Irrigation technique:

MOISTURE-STRESS SYMPTOM DATA MODIFICATION AIDS CROP IRRIGATION

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An irrigation technique utilizing crop moisture-stress symptoms as a guide to subsequent irrigations was used successfully with field corn in the San Joaquin Valley. Results compared favorably with soil-moisture data obtained from gypsum-block readings within the plots and evapotranspiration information from nearby lysimeters containing grass (tall fescue). Results indicate that the risk of crop-yield losses due to improper or late irrigations can be largely overcome by the method.

A NUMBER OF DIFFERENT METHODS have been used in the field to determine when a particular crop should be irrigated before damage to the resulting yield is irreversible. These methods include: placing instruments within the field soil, using different indicator crops interspersed within the field, observing leaf color changes, predictions based on evaporation or plant transpiration or both, and use of sandy spots as indicator areas within the particular field. Each of these methods has some limitations:—some still permit yield reductions, some measure the plant-water status indirectly, and some raise costs of production.

A different irrigation technique was tried on field corn at the West Side Field Station in 1972. This technique is a good way to schedule crop irrigations—thus helping conserve water. The method has economic potential because of its low cost, reduced risk of yield losses, and reduced danger of overirrigation. It takes into consideration environmental factors, such as insect damage, disease damage, amount of available soil moisture, and climate—all of which play a part in water use by plants. The method is relatively inexpensive because the crop itself is used to indicate when irrigation is needed.

An area of approximately three acres of Panoche Clay loam soil with a water-holding capacity of about 4 inches per foot was selected as the site for the experiment. About 2 inches of this water was considered available for plant growth. The soil was preirrigated with 12 inches of water on October 29, 1971, and received 140 lbs of nitrogen in the form of aqua-ammonia (21% N) on January 25, 1972. The area was then divided into four replications of four irrigation-treatment plots measuring 53 ft by 136 ft.

On April 5, all plots were planted to field corn (SX17-B). Corn was planted in relatively dry 40-inch beds with normal seed spacing of 10 inches, equivalent to about 15,700 seeds per acre although recommended rates sometimes exceed 20,000 seeds per acre. At this time, randomly selected portions of four different plots, one in each replication, were double-planted, thus giving beds which contained 5-inch (close) spacing of about 31,400 seeds per acre. After 8 inches of water was applied for irrigating-up on April 7, these close-planted beds were used as indicator plots for the first variable irrigation treatment. Since heavy plantings deplete moisture in the upper soil faster than normal plantings, moisture-stress symptoms (leaf curl and lower-leaf firing) shown by the double-planted beds were used for this one-time (first variable irrigation) purpose only. As previously mentioned, the entire area was irrigated-up for seed germination and the rooting zone was considered to be adequately supplied with water at this initial phase of the study.

Three weeks after plant emergence (on April 17), all plots were side-dressed (furrow depth and 9 inches to the side) with 370 lbs per acre of 13-13-6 fertilizer which is equivalent to 48-21-18 lbs of elemental N-P-K per acre.

TABLE 1. AVERAGE GROWTH OF PLANT HEIGHT IN CM/DAY FOR TWO CORN PLANT SPACINGS FOLLOWING AN 8-INCH IRRIGATION ON APRIL 7, 1972.

Spacing on 40-inch beds	May 11 to May 30	May 30 to June 13
	cm/day	cm/day
Close (5-inch)	2.87	3.49
Normal (10-inch)	2.57	3.77

The variable-furrow irrigation scheme, after plant emergence, was as follows: Close-planted plots (5-inch spacing) randomly selected within the 4 replications were measured for height periodically, and compared with the normally-spaced plots. As rate of growth in the close-planted plots began to decrease in relation to that in the normal plots, apparent leaf curl and firing of lower leaves were noted indicating moisture stress in the close-planted plots. These symptoms were found to be prevalent during the second week of June and taken to indicate that all plots needed irrigating. The intent was to irrigate the whole field before the above moisture-stress symptoms began to show in the remainder of the field. Thereafter, all close-planted plots received normal (6-inch) irrigations.

