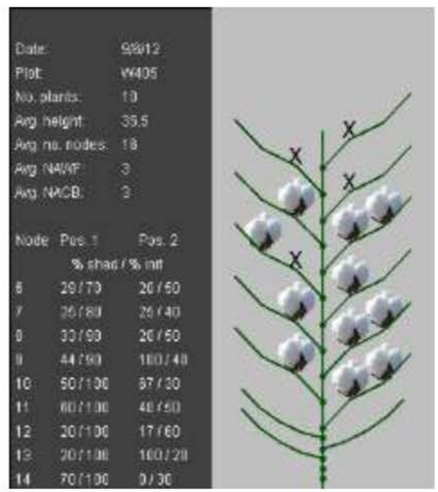


1.5"/wk - 1635 lb/A

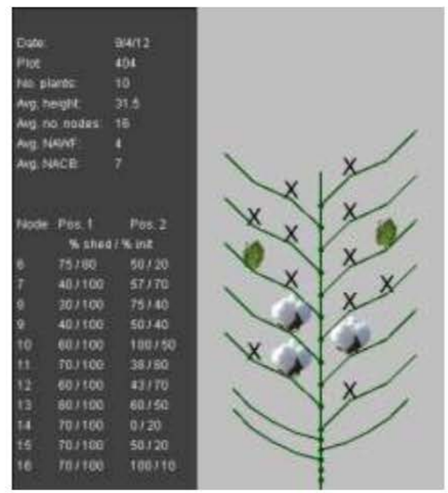
Deep silt loam



rainfed - 1579 lb/A

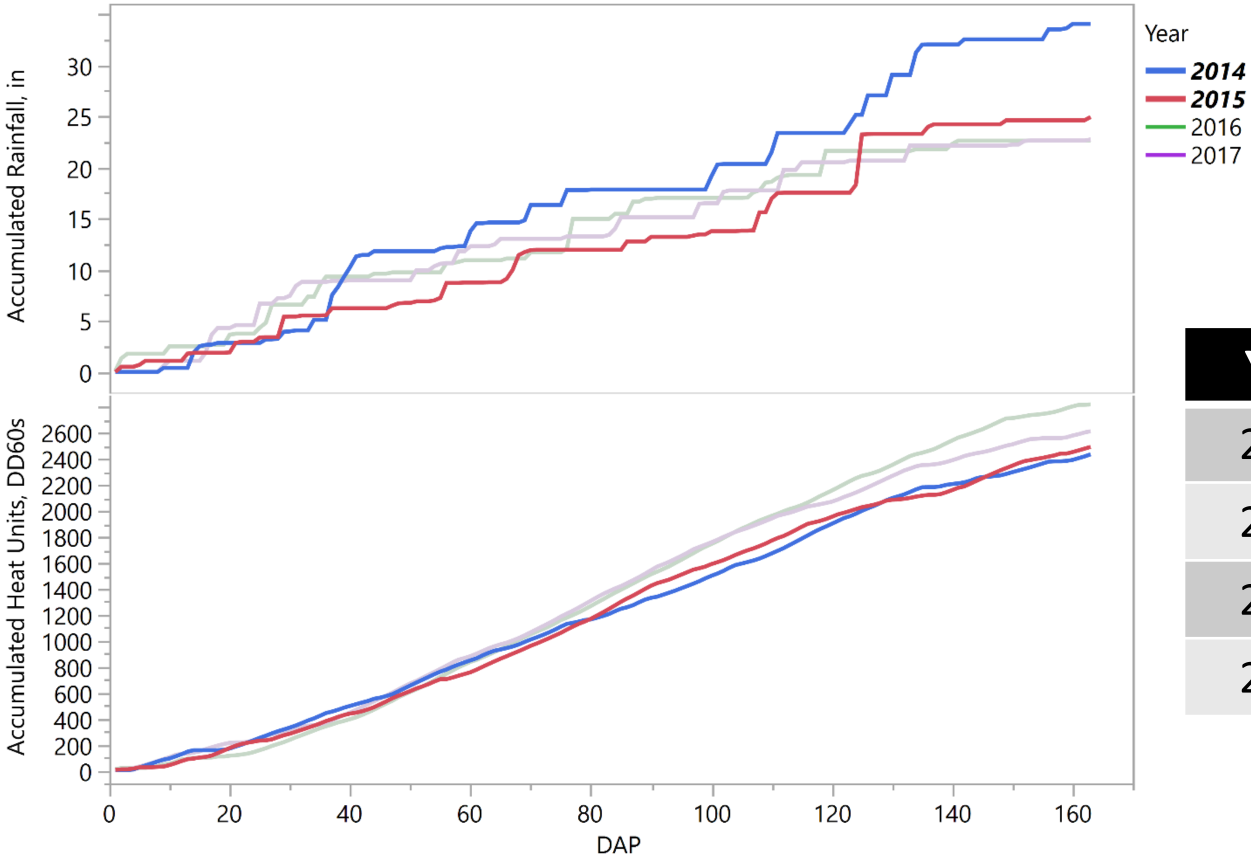


