

# ALTERNATE-FURROW IRRIGATION

## for San Joaquin Valley Cotton

Studies to evaluate the practice of irrigating alternate furrows in cotton were conducted for two years on a sandy loam soil at the U. S. Cotton Research Station, Shafter. With an alternate-furrow irrigation system, soil moisture used by the plant before irrigating is replenished on only one side of the row at the time of irrigation. This system provides a more sensitive means of regulating plant water stress, which can be of help in controlling the vegetative growth rate of the plant. However, since the entire soil zone is not all used for water storage, care must be exercised to avoid excessive water stress. Total lint yields for alternate-furrow test plots were as good or better than yields for regular furrow irrigation, and with considerable less water used.

D. W. GRIMES

V. T. WALHOOD • W. L. DICKENS

**A** CONSIDERABLE ACREAGE of cotton grown in the San Joaquin Valley is irrigated by applying water to alternate furrows at least during a part of the growing season. Little information has been available concerning the desirability of this practice, but certain economic and plant-growth advantages have been believed possible with the system: (1) a reduction in the total quantity of water applied; (2) more rapid irrigation of a field; and (3) controlled plant-water stress during a period when this is desirable to slow vegetative growth and promote a more favorable fruiting balance of the cotton plant.

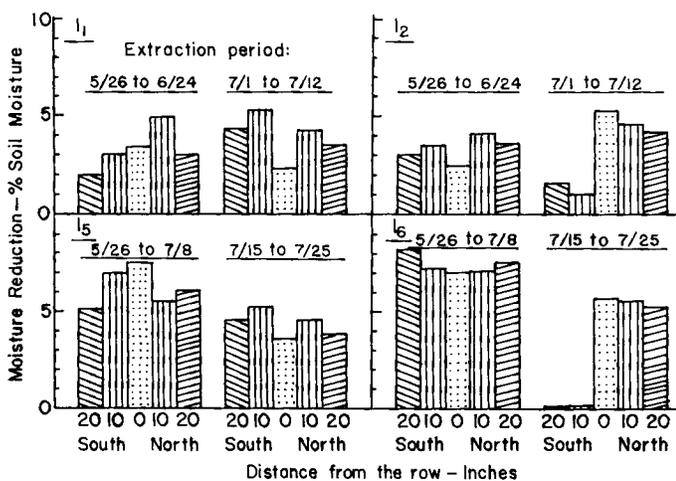
Studies to evaluate this practice were conducted for two years (1966-1967) on a Hesperia sandy loam soil at the U.S. Cotton Research Station, Shafter. The 1966 test was set up as follows:

Irrigation treatment designation	Date of seasonal irrigations		Furrow treatment	Total water applied after planting*
	first	second		
I <sub>1</sub>	5/23	6/27	Every	27.3
I <sub>2</sub>	"	"	Alternate	20.3
I <sub>3</sub>	6/6	"	Every	27.3
I <sub>4</sub>	"	"	Alternate	20.6
I <sub>5</sub>	5/23	7/11	Every	23.5
I <sub>6</sub>	"	"	Alternate	18.7
I <sub>7</sub>	6/6	"	Every	24.2
I <sub>8</sub>	"	"	Alternate	19.0

\* All plots were preplant irrigated and contained a full soil profile of water at planting.

During 1966 the alternate- and solid-furrow treatments extended throughout the growing season. While the plants on all treatments were subject to similar

Graph 1. The relationship between moisture extraction, time of irrigation, and furrow irrigation system, 1966. Each bar in the graph is an average of the soil moisture depletion in the surface 3 ft of the soil profile.



Graph 2. Soil moisture tension values at an 18-inch depth for different stress levels and furrow irrigation systems, 1967. The arrows indicate dates of irrigation.

