Pima Cotton Irrigation Scheduling Using Infrared Thermometers And the Crop Water Stress Index

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ABSTRACT

The Crop Water Stress Index (CWSI) was used to schedule irrigations on Pima S-6 cotton on 12 four-acre furrow-irrigated test plots in Coolidge and 20 drip-irrigated test plots at the Campus Agricultural Center in Tucson. Scheduling irrigations between 0.30 and 0.50 CWSI units resulted in highest lint production and plant water use efficiency at both locations.

INTRODUCTION

Legislation, increasing costs, and decreasing water supplies are urging agricultural producers to take a close look at irrigation management strategies to continue profitability. Irrigation scheduling has been somewhat elusive and impractical for most producers due to physical on farm pumping limitations. Many growers now are served by the CAP as their irrigation water source. The CAP has introduced increased water volume and delivery flexibility. However, water costs are generally higher than previously, urging growers to implement irrigation scheduling strategy to minimize production costs.

Pima cotton acreage increased significantly in 1989 due to favorable market conditions. Pima appears to be much more sensitive to irrigation management error than Upland cotton for optimum yield production. Irrigation excess promotes unwanted vegetative growth at the expense of flower production while irrigation deficiency induces wilt, promoting flower abortion. The objectives of this test were to determine optimum irrigation timing using the Crop Water Stress Index (CWSI) and measure plant water use of Pima S-6 cotton for maximum lint production at two locations.

MATERIALS AND METHODS

The Crop Water Stress Index (CWSI) which correlates thermal infrared canopy temperature to the water vapor content of the air has been used successfully to schedule irrigation on a number of commercially grown crops to date. CWSI units range from 0 (no water stress) to 1.0 (severe water stress). The CWSI was used to schedule irrigations on Pima S-6 cotton in Coolidge and Tucson. Twelve, four-acre, furrow-irrigated plots were randomized into three treatments with four replicates in Coolidge (Tierra Prospera Farms). Targeted CWSI thresholds at time of irrigation were 0.15, 0.30 and 0.45 at time of irrigation. At the Campus Agricultural Center in Tucson, 20 eight-row, 50-foot, drip-irrigated plots were randomized into five treatments with four replicates. CWSI thresholds at time of irrigation were 0.10, 0.25, 0.40, 0.55 and 0.70, representing a wide range of plant water stress.

Infrared and vapor pressure measurements were taken between 1100 and 1300 hours a minimum of every other day. In addition, soil moisture measurements using a neutron probe were made at the same time in order to measure plant water use between irrigation intervals and determine irrigation volume required to refill the soil profile at time of irrigation. Plots within treatments were scheduled independently more closely to hit the targeted irrigation threshold desired.

RESULTS AND DISCUSSION

At the Coolidge location, actual CWSI levels were 0.18, 0.28 and 0.50 at time of irrigation. Total water applied was 66, 52 and 51 inches for treatments 1, 2 and 3 respectively. Lint yields were 1000, 884 and 808 lbs/acre for treatment 1(0.18), 2(0.28) and 3(0.50). Water use efficiency was 15.15, 17.00 and 15.8 lbs./in. for the 1(0.18), 2(0.28) and 3(0.50) treatment.
At the Tucson location, actual CWSI values at time of irrigation were 0.19, 0.32, 0.47, 0.60 and 0.74 while total water applied was 46, 39, 36, 33, and 29 inches for treatments 1-5. Lint yields were 1078, 1044, 1045, 841, and 568 lbs./acre for the 0.1, 0.25, 0.40, 0.55 and 0.70 treatments respectively. Water use efficiency was 23.4, 26.8, 29.0, 25.5 and 19.6 lbs./in. for treatments 1-5.

No significant yield differences were observed at either test location when CWSI at time of irrigation ranged from 0.20 to 0.50 units. Although not significant, lint production decreases were linear with increasing stress at both locations. The Tucson test site included two drier treatments than Coolidge with yield decreasing significantly when stress is increased beyond 0.50 CWSI units at time of irrigation.

Significant differences were observed at both sites regarding applied water. Significantly higher water volumes were required for the 0.20 than the 0.30 treatment and no difference between the 0.30 and 0.50 treatment. This would strongly suggest that irrigation be scheduled near 0.30 to allow for water delivery lead time and applied no later than 0.50 CWSI units on Pima S-6 cotton to result in maximum lint production and plant water use efficiency. Irrigation application after 0.50 resulted in significant yield losses.

Table 1. The relationship between water stress (CWSI), water applied, number of irrigations, lint yield and water use efficiency of Pima S-6, Coolidge, AZ, 1989.

TRT	CWSI	Applied water (in.)	# irrig.	Lint lb/ac	Water use efficiency(lb/in)
1	.18 C	66 A	10 A	1000 A	15.15
2	.28 B	52 B	6 B	884 A	17.00
3	.50 A	51 B	5 C	808 A	15.80

Table 2. The relationship between water stress (CWSI), water applied, number of irrigations, lint yield and water use efficiency of Pima S-6 cotton, Tucson, AZ, 1989.

TRT	CWSI	Applied water (in.)	# irrig.	Lint lb/ac	Water use efficiency(lb/in)
1	.19 E	46 A	16 A	1078 A	23.4
2	.32 D	39 B	10 B	1044 A	26.8
3	.47 C	36 BC	9 C	1045 A	29.0
4	.60 B	33 C	7 D	841 B	25.5
5	.76 A	29 D	5 E	568 C	19.6