1"/wk - 1982 lb/A



1.5"/wk - 1466 lb/A

Water and Cotton



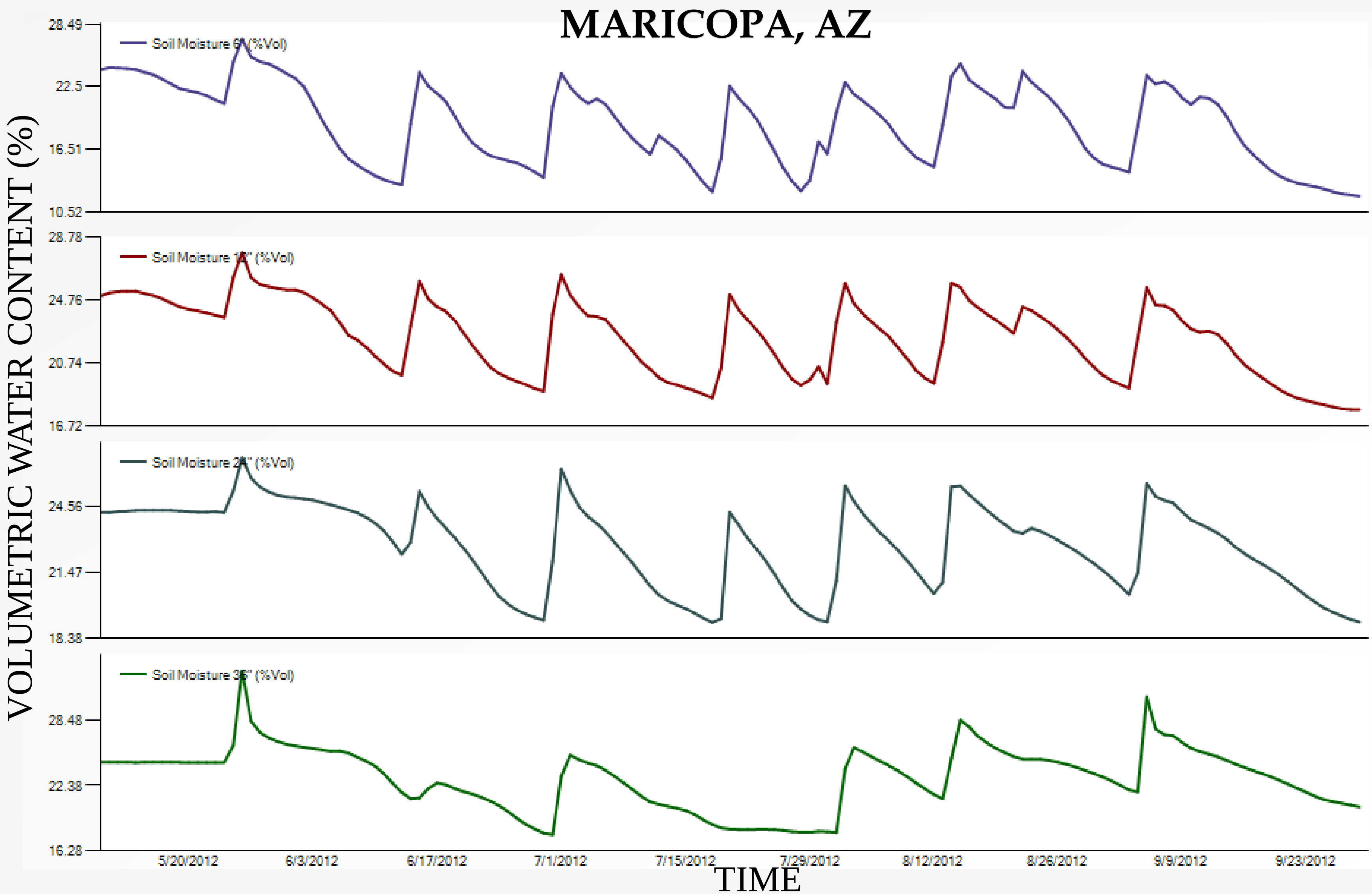
Year	Yield (lb/ac)
2014	878
2015	1,046
2016	1,104
2017	1,065