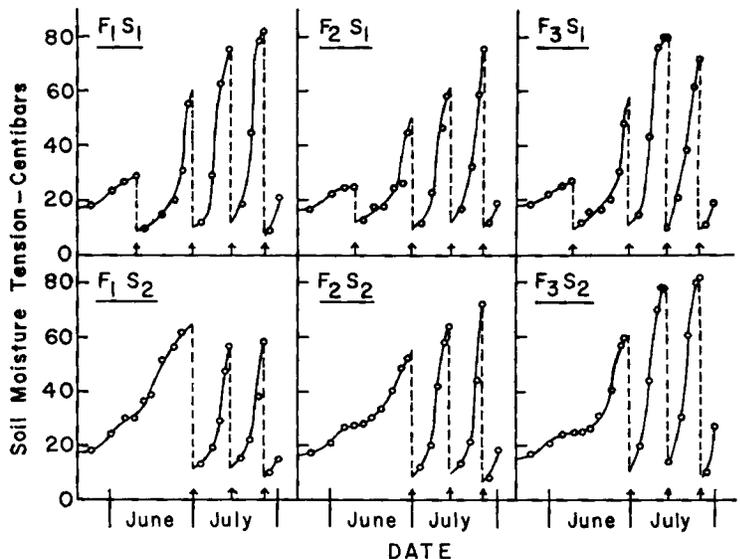


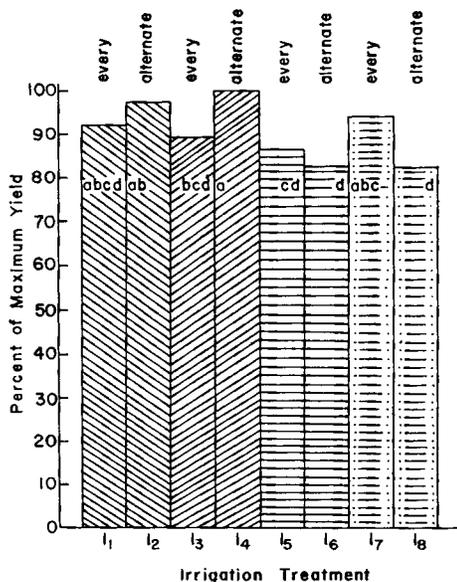


Photo to left, above, shows cotton plot being irrigated with water in each furrow compared with plot in photo to right being irrigated in alternate furrows only. Note zone of wetting with the alternate furrow system (right photo).

stress conditions after the first two irrigations, the increased frequency of irrigation necessary for alternate-furrow treatments during July and August, when water demand is at a peak, is undesirable. For example, from June 27 to the end of the irrigation season, treatment I<sub>1</sub> was irrigated four times while it was necessary to irrigate treatment I<sub>2</sub> six times during this period. In the 1967 study, water was applied to every furrow following the early-treatment period.

In the 1967 test the three furrow treatments were subjected to both stress levels, giving a total of six treatments. Following the first two irrigations, all treatments were irrigated the same. The total seasonal water application (in inches), in

Graph 3. Relative cotton lint yield as influenced by irrigation schedule and furrow system, 1966. Bars in the graph not containing the same letter differ at the 5% probability level.



addition to a full soil profile of water at planting, for each treatment was: F<sub>1</sub>S<sub>1</sub>, 26.2; F<sub>1</sub>S<sub>2</sub>, 23.0; F<sub>2</sub>S<sub>1</sub>, 24.6; F<sub>2</sub>S<sub>2</sub>, 21.5; F<sub>3</sub>S<sub>1</sub>, 21.4; F<sub>3</sub>S<sub>2</sub>, 19.8.

Field plots were planted with Acala SJ-1 seed in 40-inch rows. In 1966, plots were planted April 13 and machine harvested October 11 and November 5. Because of unfavorable spring weather conditions in 1967, planting was delayed until May 3, and plots were machine harvested October 17 and November 14.

The 1967 test was set up as follows:

Furrow system	Treatment description
F <sub>1</sub>	Solid-furrow irrigation throughout the season.
F <sub>2</sub>	Alternate-furrow irrigation for the first seasonal irrigation only.
F <sub>3</sub>	Alternate-furrow irrigation for the first and second seasonal irrigations only.

#### Moisture stress levels

- S<sub>1</sub> Low stress. Irrigated at the first and second irrigations when tensiometers placed at 18 inches showed an appreciable use of soil moisture at this depth.
- S<sub>2</sub> High stress. Irrigated at the first and second irrigations when tensiometers placed at 36 inches showed soil-moisture use at this depth.

#### Moisture extraction

In the 1966 study, gypsum moisture units were placed at strategic soil depths and positions with respect to the planted row, to allow observations of moisture extraction and replenishment under an alternate-furrow system, as compared with irrigating every furrow. A summary of these observations from selected treatments is shown in graph 1.

