COTTON CROP WATER USE AND IRRIGATION SCHEDULING

Craig Bednarz, Glen Ritchie, Jim Hook, Rad Yager,
Sidney Cromer, Dudley Cook and Ivey Griner
University of Georgia Department of Crop and Soil Sciences, Tifton
and Stripling Irrigation Research Park, Camilla

Summary

Our primary objective with this research is to determine (1) how much water a cotton crop may use on a weekly basis under high yield potential conditions and (2) the stage of crop growth that is the most susceptible to water stress. This information will then be used for the production of irrigation guidelines for Georgia cotton growers.

In 2002 and 2003 the study was conducted at the UGA Coastal Plain Experiment Station Gibbs and Lang Farms and the UGA Stripling Irrigation Research Park. These facilities are equipped with overhead irrigation systems. Several irrigation treatments were imposed season long. In 2002 the highest yielding treatment was that receiving full irrigation. The data indicate the period from first flower to first flower plus three weeks is very sensitive to water stress. In addition, these data indicate withholding water from emergence to first flower can reduce yields.

In 2003 the studies received between 25 and 30 inches of rainfall during the growing season. All study locations were irrigated only one or two times and rainfall was received within 24 hours after each irrigation event. Thus, due to more than sufficient rainfall in 2003, irrigation capacity did not improve lint yields.

Introduction

The Southeast generally receives approximately 50 inches of rainfall annually. It has been suggested that an individual cotton plant requires about 10 gallons of water to achieve maximum yield potential. If an acre-inch of water contains 27,193 gallons, a crop with 50,000 plants per acre would require slightly more than 18 inches of water to maximize yields. This 18 inches is much less than the 50 inches that the Southeast annually receives. However, rainfall distribution in the Southeast is generally not synchronized with peak crop water requirements. Also, the sandy soils of the Coastal Plain may hold about 1 inch of water per foot of soil, which would not meet the crops' water requirements during peak water usage without rainfall or supplemental irrigation. Irrigation capacity can easily increase yield potential 300 to 400 pounds per acre for many Georgia growers. The practical question is "How should irrigation be managed for maximum lint yield?"

Our objective is to conduct research that will lead to reliable irrigation scheduling techniques for Georgia cotton producers. In order to do this crop water use throughout crop growth and development must first be determined. Therefore, our primary objective is to determine how much water a cotton crop may use on a weekly basis under high yield potential conditions. Irrigation capacity will not be limiting in these studies.

Materials and Methods

In 2000 the study was conducted at the UGA Coastal Plain Experiment Station Ponder Farm. This facility is equipped with an overhead irrigation system. Cotton 'DPL 33b' was planted on May 4, 2000. Irrigation treatments were (1) non-irrigated, (2) 70% actual evapo-transpiration replacement, and (3) 100% actual evapo-transpiration replacement. Each of these three treatments were imposed season long. Actual evapo-transpiration was determined with water mark sensors.

In 2001 the study was conducted at the UGA Coastal Plain Experiment Station Gibbs Farm. This facility is equipped with an overhead irrigation system. Cotton 'DPL DELTA PEARL' was planted on May 24, 2001. Irrigation treatments were (1) non-irrigated, (2) full irrigation, (3) non-irrigated until stand establishment to first square, (4) non-irrigated until first square to first flower, (5) non-irrigated until first flower to first flower plus three weeks, (6) non-irrigated until first flower plus three weeks to first flower plus six weeks and (7) non-irrigated until first flower plus six weeks to cracked boll. Actual evapo-transpiration was determined with water-mark sensors.

In 2002 and 2003 the study was conducted at the UGA Coastal Plain Experiment Station Gibbs and Lang Farms as well as the UGA Stripling Irrigation Research Park near Camilla, GA. All facilities are equipped with overhead irrigation systems. Cotton (DPL 458 in 2002 and DPL 555 in 2003) was planted in late April or early May in all studies. Irrigation treatments were (1) non-irrigated, (2) full irrigation, (3) non-irrigated from stand establishment to first square, (4) non-irrigated from first square to first flower, (5) non-irrigated from first flower to first flower plus three weeks, (6) non-irrigated from first flower plus three weeks to first flower plus six weeks and (7) non-irrigated from first flower plus six weeks to cracked boll. Actual evapo-transpiration was determined with water-mark sensors.

