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

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2022 Beltwide Cotton Conference
January 5, 2022

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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.

Background

- 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.

Irrigation Scheduling Method	Entire US (%)	AL (%)	FL (%)	GA (%)	SC (%)	MS (%)
Visible Stress	78	86	83	87	89	86
Feel of Soil	40	42	36	27	22	41
Soil Moisture Sensor	12	8	16	11	12	27
Scheduling Service	8	1	5	4	3	4
Weather Report	7	1	5	8	1	4
Calendar Schedule	20	10	15	15	11	15
When Neighbor Irrigates	6	1	2	3	2	6

Source: USDA NASS 2018

Background

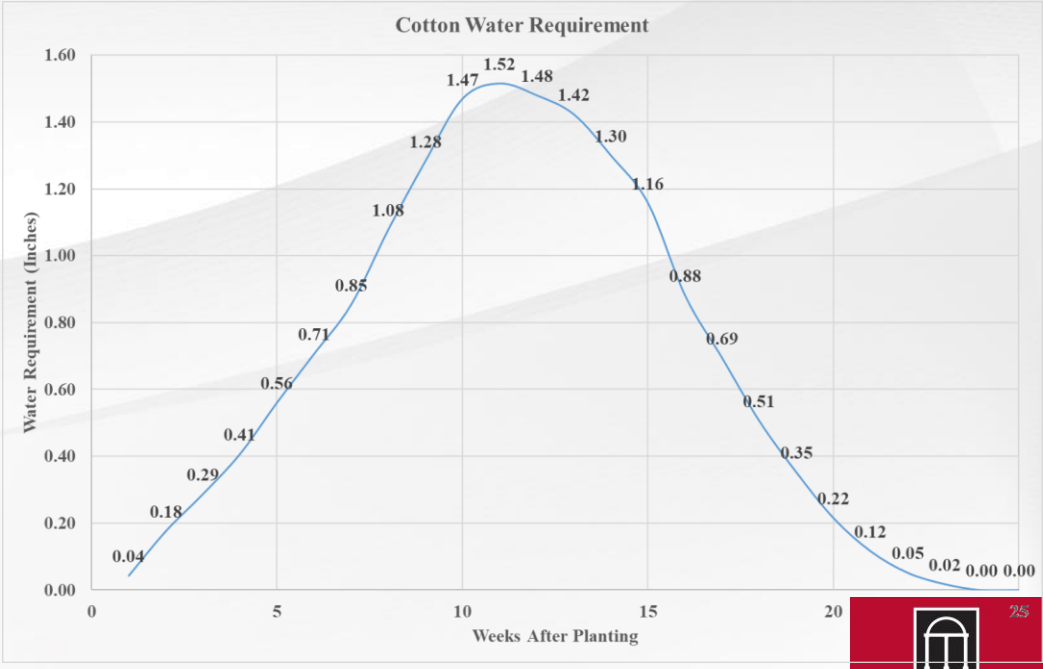
- In addition to the negative yield penalties for over-irrigating cotton it can become very expensive to pump irrigation water.
  - While most places do not have a per gallon associated cost with accessing irrigation water, there is an associated energy cost with moving the water from source to crop.
  - 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



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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

Treatment	Irrigation (in)	Total Water (in)	Lint Yield (lb/ac)	IWUE (lb/in)	Profit for $7/ac-in @ $0.79 Cotton	Profit for $12/ac-in @ $0.79 Cotton
Rainfed	1.0	22.4	795	N/A	621	616
45 kPa	5.5	26.9	1304	237	992	964
20 kPa	7.75	29.1	1293	167	967	928
75 kPa	3.25	24.6	1129	347	869	853
Irrigator Pro	5.5	26.9	1245	226	945	918
CropX	4.0	25.4	1113	278	851	831
Valley Scheduler	8.5	29.9	1240	147	920	878
SI Cotton App	6.25	27.6	1270	203	960	928
Checkbook	11.0	32.4	1196	109	868	813