Total water use before the first irrigation on May 23 was only about 1½ inches. As a result, moisture extraction from the surface 3 ft of soil following the

first irrigation was uniform, regardless of which furrow system was used. However, the second extraction period, extending from July 1 to July 12 (treatments I<sub>1</sub> and I<sub>2</sub>), illustrates the influence of irrigating furrows on the soil moisture extraction pattern. Prior to the second irrigation on June 27 the soil moisture content was reduced by 3 to 4 per cent. The moisture depleted was replaced on the north side of the planted row, on which observations were made (treatment I<sub>2</sub>), but not on the south side. Since a large part of the available water was removed before the second irrigation, and was not replaced in the dry furrow with the alternate system, only a small amount of water was extracted from the zone during the July 1 to 12 extraction period.

#### Delayed irrigation

This effect is even more pronounced with treatment I<sub>6</sub> because of the late second irrigation, applied July 11. By delaying the second irrigation, essentially all of the available water was extracted in the top 3 ft of soil. The July 15 to 25 extraction period shows that essentially no water was extracted from the dry furrow in this treatment.

In the 1967 test, tensiometers (of the type using a Bourdon vacuum gauge) were placed at 18- and 36-inch depths in the planted row for observations on moisture extraction and as an aid in scheduling irrigations. Tensiometer readings obtained at the 18-inch depth through July are shown in graph 2.

Plots in the S<sub>1</sub> series were irrigated for the first time during the growing season

# PRUNING *bearing*

W. C. MICKE • K. RYUGO

D. C. ALDERMAN • J. T. YEAGER

Sweet cherry trees in many commercial California orchards have been allowed to grow excessively tall. This practice tends to elevate the bearing area with subsequent loss of much of the lower fruiting wood. Cultural and harvesting operations then become more inefficient and expensive. Height of young bearing trees can be controlled and maintained by pruning. A reduction in yield often results from pruning bearing trees and is generally proportionate to the severity of pruning. However, this reduction in yield may be partially offset by somewhat larger fruit size, more efficient cultural and harvesting operations, and slightly increased tree vigor.

**F**RUITS OF THE SWEET CHERRY are borne laterally on spurs which may be productive for ten years or more. Since these spurs are long-lived, the cherry tree needs very little pruning to maintain satisfactory production once the basic framework is developed. Consequently, many cherry trees in California have received little or no pruning after the third year in the orchard, except for the removal of dead, diseased, or broken limbs.

This lack of pruning and the upright growth habit of cherry trees have resulted in many trees reaching heights of 25 to 40 ft. On such large trees, most of the lower branches often lack fruiting spurs due to shading and natural mortality, and therefore few fruits are produced within 8 to 10 ft of the ground.

Over the past four years, studies were conducted to determine whether the height of bearing cherry trees could be lowered and then maintained at this level without severely reducing production. The possibility of minimizing the loss of lower fruiting wood in order to maintain the bearing area closer to the ground was also studied.

on June 9. These plots were irrigated for the second time on June 30 when plots in the S<sub>2</sub> series were irrigated for the first time. In general, these results are similar to those observed in the 1966 study. Where most of the available water was removed prior to an irrigation, a rapid rise in the tensiometer reading resulted where plots were irrigated only in alternate furrows (see treatment F<sub>3</sub>S<sub>2</sub>, graph 2). This is to be expected since less total water is available in the soil profile following an irrigation with this system.

## Plant growth

Plant height measurements were made periodically in both test years as a measure of the degree of moisture stress imposed by individual treatments. Height measurements obtained July 28 and August 3 were selected to illustrate the results of stress conditions after treatments were imposed for the two test years (table 1).

During 1966 the vegetative growth rate was most rapid under the I<sub>1</sub> treatment. Delaying the date of the first irrigation (treatment I<sub>3</sub>) caused some reduction in the growth rate; however, the delayed second irrigation (treatments I<sub>5</sub> and I<sub>7</sub>) caused the greatest reduction in growth under a system of irrigating every furrow. Greater stress was imposed by the alternate furrow systems, as was suggested by the extraction patterns. The greatest reduction in plant growth, resulting from irrigation of alternate furrows, occurred with the longest time interval between the first and second irrigations (see treatments I<sub>5</sub> and I<sub>6</sub>).