Cotton Inc’s Water Strategy

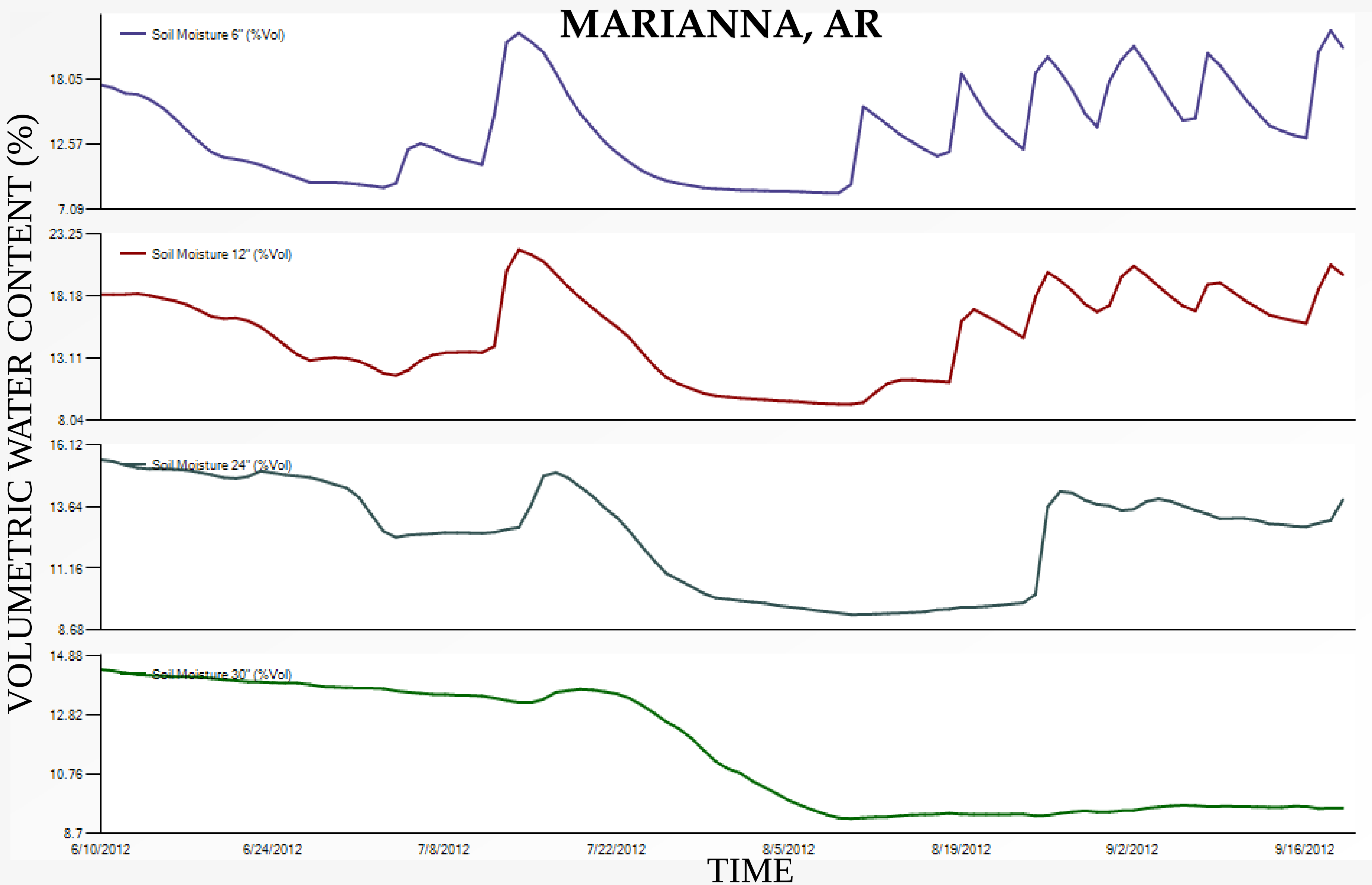
Water Use Efficiency

- Approaches to increase WUE in the Mid-South and Southeast:
  1. Maximize Rainfall Capture