Results

From 2000 to 2002 crop water use has been monitored in a total of five locations at Tifton. Figure 1 illustrates the average water use curve for these locations. Across locations, crop water use increased until the third week of flowering and then began to decrease. This information will eventually be used for the development of a cotton irrigation model.

Lint yields in 2000 ranged from 893 lbs/acre in the dry land plots to 1082 lbs/acre in the 70% ETa replacement plots to 1259 lbs/acre in the 100% ETa replacement plots. Thus, irrigation in 2000 regardless of volume, resulted in increased yields.

In 2001 the highest yielding treatment was that receiving irrigation from first flower plus three weeks to first flower plus six weeks (1539 lbs/acre), the next highest yielding treatment was the full irrigation (1476 lbs/acre) and the third highest yielding treatment was that receiving irrigation from first flower to first flower plus six weeks (1204 lbs/acre). The remainder of the treatments averaged 1099 lbs/acre. 5.5 inches of supplemental irrigation water were applied during a six-week period beginning at first flower. These were the only irrigations required during the growing season. This additional 5.5 inches of water increased yield in the full irrigation treatment by more than 350 lbs lint/acre. These data indicate the period from first flower to first flower plus six weeks is very sensitive to water stress.

The combined analysis for lint yield for the Lang and Gibbs farms and the Stripling Irrigation Research Park in 2002 is presented in Figure 1. Withholding water for the first three weeks of flowering reduced seed cotton yields by 350 lb/acre. These data again indicate the flowering period of cotton is very sensitive to water stress. Irrigation and rainfall amounts are presented in Table 1.

In 2003 the studies received between 25 and 30 inches of rainfall during the growing season. All study locations were irrigated only one or two times and rainfall was received within 24 hours after each irrigation event. Thus, due to more than sufficient rainfall in 2003, irrigation capacity did not improve lint yields.

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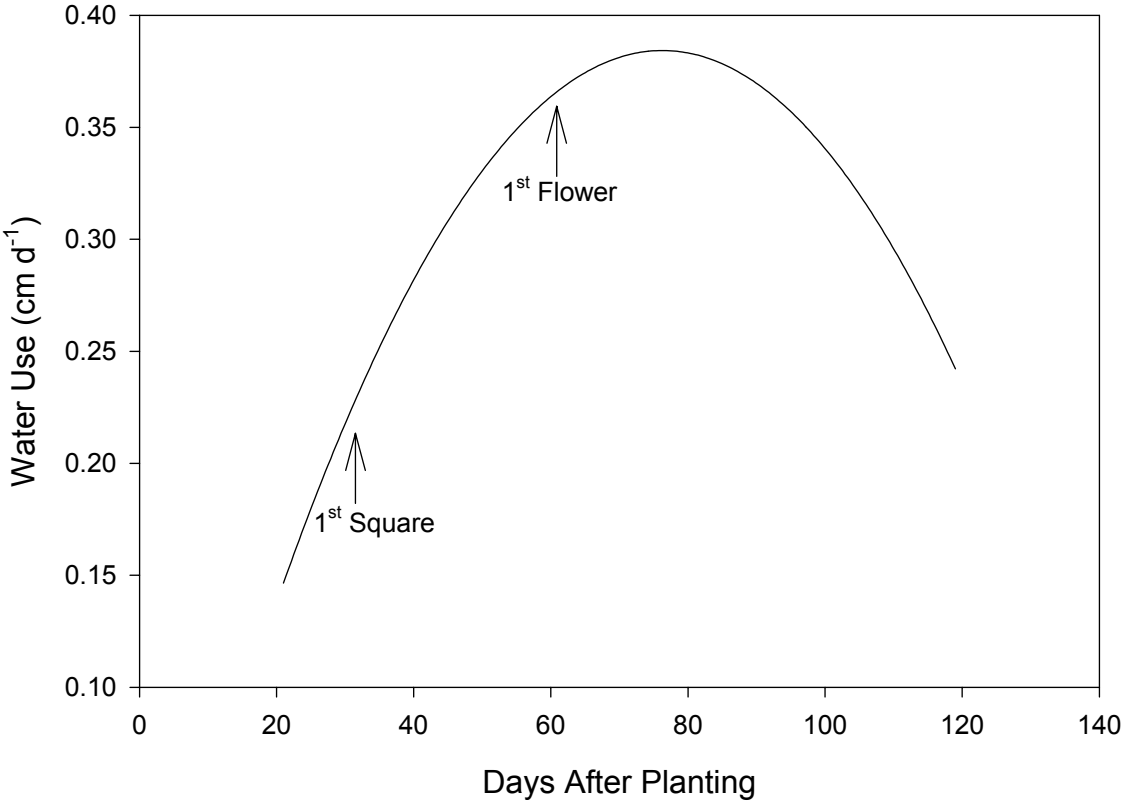

Figure 1. Average daily crop water use in irrigation studies conducted at the University of Georgia Coastal Plain Experiment Station on a Tifton Loamy Sand in 2000, 2001 and 2002.