Irrigation

Graph 1 shows the accumulative growth curves between plant emergence and the first variable irrigation for the close-planted and normal plots on June 14, 1972. Height increases were more rapid with the close (5-inch) spacing than with the normal (10-inch) spacing until about the end of April. Thereafter, moisture stress apparently slowed growth in close-planted plots to the point that the nonstressed normal spacing showed more rapid growth. Table 1 shows rate differences in plant height increases for two time periods.

On June 14, the first variable irrigation was applied—involving eight subplots selected randomly (4 plots each separated by borders from remaining plot area) to receive only 3 and 4 inches of water, while the remainder of the field received a normal 6-inch irrigation. These subplots then became indicator plots for the next variable irrigation. This procedure was followed twice more, each time using different randomly selected plots which had been irrigated normally until use as indicator plots, and thereafter irrigated normally. As with the

TABLE 2. IRRIGATION TREATMENT AMOUNTS, DATES OF APPLICATION AND PLANT WATER STRESS PERIODS OF IRRIGATION EXPERIMENT

	Close (5-inch)	Normal (10-inch)								
Treatments* Plots	A	B	C	D	E	F	G	H	Date	ET†
	Inches of water applied									inches
1st var. irrigation	6	6	3§	4§	6	6	6	6	June 14, 1972	3.3
2nd var. irrigation	6	6	6	6	3§	4§	6	6	June 28, 1972	4.6
3rd var. irrigation	6	6	6	6	6	6	3§	4§	July 17, 1972	3.7
Uniform irrigation	6	6	6	6	6	6	6	6	August 3,1972	
TOTAL‡	24	24	21	22	21	22	21	22		

*Pre-Irrigation: 12 inches of water—all plots, 10/29/71—Irrigation for germination: 8 inches of water—all plots, 5/07/72—Spacing on 40-inch beds.
† Evapotranspiration in inches of water obtained from two lysimeters in a grass area—fully covered.
‡ Add 8 inches water applied April 7 for germination and plant emergence for total seasonal irrigation.
§ Plots chosen randomly to undergo stress period (receiving less than the normal 6-inch irrigation).

Leaf curl in field corn caused by moisture stress at West Side Field Station.

close-planted plots earlier, these indicator plots were observed for leaf curl and firing of lower leaves to indicate moisture stress, and need for another irrigation on the remainder of the field.

Table 2 shows the sequence, amounts, and dates of the irrigation. As can be seen, the various plots differed very little in total irrigation water applied. Even so, the moisture-stress periods resulting from inadequate water did reduce grain yields. Different strip areas, 4 to 8 rows wide, were randomly selected during the growing season for deliberate under-irrigation in a single (between-irrigation) period only. Soil and environmental factors were thus integrated, and the results expressed through visual plant moisture-stress symptoms—preventing large decreases in subsequent yields from late or insufficient irrigations over the total field.