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

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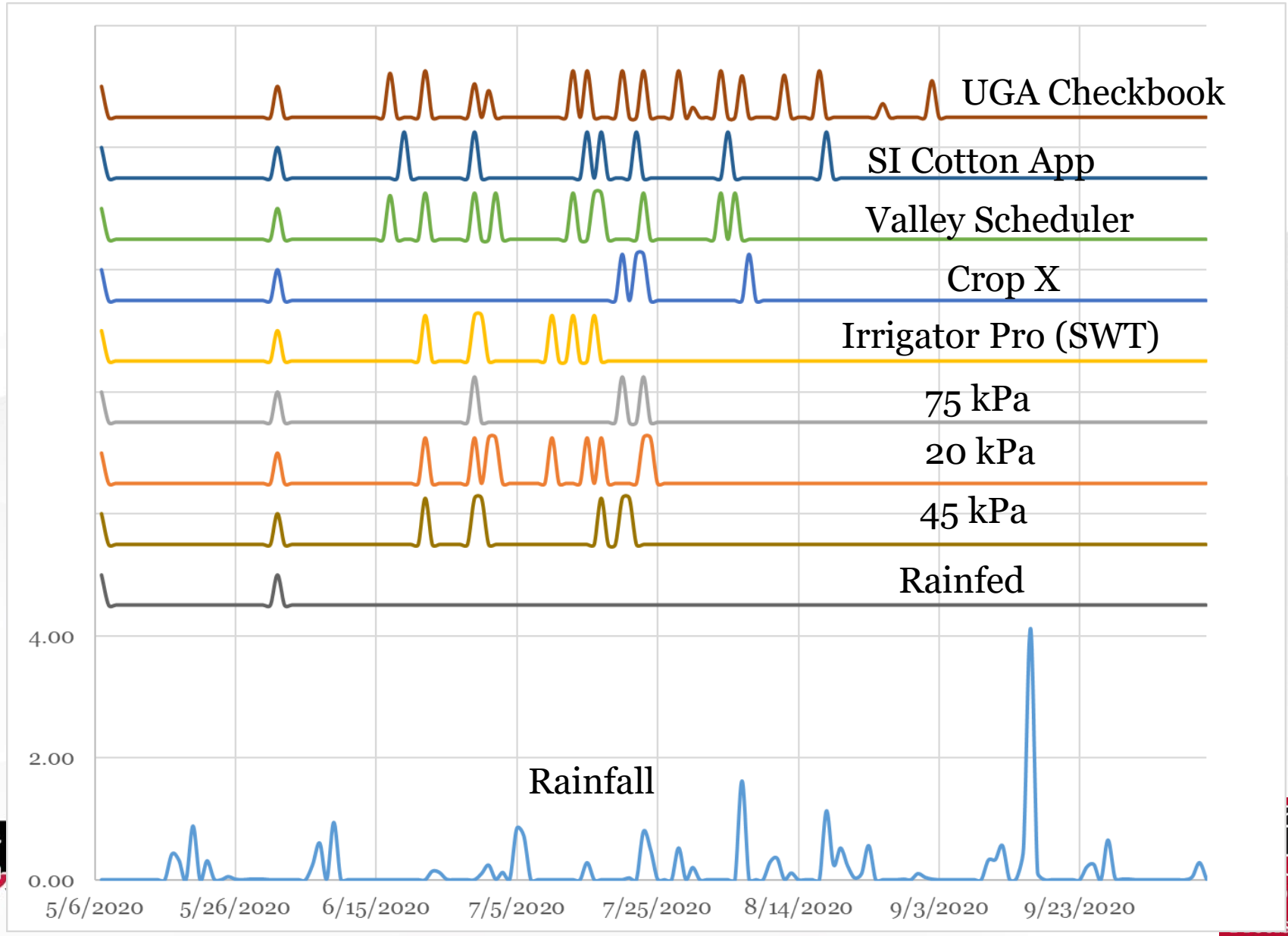
2020 Results



2021 Results

Treatment	Irrigation (in)	Total Water (in)	Lint Yield (lb/ac)	IWUE (lb/in)	Profit for $7/ac-in @ $1.00 Cotton	Profit for $12/ac-in @ $1.00 Cotton
Rainfed	1.0	30.66	1119	N/A	1112	1107
45 kPa	2.36	32.1	1191	505	1175	1162
20 kPa	3.86	33.6	1197	310	1170	1151
Irrigator Pro	2.36	32.1	1175	498	1159	1147
Valley Scheduler	2.36	32.1	1148	486	1131	1120
SI Cotton App	2.36	32.1	1164	493	1148	1136
Checkbook	7.26	37.0	1177	162	1126	1090