$Y = -0.0686 + 0.0119X - 7.7838e^{-5}X^2$

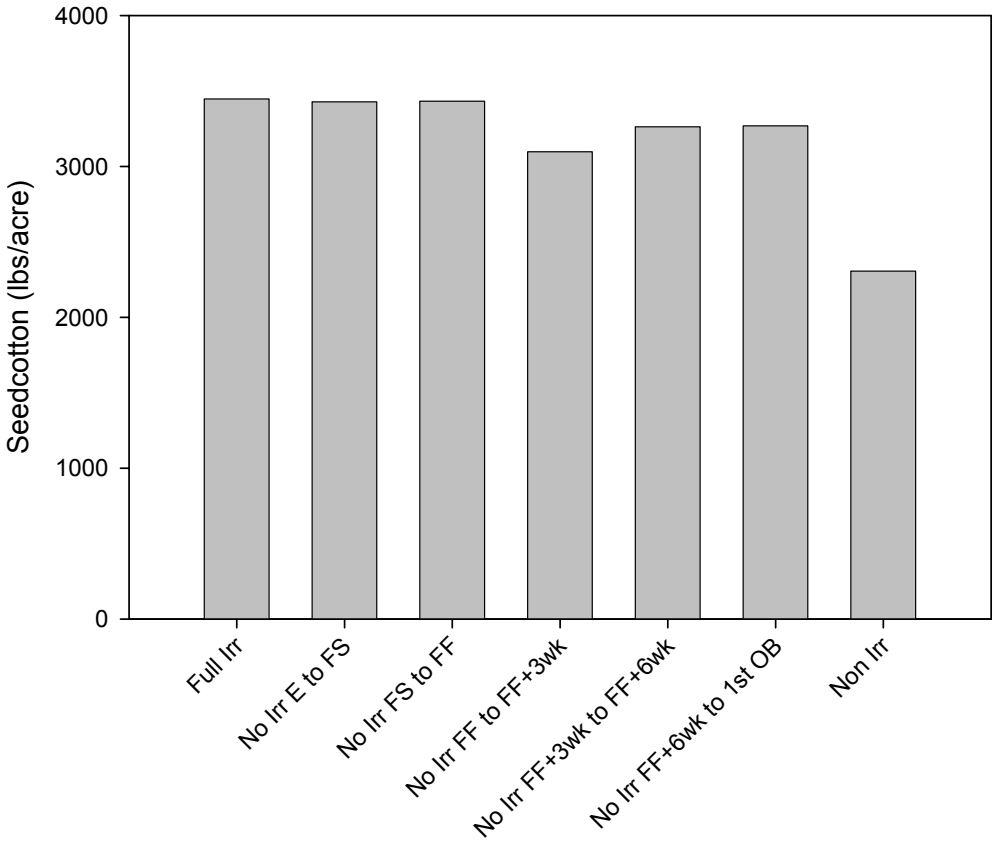

Figure 2. Average seedcotton yields for irrigation studies conducted at the University of Georgia Gibbs and Lang Farms and Stripling Irrigation Research Park in 2002.

Table 1. Rainfall and irrigations received (inches) at the irrigation studies conducted at the University of Georgia Lang and Gibbs farms and Stripling Irrigation Research Park in 2002.

	Lang Farm	Gibbs Farm	SIRP
Rainfall	12.62	24.3	15.2
Full Irrigation until first cracked boll.	8.88	7.5	6.3
No Irrigation from emergence to first square.	9.73	6.5	6.3
No irrigation from first square to first flower.	8.68	5	5.7
No irrigation from first flower to first flower plus 3 weeks.	7.36	6.5	5.8
No irrigation from first flower plus three weeks to first flower plus six weeks.	7.32	6.5	5.1
No irrigation from first flower plus six weeks to first cracked boll.	7.9	5.5	5.7
Non-irrigated.	0	0	1.5