IRRIGATION

Irrigation Frequency During Fruiting as a Yield Determinant in Upland Cotton

J. W. Radin, J. R. Mauney, and O.F. French

ABSTRACT

When cotton is irrigated at long intervals, the root systems become less effective at absorbing water during heavy fruiting, even when the soil is moist. That ineffectiveness, if not counteracted by frequent watering, can exaggerate water stress responses during fruiting and promote early cutout. Deltapine 90 cotton was grown at the Maricopa Agricultural Center in 1988 and watered either by daily drip irrigation or by level-basin flooding. In the flood-irrigated plots, various schedules for applying water during fruiting were compared, with minimal differences in total water applied. The check treatment (9 postplant irrigations) yielded approximately 2 bales of lint per acre. Small supplemental irrigations on 13 July and 22 July, splitting the normal irrigation cycles, increased yield 45% for only 6% more applied water. Daily drip irrigation in the trials increased yield 63% above the check on 1% more applied water over the season. The results show that flood-irrigated yields can approach drip-irrigated yields without excessive water use, if the irrigation cycle is shortened during fruiting.

INTRODUCTION

High-frequency drip irrigation often delays cutout and increases cotton yields over conventional irrigation methods. We reported in the 1988 Cotton Report that the hydraulic conductance (ability to transport water from the soil to the tops) of field-grown cotton decreases during heavy fruiting, especially when the interval between irrigations is as long as 2 weeks. When the plant conductance is low, the plants can become stressed for water, even in moist soil, because they are unable to take up the available moisture fast enough. Daily drip irrigation minimizes the occurrence of the problem of low conductance during fruiting. Shortening the irrigation interval during fruiting by other means also delays cutout and increases yields.

MATERIALS AND METHODS

Deltapine 90 cotton was planted on Irrigation Laboratory land at the Maricopa Agricultural Center, and stands were thinned to about 40,000 plants per acre. The field was divided into 4 blocks, each with 5 treatments in level basins in a randomized complete-block design. The 5 treatments consisted of daily drip irrigation and 4 different schedules of flood irrigation. All treatments, including the drip-irrigated treatment, were given a preplant irrigation of 8 inches and 2 postplant irrigations of 6 inches each. Installation of the drip system was completed and dripping begun in late June, about the time of first flower. Table 1 shows the timing and rates of irrigation after that time.

RESULTS AND DISCUSSION

Drip-irrigated plants grew at a steady rate all season (Fig. 1). Bolls first appeared in late June, and in dripped plants the dry weight of the bolls steadily increased thereafter. By the end of the season the bolls accounted for more than 50% of the total dry weight. In the check, overall growth rate was slower than in the drip treatment beginning in mid-July, but boll loading was not markedly affected at first (Fig. 1). The production of bolls was not affected until mid-August, when the plants went into cutout.

When the irrigation interval was shortened by supplemental irrigations in July, plants responded to the altered schedule even though the total amount of applied water was little changed. Growth of the supplemented plants almost matched that of the dripped plants until late August, when it slowed somewhat (Fig. 1). With the supplemental irrigations, boll loading continued considerably longer than in the check. Boll dry weight was the same as in drip-irrigated plants until early September, when the supplemented plants cut out.

It is apparent that shortening irrigation intervals in July produced faster growth rates than in the check treatment, providing a larger plant frame for boll loading. The extension of vegetative growth allowed cutout to be delayed by about 2 weeks. The effect resembles the effect of drip irrigation. Final yields behaved similarly to the trends indicated by the sampling during the season (Table 2). Seed-cotton yield (machine harvested, once through) was increased from 3,465 pounds per acre in the checks to 5,010 pounds per acre in the double-supplemented treatment, a 45% increase. Yields in the single-supplemented treatments were intermediate between those 2 values. For comparison, yield in the dripped plots was 5,635 pounds per acre, 63% higher than the check. Thus the 2 supplements in July "recaptured" two-thirds of the yield increase due to dripping, yet they did so without an excessive amount of water being applied. The total applied water with the supplemental irrigations was only about 6% greater than in the check and 5% greater than in the drip-irrigated treatment.

Much of the advantage of daily drip irrigation is because of enhanced vegetative growth early in the fruiting cycle, with subsequent delay of cutout. Our earlier work suggested that growth slows too early in plants irrigated at long intervals because the root system becomes ineffective at delivering water rapidly (possibly because of root dieback during fruiting). The resulting plant stress is not fully relieved by rewatering. The results from 1988 show that shortening the irrigation cycle by any means, not just by dripping, can circumvent the problem and increase yield. Furthermore, the interval apparently needs to be shortened only during fruiting, not during the entire season. The results point to possible new guidelines for irrigation techniques and scheduling to achieve high yields without the expense of installing and maintaining a drip irrigation system.

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Table 1. Dates and rates of water application in the 1988 experiment. Only the flood-irrigated treatments are shown. All treatments received 20 inches in the first part of the season in addition to the irrigations shown below. For comparison, the total amount of water applied to the drip-irrigated treatment was 48.7 inches.

Date	Check	Suppl. 1	Suppl. 2	Suppl. 1+2
		inches		
6 July	4	4	4	4
13 July	0	2.7	0	2.7
15 July	4	2.7	4	2.7
22 July	0	0	2.7	2.7
26 July	4	4	2.7	2.7
5 August	4	4	4	4
12 August	4	4	4	4
19 August	4	4	4	4
2 September	4	4	4	4
TOTAL (incl. first 20")	48	49.4	49.4	50.8

Table 2. Seed-cotton yields of treatments in the 1988 experiment. Numbers followed by the same letter are not significantly different at the 95% probability level.

Treatment	Yield
	lb/acre
Check	3,465 a
Suppl. 1	3,911 ab
Suppl. 2	4,277 ab
Suppl. 1+2	5,010 bc
Drip	5,635 c

Fig. 1. Growth and boll dry matter production of cotton on various irrigation regimes. S_1 and S_2 refer to the dates for supplemental irrigation.