Planted: May 7, 2021
Picked: October 20, 2021
2021 Rainfall = 29.66 in

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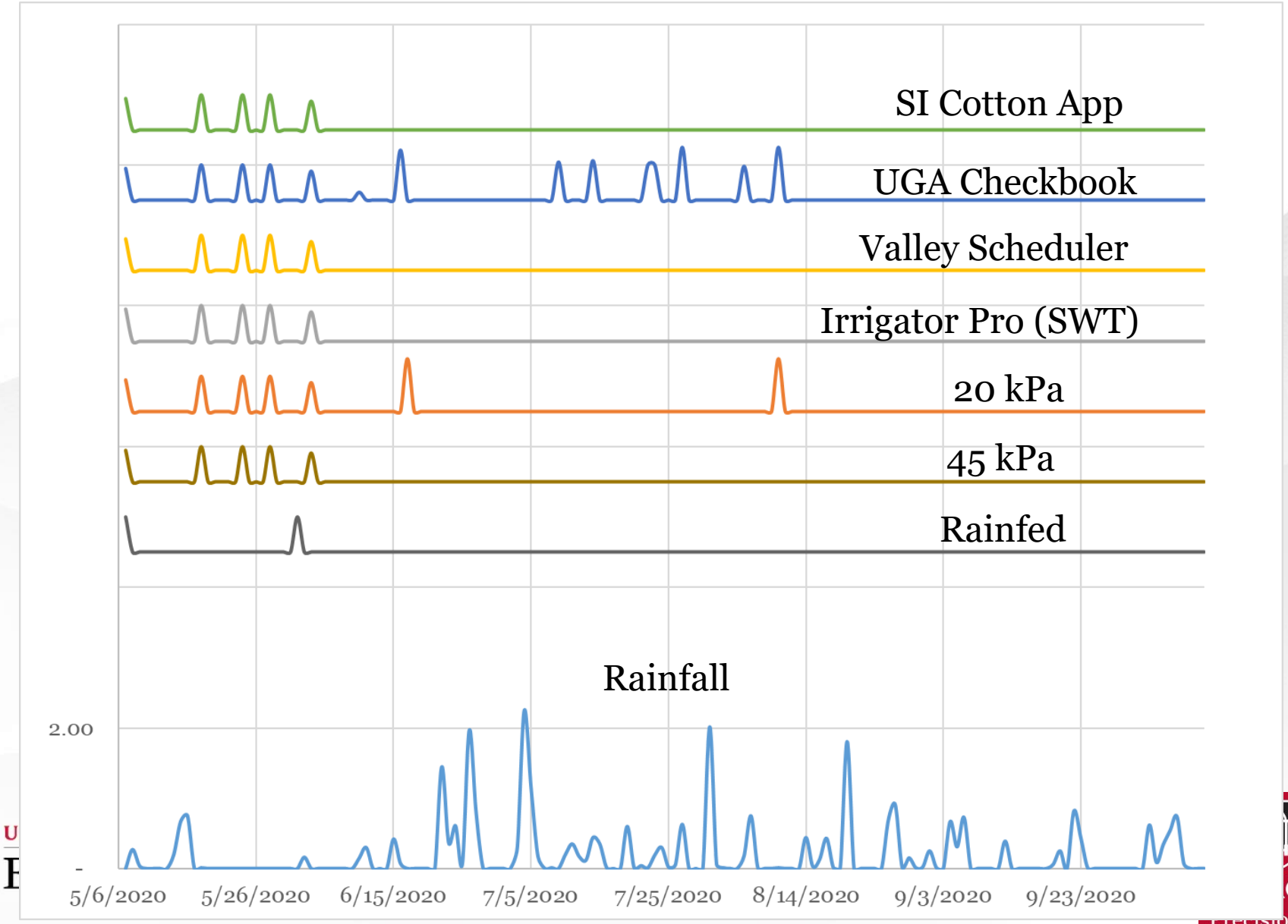
2021 Results



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.

Acknowledgements

- The authors would like to acknowledge the following for their support and help on this project:
  - Staff at Stripling Irrigation Research Park
  - Technical and student support, Matt Gruver, Mike Tucker, Cody Mathis, Chris Bolles, Cole Patterson, Seth Newell, Seth Williams, Evan Shuman, and Lucas Tostenson.
  - Funding from the GA Cotton Commission to make the project possible.

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THANKS!

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