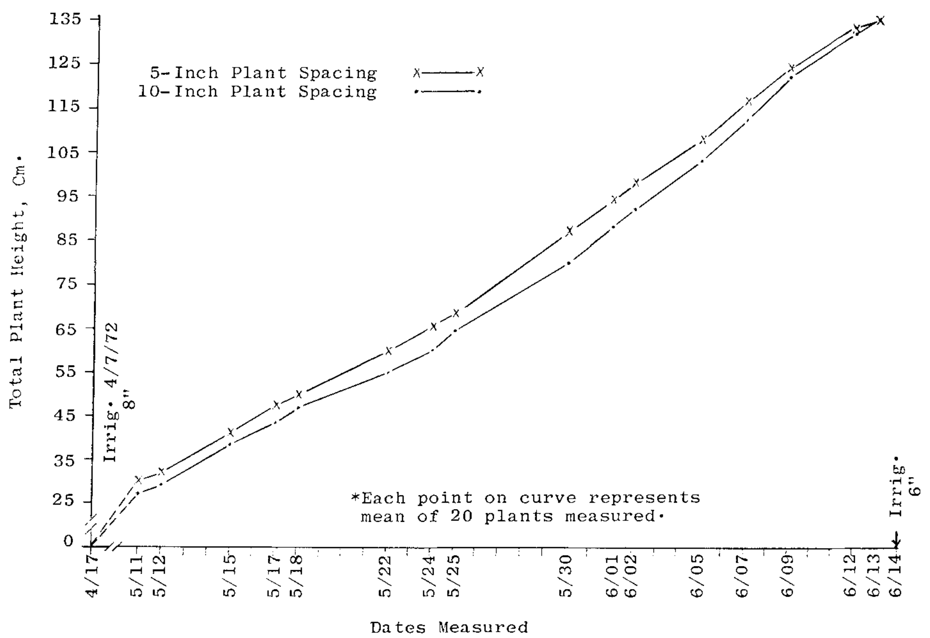
Indicator strips

Table 2 also shows that plots C and D were used as indicator strips up to the June 28 irrigation, at which time they received 6-inch irrigations and plots E and F were used as indicator strips up to the July 17 irrigation, when plots G and H were used as indicators up to the final (uniform) irrigation, on August 3. Water use by plants in nearby lysimeters during the variable irrigation periods indicated that the plants in underirrigated plots were indeed becoming water deficient while plots that received 6 inches still had some available soil-moisture reserve.

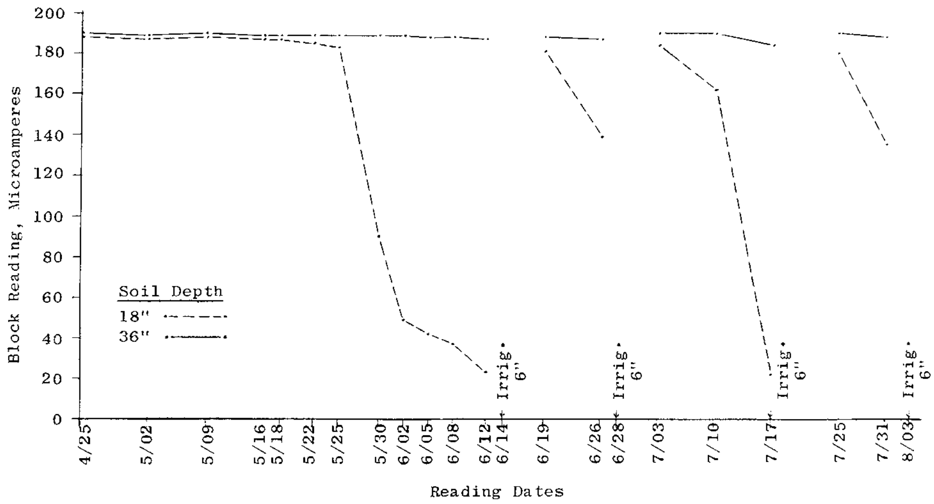
Gypsum blocks

To check on the irrigation technique from the standpoint of soil water use by plants, gypsum blocks were placed 18 and 36 inches deep within rows to measure soil moisture content indirectly during the growing season.

GRAPH. 1. PLANT HEIGHT* IN CM FOR TWO PLANT SPACINGS BETWEEN TWO IRRIGATIONS, CORN—WSFS, 1972.



GRAPH 2. AVERAGE GYPSUM BLOCK READINGS, UNIFORM IRRIGATION, 5-INCH PLANT SPACING, CORN—WSFS, 1972.



Graphs 2 and 3 compare indirect measures of water use under close and normal spacings. Graph 2 shows that in close-planted plots soil moisture began to be depleted at the 18-inch soil depth about 8 to 10 days before it was in normally spaced plots. At the time of the first variable irrigation, block readings were considered critically low (below 30 microamperes) for close-spacing but were 50 to 60 microamperes for normally spaced plots. (Graph 3 indicates that soil water at the 18-inch soil depth apparently was allowed to go a bit too low just before the third variable irrigation. This may have been caused by plant roots reaching well within the deeper soil zones and extracting water from that area, so the plants were slower to show visual symptoms of plant moisture stress.

Water use

Water use between the third variable irrigation (late July) and the final (uniform) irrigation indicated that the plants were nearing maturity and were slowing in their overall use of soil water. Visual symptoms of plant moisture stress were not very apparent before final irrigation except for the firing of lower leaves. To ensure maximum translocation of nutrients and organic compounds from plant to seed, however, one last irrigation appeared necessary in early August. With everything considered, visual plant symptoms in the stressed plots compared well with information obtained by gypsum (moisture) blocks installed within those plots and with ET measurement from nearby grass-covered lysimeters.

