ET and Deficit Irrigation Approaches in Cotton

Daniel Munk

University of California Cooperative Extension – Fresno

dsmunk@ucdavis.edu
Current Issues

- State water supply- increasing water for environmental, municipal and recreation uses. (*Delta Smelt and Friant-Kern Compromise*)

- “The water molecule is quickly becoming the newest California endangered species”
  
  *Harry Cline*

- Demand for food and fiber production continue
Daily / Weekly Cotton ET

Data from DWR Bulletin 113-4
Water Management Options
Scale dependent

- District and regional
- Field and farm scale
Field and Farm Options

1. Seasonal contributions
Field and Farm Options

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2. Residual soil moisture
Field and Farm Options

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2. Residual soil moisture
3. Modify cropping system/selection
Field and Farm Options

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3. Modify cropping system/selection
4. Deep well availability
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Field and Farm Options

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5. System type (DU)
6. System performance- design & maint. (DU)
Field and Farm Options

1. Seasonal contributions
2. Residual soil moisture
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5. System type (DU)
6. System performance- design & maint. (DU)
7. Crop irrigation scheduling and imposing deficits
Why Consider Deficit Irrigation?

- Depending on commodity, water costs and availability, DI can be an economically sound option
- Keep land in production
- Provide more beneficial use on remaining acreage
What is Deficit Irrigation?

- From a crop production standpoint
- From a physiological perspective
- Cotton ET will increase as applied water increases... to a point
- Cotton production increases with increasing water applied?
Crop Water Response

- How does irrigation influence yield?
- What impact does irrigation have on economics?
Yield response to applied water
What is Deficit Irrigation?

Deficit Irrig. (water stress)

Peak Yield

Destructive (anaerobic)
Regulated Deficit Irrigation
(strategic)

- Uses knowledge of crop phenology and physiology to determine timing of deficits
- Makes use of existing deficit irrigation databases to gauge time $\times$ intensity relationships and estimate economic impacts on production and quality
UCCE Irrigation Management Guidelines

- Minimum water stress during prebloom period
- Modest water stress during effective bloom
- Late flower water use $\leq 0.32$ in./day
- Best opportunity to deficit irrigate is post cutout

-15, -18 bars Acala’s Limit (-20)
-16, -20-21 bars Pima’s Limit (-22)
Midday LWP Hanford Sandy Loam

\[ y = 0.67x + 7.73 \]

\[ R^2 = 0.93 \]
WSREC Irrigation Trials - Acala

\[ y = -15.274x + 2337.2 \]

\[ R^2 = 0.6509 \]
WSREC Irrigation Trials – Acala

\[ y = -0.0035x^2 + 8.7643x - 3489.4 \]
\[ R^2 = 0.932 \]

\[ y = -0.0024x^2 + 6.7547x - 3280.5 \]
\[ R^2 = 0.9504 \]
Water Applied and Cotton Yield (5 years), Furrow Irrigated Cotton WSREC

SJV Pima
Changing System Efficiencies

![Graph showing the yield of SJV Pima cotton as a function of water applied. The graph compares Standard Furrow System and Elevated Water Use Efficiency. The yield increases with water applied but levels off after a certain point.]

- Water Applied (acre inches)
- Yield (pounds of Lint per Acre)
Increasing Plant Water Deficits

**Field Geography**
- High Water Potential
- Low Water Potential

**Plant Effects**
- Veg. Growth ↓
- Fruit Retention (fruit & quality losses)

**Xylem**
- Isolated (texture, salinity)

**Nutrients**
- Diminishing Nutrient Transport

**ET**
- VPD
- Transient Reductions
- Stomatal Closure

**Ps**
- Light & Temp.
- Minor Declines
- Injury of Ps Apparatus
Consider Earliness Effects

Nodes Above Cracked Boll vs. Time
Potential Problems with Deficit Irrigation

**Quality: length**

95, 96, and 97 WSREC Irrigation Trials

- $y = 0.0016x + 111.74$, $R^2 = 0.0019$
- $y = 0.0075x + 103.14$, $R^2 = 0.5949$
- $y = 0.0077x + 101.61$, $R^2 = 0.5459$