Maximize Water Capture

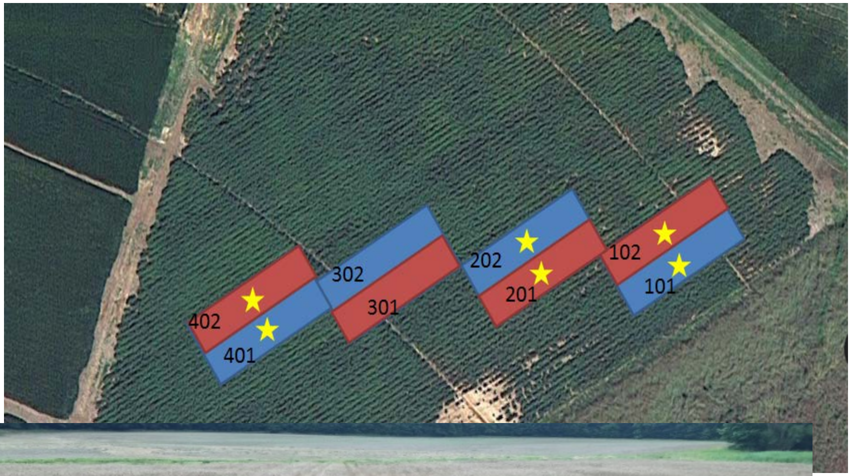


Maximize Water Capture

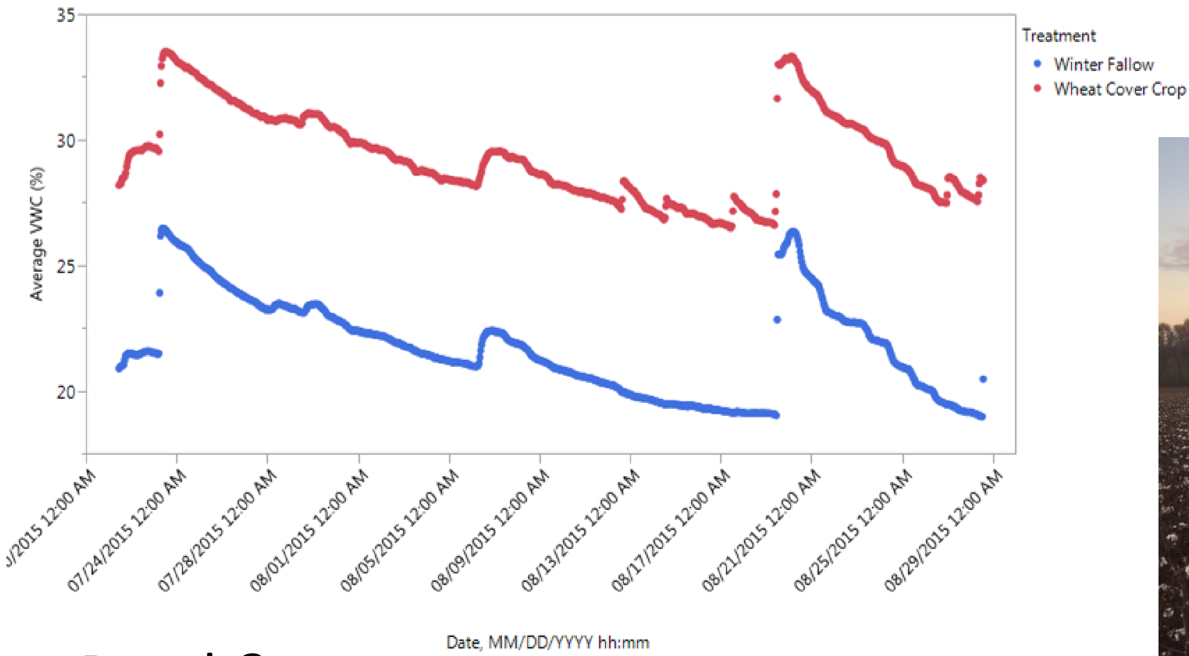


Maximize Water Capture

- Cover (wheat) vs no cover
- Soil moisture sensors placed at 4 depths in 3 replications
- Terminated 2 weeks prior to planting



Maximize Water Capture



- Result?
  - 111 lb increase in lint yield per acre!

- Why?
  - Increased water holding capacity during effective flowering window

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Maximize Water Capture

- Dryland Production
  - Increased infiltration and water holding capacity IN YEAR ONE
- Irrigated production
  - Increase in macropores? Increase hydraulic conductivity of the soil
  - Reduce time in which soil says saturated after irrigation
- Species
  - Heavy monocot mixtures. . . Greater C:N ratios

