# QUANTIFYING THE EFFECTS OF IRRIGATION TIMING ON COTTON YIELD UNDER RAIN-SHELTERED CONTROLLED CONDITIONS **Carlos J. Fernandez** Juan C. Correa Dan D. Fromme Juan A. Landivar **Texas AgriLife Research and Extension Center Corpus Christi, TX**

# Abstract

In deficit irrigation or supplemental irrigation practice, the challenge is to decide when is best to apply a limited amount of irrigation. The answer to this challenge requires a better understanding of the yield responses of cotton to timing of irrigation during the growing season. The objective of this study is to assess the effects of timing of oneshort-irrigation on growth and yield of moderately water-stressed cotton grown under controlled rain-sheltered conditions. Results showed that under these growing conditions it is best to delay a short term supplemental irrigation until the mid bloom stage.

#### Introduction

Soil water deficit is the most dominant yield-limiting environmental factor in drought-prone croplands. Even irrigated crops are usually exposed to some degree of soil water deficits, particularly when deficit irrigation or supplemental irrigation is practiced. These irrigation practices are common as driven by dwindling irrigation water resources and/or higher pumping costs. In both scenarios, either practicing deficit irrigation or supplemental irrigation, the challenge is to decide when is best to apply the limited amount of irrigation. The answer to this challenge requires a better understanding of the yield and fiber quality responses of cotton to the timing of irrigation during the growing season. Successful production of cotton in semiarid, short-growing-season environments requires adequate water supply during the early reproductive phase to minimize square shedding and increase boll retention. This concept was confirmed in a three-year study, which evaluated yield responses of cotton cultivars of different maturity to early termination of irrigation (3 weeks after first bloom) and normal termination of irrigation (first open boll) (Fernandez et al., 1996). However, these studies do not provide an answer to a situation where cotton is growing under moderate water stress and there is only a limited amount of irrigation water that allows only a short period of irrigation.

The objective of this study is to assess the effects of timing of one-short-irrigation on growth and yield of moderately water-stressed cotton grown under controlled rain-sheltered conditions.

#### **Materials and Methods**

The study was conducted in the Drought Tolerance Laboratory at the Texas AgriLife Research and Extension Center in Corpus Christi during the 2010 cotton-growing season. This facility consists of two joined modified greenhouse structures housing a large number of electronic mini lysimeters capable of measuring continuous whole-plant transpiration under controlled watering regimes. Computerized systems monitored whole-plant plant water use and controlled watering with a nutrient solution. Data collected were automatically transferred to a dedicated Web server for archiving and analysis.

Cultivar PHY375 planted on May 28 in wetted fritted clay 3.578-gallon pots. Seeds were pre-germinated and planted at 4-per-pot and later thinned to one-per-pot. Experimental plants were individually irrigated with a modified Hoagland solution made up with purified city water using an automated watering system. All pots irrigated at 1L per day until early squaring on June 28 to induce moderate water stress. The experimental set up consisted of four irrigation-timing treatments as follows: Treatment 1: Control (irrigated at 1L/day throughout study); Treatment 2: Full irrigation (3L/day) from early squaring to first bloom (Jun 28-Jul 13) and 3L every other day till maturity (end of study) on Aug 20; Treatment 3: 1L/day till first bloom then full irrigation (3L/day) from first bloom to mid bloom (Jul 13-Jul 31) and 3L every other day till maturity (end of study); Treatment 4: 1L/day till mid bloom then full irrigation (3L/day) from mid bloom (Jul 31) till maturity (end of study). Whole-plant transpiration was measured continuously using electronic weighing mini-lysimeters. Study was terminated on August 20, 2013 once plants completed full maturity. Plants were harvested individually for measuring growth and yield parameters.

## **Results and Discussion**

Plants in the control treatment were maintained at moderate water stress throughout the experiment at a daily wholeplant transpiration of about 500 ml d<sup>-1</sup>. Daily transpiration variation followed the daily fluctuation of environmental conditions (Fig. 1). Plants exposed to treatments 2, 3 and 4 exhibited increased daily transpiration during the period of supplemental irrigation as a consequence of water stress relief (Fig. 1 A, B, and C), which most certainly resulted from increased leaf conductance (stomata opening) and progressively increasing leaf area production (uninhibited leaf expansion) (Bradford and Hsiao, 1982; (McCree and Fernandez, 1989). The patterns of daily whole-plant transpiration in all treatments corroborate the efficacy of the irrigation timing treatments applied. Cumulative wholeplant transpiration values throughout the test period showed no significant differences among treatments 2, 3, and 4 (the ones receiving supplemental irrigation), but all three were significantly higher than the control treatment 1. (Table 1).

Table 1. Mean values of growth, yield-components, and water use efficiency indicator and significance of differences among treatments.

Treatments	Plant height inches	Height-to-Node Ratio inches	Seed Cotton g plant <sup>1</sup>	Lint g plant <sup>-1</sup>	Avg boll weight g boll <sup>-1</sup>	Cumulative Transpiration L plant <sup>1</sup>	Lint per transpiration mg L <sup>-1</sup>
1	31.9 c	2.17 b	17.5 b	7.84 b	2.48 ab	33.0 b	263 a
2	45.7 a	2.64 a	18.7 b	7.30 b	1.99 bc	49.1 a	158 bc
3	42.0 b	2.24 b	14.1 b	5.69 c	1.66 c	45.1 a	132 c
4	42.1 b	2.12 b	24.6 a	10.6 a	2.89 a	51.1 a	230 a

\*Means in a column, followed by the same letter, are not significantly different at P=0.05

Plant height was shortest in the control treatment as it was maintained at moderate stress throughout the experiment (Table 1). Plants in treatment 2, which were irrigated from early squaring to first bloom stage were the highest, while those of treatments 3 and 4 irrigated at later stages were shorter than those of treatment 2 but higher than treatment 1. Plants in treatment 2 showed the highest height-to-node ratio.

Seed cotton production per plant was highest in plants of treatment 4 (41% higher than the control), which received supplemental irrigation from mid-bloom to full maturity (Table 1). Applying supplemental irrigation at earlier growth stages did not increased seed cotton yield over the control.

Average boll weights were significantly higher in the control treatment and treatment 4 than in treatments 2 and 3 (Table 1). The difference in yield between the control and treatment 4 resulted from the higher number of bolls in treatment 4 than in the control (data not shown).

Lint yield was significantly higher in treatment 4 (late supplemental irrigation) than the control (35.2%) and treatments 2 and 3. Plants in treatment 3 showed the lowest lint yield (Table 1).

Lint produced per unit transpiration, calculated as a variable to indicate water use efficiency, was significantly higher in both the control and treatment 4 than in treatments 2 and 3 (Table 1).

## **Conclusions**

This study indicates that for cotton plants subjected to moderate water stress it is best to delay a short term supplemental irrigation until the mid bloom stage. This timing of supplemental irrigation resulted in highest seed cotton and lint yield and a higher water use efficiency estimated as lint per water used.







Figure 1. Comparison of the daily progression of whole-plant transpiration between the Control treatment (moderate stress with no supplemental irrigation) and supplemental irrigation timing treatments (A) early squaring to first bloom, (B) first bloom to mid bloom, and (C) mid bloom to full maturity.

## **References**

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