Length

- 95', WS Irr.
- 96', WS Irr.
- 97', WS Irr.
RDI Benefits and Challenges

- Energy and resource efficiencies increased
- Some production uncertainties remain
- Potential for reductions in groundwater contamination
- Long term consideration for future buildup of soil solutes, need for managing salts
Applying a Deficit Approach

- Assess water and commodity costs
- Evaluate weak links; soils, system, soils x system
- Where will water savings go?
- Start conservatively and plan
- Start early season & build stress w/ each irrigation
- Reasonable expectations – expect quality impacts to begin as yield declines beyond 15%
Thank you
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cottoninfo.ucdavis.edu
Thank You Meeting Sponsors

- Agri-Valley Irrigation
- Netafim Irrigation
- Watson Ag. Irrigation
- CIT Agricultural Pump Efficiency Program
Question: Preirrigation needs include:

- Residual Moisture
- Rooting depth at first irrigation
- Alternate Furrow
- Reduced run length
Economic Yield Response Curve

Y = ax^2 + bx + c

Rational Use Zone

Lower Limit

Upper Limit

Yield

Applied Water
Why Deficit Irrigate?

- Can have minimal impacts on yield
- Can have predictable impacts on yield
- Not always your best option but can be a useful tool
Improving WUE

- Decreasing variability of water uptake
- Limiting deep percolation
- Decreasing Evaporation
- Increasing reliability of a scheduling system
Diurnal Variation of LWP (-Bars)

Furrow Acala Maxxa7/19

6:00 AM 7:00 AM 8:00 AM 9:00 AM 10:00 AM 11:00 AM 12:00 AM 1:00 PM 2:00 PM 3:00 PM

4.00 5.00 6.00 7.00 8.00 9.00 10.00 11.00 12.00
Time-Stress Response to Soil Water Availability

Leaf Water Potential during a 27 Day Period

**Sandy Loam**
- $y = 0.67x + 7.73$
- $R^2 = 0.93$

**Clay Loam**
- $y = 0.396x + 7.6897$
- $R^2 = 0.9041$

- Leaf Water Potential (bars)
- Days After Irrigation

Legend:
- Blue line: Sandy Loam
- Red line: Clay Loam
Transpiration and Water Stress

Graph showing the relationship between daily transpiration and water stress.
Why Consider Deficit Irrigation?

- Production Losses
- Crop quality
- Is deficit irrigation predictable?
- Risk management decisions (cost benefit)
Irrigation Scheduling
Plant Water Status Emphasis

- Leaf water potential - Pressure chamber
- Leaf temperature and canopy spectra – IRT, ground and aerial spectral data including NDVI
Yield and vegetative growth response to applied water
## Approximate amount of water needed to bring selected soil textures to field capacity

<table>
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<tr>
<th>Available soil water remaining (%)</th>
<th>Loamy Sand</th>
<th>Sandy Loam</th>
<th>Silt Loam and Clay Loam</th>
<th>Sandy Clay and Silty Clay</th>
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<td>0-25</td>
<td>0.9 - 0.7</td>
<td>1.4 - 1.1</td>
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<td>0.4 - 0</td>
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<td>At field capacity</td>
<td>0.9</td>
<td>1.4</td>
<td>2.2</td>
<td>2.3</td>
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Poorly Drained Soils

Optimum Irrig. Schedule

Yield vs. Applied Water
How much?

- Retain ability to monitor changes in pump performance
- Water meters, depth to groundwater, drawdown
Irrigation Scheduling
Soil / Water Balance Emphasis

- Knowledge of crop ET
- \( ET_c = ETo \times Kc \) (DWR’s CIMIS program)
- Knowledge of crop growth including plants underground hydraulic system
- Water holding capacity of the soil
- Allowable depletion of root zone
Overview

- Current issues
- Cotton water requirements
- Plant responses to water applied
- Considerations in deficit irrigation
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What is Deficit Irrigation?
Farms: Dealing with Change

- Implement short and long term Planning
- Evaluate all options
Thank You Meeting Sponsors

- Agri-Valley Irrigation
- Netafim Irrigation
- Watson Ag Irrigation
- CIT Agricultural Pump Efficiency Program