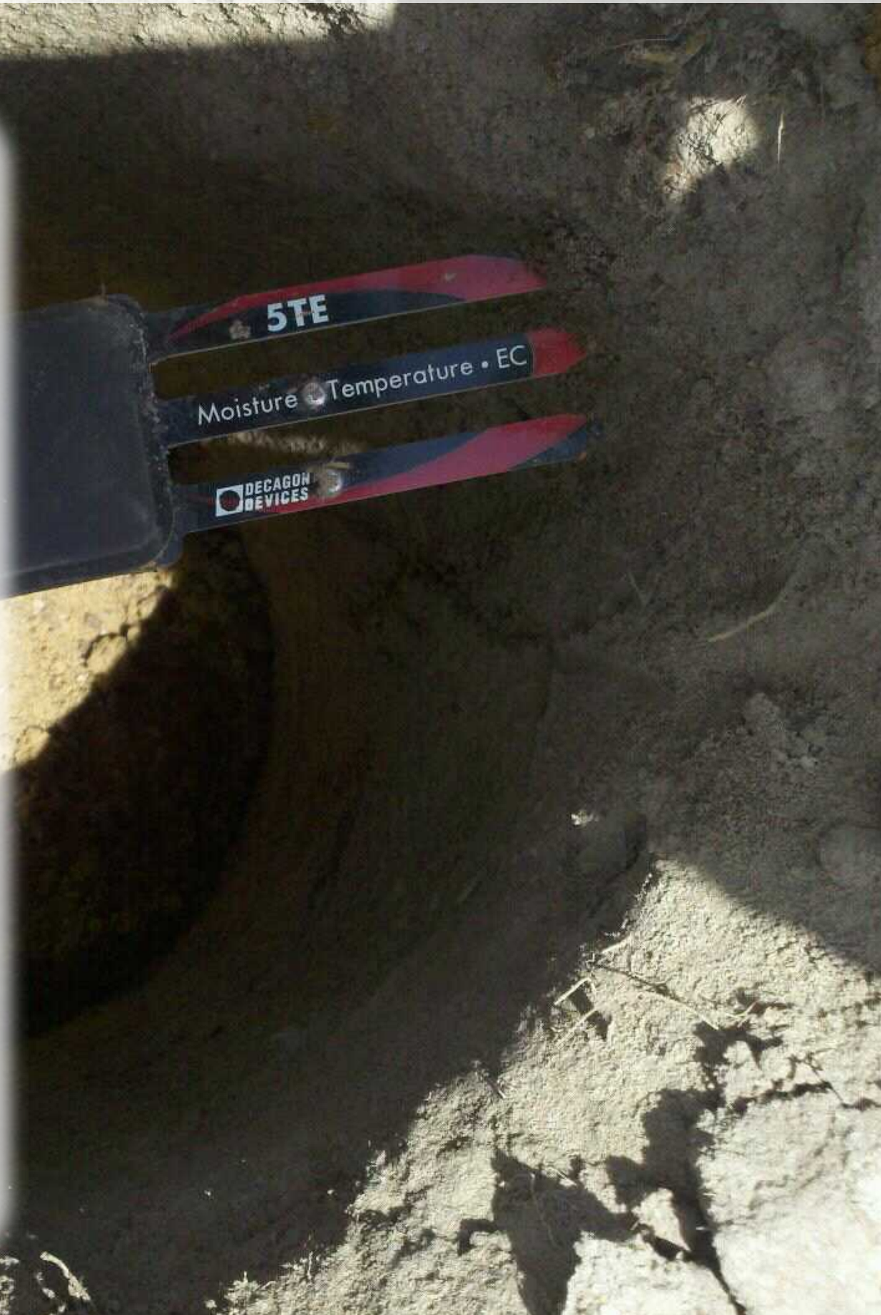
Water Use Efficiency

- Approaches to increase WUE in the Mid-South and Southeast:
  1. Maximize Rainfall Capture
  2. Optimize Irrigation Water
     - Checkbook, time-interval methods currently used
       – May not take into account water use of crop and/or atmospheric demand
     - Use of some in-season measurement could increase WUE
       – Soil Moisture
       – Canopy Temperature
       – Atmometer
       – Modeled, extrapolated weather data

Optimize Irrigation Water

Instrumentation capable of giving insight to drought stress:

- Soil Moisture
  - Difficult to install
  - Very small sphere of influence
  - Good relationship with soil moisture, plant water status
  - Gives insight into water availability even under cloudy conditions



Optimize Irrigation Water

Instrumentation capable of giving insight to drought stress:

- Soil Moisture
  - What type of sensor should I use?
  - What does the reading mean?
  - How many do I need to install?
    - What depths?
  - Are readings similar from sensor to sensor?

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Optimize Irrigation Water

Instrumentation capable of giving insight to drought stress:

- Canopy Temperature
  - Easy to install
  - Large spheres of influence
  - Can interfere with row-traffic
  - Good relationship with drought stress

Optimize Irrigation Water

Instrumentation capable of giving insight to drought stress:

- Canopy Temperature
  - Challenge in Mid-South/Southeast?
    - Variable atmospheric conditions. . . clouds

Optimize Irrigation Water

Instrumentation capable of giving insight into drought stress:

- Atmometer
  - Mini-weather station
  - Capable of providing a reference ET (ETo)
  - Very easy to install
  - Can be extrapolated across several fields (miles?)
  - Basically allow water to evaporate out of a ceramic cup
  - Rate of evapotranspiration indicates atmospheric demand, with addition of crop coefficient can be used to calculate ETc

