Cotton Irrigation Scheduling Methods: Which Method is a Best Fit?

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Background

- Irrigation scheduling is determining how much and when to apply irrigation to a crop to maximize water use efficiency without reducing crop yield or on farm profitability.

- Cotton is a difficult crop to adequately determine an appropriate irrigation scheduling strategy for.
  - Many studies have shown positive effects on cotton growth and biomass development but negative effects on final yield when “excessive” irrigation is applied.
  - Cotton is a crop that responds positively to well-timed periods of stress during the production season.
• Producers have many options available to them for the purpose of scheduling irrigation in crop production.
• The methods range from free, to inexpensive, to a perceived expensive cost.
  – Additionally, each scheduling method comes with an associated time required to make decisions from these methods.

<table>
<thead>
<tr>
<th>Irrigation Scheduling Method</th>
<th>Entire US (%)</th>
<th>AL (%)</th>
<th>FL (%)</th>
<th>GA (%)</th>
<th>SC (%)</th>
<th>MS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible Stress</td>
<td>78</td>
<td>86</td>
<td>83</td>
<td>87</td>
<td>89</td>
<td>86</td>
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<tr>
<td>Feel of Soil</td>
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<td>42</td>
<td>36</td>
<td>27</td>
<td>22</td>
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<td>8</td>
<td>16</td>
<td>11</td>
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<td>5</td>
<td>4</td>
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<td>4</td>
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<tr>
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<td>1</td>
<td>5</td>
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<td>1</td>
<td>4</td>
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<td>Calendar Schedule</td>
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<td>10</td>
<td>15</td>
<td>15</td>
<td>11</td>
<td>15</td>
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<tr>
<td>When Neighbor Irrigates</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>6</td>
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</tbody>
</table>

Source: USDA NASS 2018
Background

• In addition to the negative yield penalties for over-irrigating cotton it can become very expensive to pump irrigation water.
  – While most places do not have a per gallon associated cost with accessing irrigation water, there is an associated energy cost with moving the water from source to crop.
  – UGA Enterprise budgets estimate these costs at approximately:
    • $7/ac-in for electric
    • $13.50/ac-in for diesel
    • Or a combined cost of $9.30/ac-in
    • To look at it another way just two 1-inch (electric) irrigation events cost $14 per acre or $1,400 on a 100-acre field (diesel would be almost double).
Objectives

• The main objective of this study was to research various irrigation scheduling strategies on cotton.

• The subobjectives were:
  – Monitor soil moisture and determine optimal irrigation scheduling times for each irrigation scheduling method.
  – Log the total amount and distribution of rainfall and irrigation for each irrigation scheduling method.
  – Determine the effect of irrigation scheduling method on final crop yield and Irrigation Water Use Efficiency (IWUE).
Methods

- A randomized blocked trial was implemented under a lateral irrigation system equipped with a variable rate controller allowing plots of eight rows wide by 42 ft long at UGA’s Stripling Irrigation Research Park near Camilla, GA.

- The nine treatments that were implemented were:
  - SWT of 45 kPa (optimal in sandy loam soils)
  - SWT of 20 kPa (wet)
  - SWT of 75 kPa (dry)
  - USDA-ARS Irrigator Pro
  - CropX Sensor System (2020)
  - Valley’s Scheduling Tool
  - SmartIrrigation Cotton App
  - UGA Checkbook
  - Dryland
Methods

• SWT Irrigation Triggers:
  – A probe with three Watermark Sensors at 4”, 8” and 12” was installed in two of the three replications of all treatments.
  – This probe was used to schedule irrigation for the 20, 45, and 70 kPa treatments by using an in-season adjusted weighted average of sensor depth applied to the three depth averages of the two probes for days after planting as follows:
    • DAP 1-30: 0.6*D1 + 0.3*D2 + 0.1*D3
    • DAP 31-60: 0.4*D1 + 0.4*D2 + 0.2*D3
    • DAP 61-120: 0.3*D1 + 0.5*D2 + 0.2*D3
    • Irrigation was terminated once the field average reach 10% open boll.
## 2020 Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Irrigation (in)</th>
<th>Total Water (in)</th>
<th>Lint Yield (lb/ac)</th>
<th>IWUE (lb/in)</th>
<th>Profit for $7/ac-in @ $0.79 Cotton</th>
<th>Profit for $12/ac-in @ $0.79 Cotton</th>
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</thead>
<tbody>
<tr>
<td>Rainfed</td>
<td>1.0</td>
<td>22.4</td>
<td>795</td>
<td>N/A</td>
<td>621</td>
<td>616</td>
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<tr>
<td>45 kPa</td>
<td>5.5</td>
<td>26.9</td>
<td>1304</td>
<td>237</td>
<td>992</td>
<td>964</td>
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<td>20 kPa</td>
<td>7.75</td>
<td>29.1</td>
<td>1293</td>
<td>167</td>
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<td>928</td>
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<td>75 kPa</td>
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<td>1129</td>
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<td>853</td>
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<td>1245</td>
<td>226</td>
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<td>CropX</td>
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<td>25.4</td>
<td>1113</td>
<td>278</td>
<td>851</td>
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<td>29.9</td>
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<td>32.4</td>
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<td>109</td>
<td>868</td>
<td>813</td>
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</table>

Planted: May 9, 2020  
Picked: October 26, 2020  
2020 Rainfall = 21.36 in
2020 Results

- UGA Checkbook
- SI Cotton App
- Valley Scheduler
- Crop X
- Irrigator Pro (SWT)
- 75 kPa
- 20 kPa
- 45 kPa
- Rainfed

Rainfall

Dates: 5/6/2020 to 9/23/2020
## 2021 Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Irrigation (in)</th>
<th>Total Water (in)</th>
<th>Lint Yield (lb/ac)</th>
<th>IWUE (lb/in)</th>
<th>Profit for $7/ac-in @ $1.00 Cotton</th>
<th>Profit for $12/ac-in @ $1.00 Cotton</th>
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<tbody>
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<td>N/A</td>
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<td>20 kPa</td>
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<td>33.6</td>
<td>1197</td>
<td>310</td>
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<tr>
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</table>

Planted: May 7, 2021  
Picked: October 20, 2021  
2021 Rainfall = 29.66 in
Conclusions - Make Succinct

• Nine treatments were tested for their effects on crop yield and IWUE.
  – 2020 was wet (> 20” of rain) but there were periods that irrigation was required to maximize yields as dryland yields were under 2 bales/acre.
  – 2021 was excessively wet (~30” of rain).
    • Excessive rain led to no differences in yield in any treatments.
  – Overall, in both years, there were no significant differences between yields for irrigation scheduling treatments, but there were differences in IWUE and “engineering” profitability.
Conclusions

– The 45 kPa treatment did not have the highest IWUE but had the highest profit, **additional irrigation between the 45 vs 20 kPa treatments did not have an impact on yield but reduced profitability and IWUE.**

– The SI Cotton App, Irrigator Pro and Valley Scheduler all had high profitability, but the Valley Scheduler did have a lower IWUE.

– Engineering Economics do not include the cost of system and management time but are just for a reference of profitability.

– As can be seen from these data, selecting the appropriate irrigation scheduling tool for your farm can be a daunting but critical task, with the proper management and selection significant profitability is possible, even in years with adequate or excessive rainfall.
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THANKS!

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