

Water Stress Effects on Upland Cotton Lint Yields Using Infrared Thermometry to Schedule Irrigations

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Abstract

The Crop Water Stress Index (CWSI) was used to schedule irrigation on D+PL 90 cotton on a large scale commercial basis in Waddell, Az. The test consisted of sixteen one acre surface irrigated plots. There were four treatments with four replicates arranged in a randomized complete block design. Highest lint yields were attained when irrigations were scheduled at 0.28 CWSI units.

Introduction

Agricultural production in Central Arizona is currently undergoing dramatic changes. Production costs are increasing at a rapid rate while commodity returns remain relatively constant. The single highest input cost into a production system is water. Many farms are now being serviced by Central Arizona Project (CAP) water. Supply assurance has been reinforced due to the advent of CAP but delivery and water costs have risen significantly. Growers operating under a combination of these factors have significant economical incentive to evaluate carefully their irrigation management strategy.

In addition, due to the 1980 Groundwater Management Act, four Active Management Areas (AMA) have been created where the overall objective is to reduce groundwater pumpage to a level of "safe yield" by the year 2025. The law is designed to accomplish this objective by creating four, ten year management periods. We are now engaged in the Second Management Plan which ends December 31, 1999. The Second Management Plan in the Phoenix AMA, in general, reduces a farm's average water allotment from 5.74 acre feet per acre to 4.54 acre feet per acre in the year 2000. Due to all of the above mentioned factors, it is imperative that water management strategies be identified and implemented if cotton production is to remain profitable and sustainable.

Materials and Methods

The Crop Water Stress Index (CWSI) which correlates thermal infrared canopy temperature to the water content of the air, has been used successfully to schedule irrigations on a number of commercial crops including cotton to date. CWSI unit scale ranges from zero (no water stress) to one (severe water stress). The CWSI was used to schedule irrigations on D+PL 90 Upland cotton in 1990. Sixteen, one acre, surface irrigated plots were randomized into four treatments with four replicates on Moore Ranches in Waddell, Arizona. The test design used was a randomized complete block. Targeted CWSI thresholds at time of irrigation were 0.15, 0.30, and 0.50 CWSI units. The fourth treatment monitored the standard farm irrigation scheduling practice.

Infrared and vapor pressure measurements were taken between 1100 and 1300 hours a minimum of every other day. A treatment was irrigated when the average of the readings from the four replicates reached the test criteria threshold. Readings were taken by the grower cooperater under author guidance and assistance. This methodology enabled the grower to gain familiarity and understanding of the concept so that results and experience could be transferred to the entire farm unit.

Results and Discussion

Statistically significant differences were observed in all test variables. Refer to table 1 for ranking of results. Actual CWSI levels at time of irrigation were 0.14 (wet), 0.28 (medium), 0.42 (dry) and 0.17 (grower). Total water applied (including establishment irrigations) to maintain test criteria was 59 (wet), 43 (medium), 37 (dry) and 56 (grower) inches. Lint yields were 1024 (wet), 1238 (medium), 1092 (dry) and 1065 (grower) pounds per acre.

These results are extremely economically encouraging. The medium (0.30) treatment resulted in the highest lint yields with one hundred seventy three pounds more lint than the standard grower practice. In addition, these results were accomplished using roughly one acre foot per acre less water than the standard grower practice. If cotton is at seventy cents per pound and water costs are fifty five dollars per acre foot, (CAP) these results translate to an increased profitability potential of roughly one hundred seventy five dollars per acre. In many cases, with current production economics, this could be the difference between loss and profitability.

Scheduling irrigations on cotton when the CWSI nears 0.30 results in optimum yields under given growing season conditions. This should be noted in light of the extreme adverse environmental and entomological conditions encountered in 1990. Scheduling irrigations at reduced stress levels actually decreased yields significantly while increasing water application requirements. The CWSI is a viable and practical irrigation scheduling technique which could assist the commercial cotton producer with conservation objectives, mandate compliance and profitability.

**Effect of CWSI Irrigation Scheduling on Cotton Lint Yield,
Total Water Applied, and Number of Irrigations**

TREATMENT	CWSI AT IRRIGATION	SEASONALLY AVG CWSI	LINT YIELD (lb/ac)	TOTAL WATER (in)	# OF IRRIGATIONS
WET	0.14 c	0.10 c	1024 c	59	10
MEDIUM	0.28 b	0.15 b	1238 a	43	7
DRY	0.42 a	0.20 a	1092 b	37	6
GROWER	0.17 c	0.11 c	1065 bc	56	9

* Values followed by the same letter are not significantly different at the 0.01 level using Waller Duncan K-Ration T-Test.

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