In the second test year, treatment F<sub>3</sub>S<sub>2</sub>

resulted in a 16 per cent reduction in plant height by August 3 as compared with F<sub>1</sub>S<sub>1</sub> (the low-stress treatment, irrigated in every furrow). The F<sub>3</sub>S<sub>2</sub> treatment received 6.4 inches less water prior to July 26 but all treatments were irrigated alike following this date. Other treatments resulted in stress levels intermediate between these two.

## Cotton yield

Cotton yield relationships for the two studies are presented in graph 3 and table 1. The two highest yielding treatments in 1966 were irrigated with an alternate furrow system and had second seasonal irrigations on June 27 (graph 3). These treatments received an average of 6.9 inches less water than comparable treatments receiving water in every furrow and show, not only a higher absolute yield, but also more yield per inch of water added. The influence of an excessive water stress condition (treatments I<sub>6</sub> and I<sub>8</sub>) is illustrated in reduced yield where water is added in alternate furrows with a delayed second irrigation.

Total lint yields from the variously treated plots in the 1967 test did not differ appreciably (table 2). An excessive moisture deficit or "stress" early in the season may result in a delayed maturity of the cotton plant. This was illustrated by treatment F<sub>3</sub>S<sub>2</sub>, where only 82 per cent of the total yield was harvested in the first pick. Under less favorable fall weather conditions for maturing the late-set bolls, the yield from this treatment would have been reduced appreciably. However, irrigating with alternate furrows for the first two irrigations (treatment F<sub>3</sub>S<sub>1</sub>)—without an excessive moisture deficit—was most favorable.

Results of these investigations demonstrate the feasibility of an alternate furrow irrigation system as a means of regulating the degree of moisture stress on cotton. However, since the entire soil zone is not all used for water storage, care must be taken to prevent excessive stress conditions from developing.

*Donald W. Grimes is Assistant Water Scientist, and Lamar Dickens is Laboratory Technician, Department of Water Science and Engineering, University of California, Davis, and at the U.S. Cotton Research Station, Shafter. V. T. Walhood is Plant Physiologist, CRD, ARS, USDA, Shafter. Research from which this progress report was prepared was supported in part by a grant from the California Planting Cotton Seed Distributors.*

TABLE 1. COTTON PLANT HEIGHTS AS INFLUENCED BY IMPOSED MOISTURE STRESS LEVELS

1966—7/28		1967—8/3	
Irrigation treatment	Plant height	Irrigation treatment	Plant height
	cm		cm
I <sub>1</sub>	115 a*	F <sub>1</sub> S <sub>1</sub>	96 a
I <sub>2</sub>	105 bc	F <sub>1</sub> S <sub>2</sub>	92 ab
I <sub>3</sub>	110 ab	F <sub>1</sub> S <sub>1</sub>	92 ab
I <sub>4</sub>	107 bc	F <sub>2</sub> S <sub>2</sub>	87 bc
I <sub>5</sub>	106 bc	F <sub>1</sub> S <sub>1</sub>	93 ab
I <sub>6</sub>	92 d	F <sub>1</sub> S <sub>2</sub>	81 c
I <sub>7</sub>	104 c		
I <sub>8</sub>	96 d		

\* Means not followed by the same letter differ at the 5% probability level.

TABLE 2. INFLUENCE OF ALTERNATE FURROW IRRIGATION AND MOISTURE STRESS LEVEL ON TOTAL LINT YIELD, YIELD OF FIRST PICK, AND PER CENT OF TOTAL LINT HARVEST AT THE FIRST PICK, 1967

Treatment	Total lint yield	First pick lint yield	Per cent of first pick
	lbs/acre	lbs/acre	%
F <sub>1</sub> S <sub>1</sub>	977 a*	866 a	89 a
F <sub>1</sub> S <sub>2</sub>	962 a	817 ab	85 ab
F <sub>2</sub> S <sub>1</sub>	947 a	841 ab	89 a
F <sub>2</sub> S <sub>2</sub>	941 a	795 ab	85 ab
F <sub>3</sub> S <sub>1</sub>	996 a	875 a	88 a
F <sub>3</sub> S <sub>2</sub>	928 a	762 b	82 b

\* Treatment means not followed by the same letter differ at the 5% probability level.