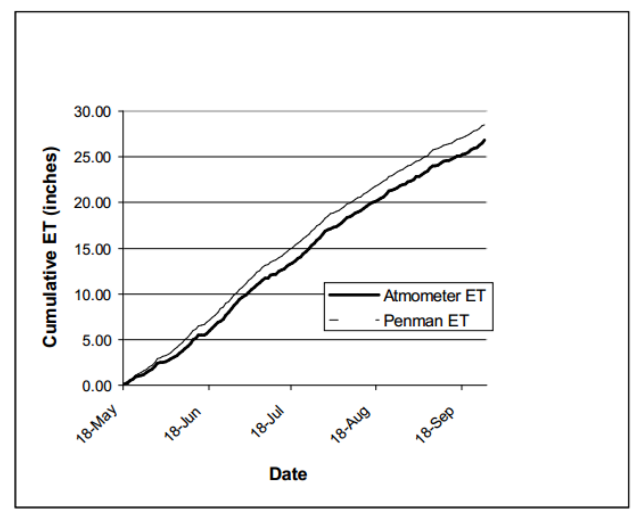


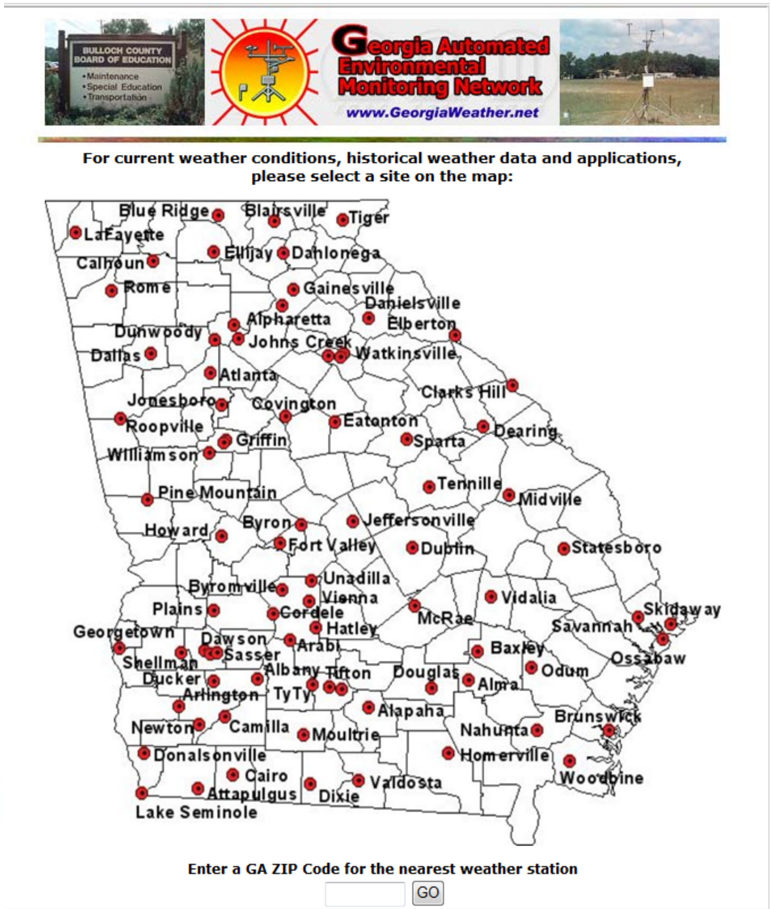
Figure 1: Comparison of Atmometer ET to Penman ET. Source: Bausch and Altenhofen.