A study of average yield components, from the standpoint of moisture stress, showed that the number of barren stalks was increased by the second stress period and by the close planting. Other apparent yield-component effects were largely limited to a lower yield in treatments C through H when compared with treatment B, which uniformly received 6-inch irrigations. Average yields of corn grain were 132 bushels per acre from the plots under moisture stress, and 142 bushels per acre from the uniformly irrigated plots (differences significant at the 10% level). The dollar savings can be easily calculated on a large tract in which only about one-tenth of the area is used for indicator strips for determining irrigations, versus the risk of lower yields over the whole area, due to improper or late irrigation. It was also apparent in this study that the 5-inch (close) plant spacing was the better of the two spacings used under the prevailing conditions and treatments, and perhaps should be considered the normal planting rate in future tests.

Corn was selected intentionally for this experiment because it is sensitive to water stress. Unlike some other crops, vegetative growth of corn and subsequent yield are very closely tied together in that they both decrease in response to water stress. Not all crops show the same temporary visual moisture-stress symptoms which result in yield losses, and this should be taken into account when this irrigation technique is considered for use on other crops.

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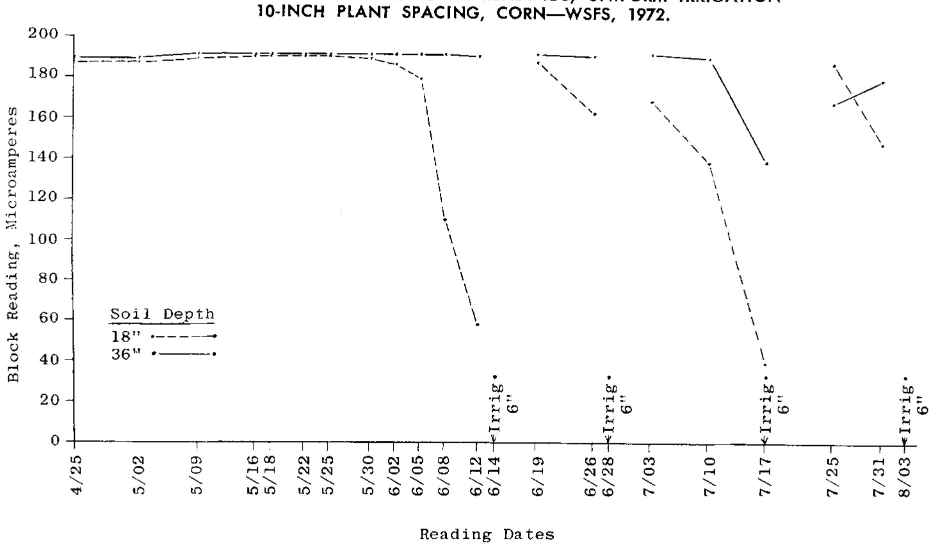
GRAPH 3. AVERAGE GYPSUM BLOCK READINGS, UNIFORM IRRIGATION 10-INCH PLANT SPACING, CORN—WSFS, 1972.



JOJOBA–

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D. M. YERMANOS · R. HOLMES

LIQUID WAX extracted from jojoba nuts has a variety of potential uses including use in the manufacture of cosmetics, pharmaceuticals, linoleums, and lubricants, and as a substitute for sperm whale oil. While the potential of this wax has never been disputed, no attempts have been made to establish commercial plantations of jojoba. This is partly because it has not been possible to predict with any degree of confidence whether the culture of jojoba would be economically profitable. While guesses can be made as to the approximate price at which the wax could sell, no information has been available about the yielding ability of jojoba under cultivation.

Growers considering such a venture will be interested in the Coit plantation of jojoba in Vista, California as a unique source of information. After serving for about 19 years as a pilot demonstration plot (as well as a testimonial to the vision and dedication of Dr. J. B. Coit to California agriculture), the land on which the Vista plantation was established is soon to be developed for non-agricultural purposes. Therefore, a summary of the information extracted from the nursery to date will provide a useful record until data from more recent experimental plantings of jojoba in other locations are available. This may also be of interest to people who have obtained jojoba nuts or cuttings from Vista.

The Vista plantation of jojoba was the second known attempt to establish such a nursery in southern California. The first one was made in 1944, at Arlington, California, on about half an acre of land on the J. G. Eddy farm