Optimize Irrigation Water

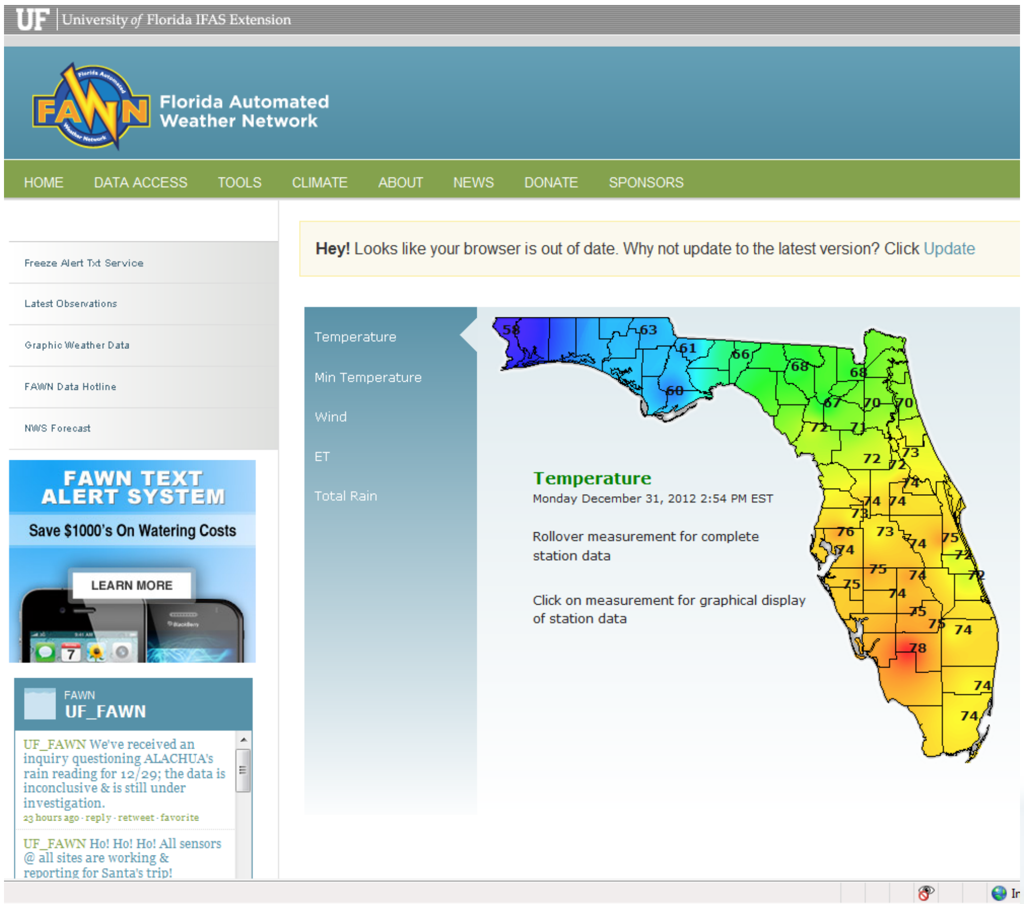
- Does not recommend irrigation amounts
- Advises user of Root Zone Water Deficit in terms of inches and % total
- Maximum Recommended Deficit is 50%
- Provides weekly (Monday-Sunday) estimated ET_C

Optimize Irrigation Water

GAEMN - Georgia Automated Environmental Monitoring Network



FAWN - Florida Automated Weather Network



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Water Use Efficiency

- Approaches to increase WUE in the Mid-South and Southeast:
  1. Maximize Rainfall Capture
  2. Optimize Irrigation Water
  3. Increase plant water use efficiency
     - What does that mean for you?
       - Select drought tolerant varieties
       - Very large variety testing program conducted within MS/TN/AL

Take Home

- Cotton Agronomics
  - Cotton is an indeterminate, drought tolerant plant which does not like saturated soils
  - Increase infiltration, water holding capacity with cover crops
  - Target less frequent, more thorough irrigation events

- Scheduling
  - We have a number of tools to help us understand plant water status and guide our irrigation events
  - Still need boots on the ground to calibrate ALL of these instruments
  - Provide valuable insight on when to start, how long we can wait between events, and when to terminate

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