EFFECTS OF IRRIGATION ON SAFFLOWER SAN JOAQUIN

B. B. FISCHER · H. YAMAD

Highest yields of safflower were obtained when a medium pre-irrigation of 18 inches and two supplemental 8-inch crop irrigations were applied, according to the trial reported here. When approximately the same total amount of water was applied in one pre-irrigation or in a pre-irrigation and one supplemental crop irrigation, the yields were significantly lower. This study strongly suggests that maximum safflower yields (on Panoche clay loam soil) depend on readily available soil moisture in the top 4 feet of soil during bud and flowering periods.

SAFFLOWER IS widely grown on the west side of the San Joaquin Valley. Yields vary greatly from season to season and from field to field, ranging from as low as 1000 lbs per acre to as high as 3500 lbs. This great fluctuation can be minimized by providing the plants with moisture especially during the bud and flowering stages of development

This experiment was conducted on a Panoche clay loam soil at the Boston Ranch Company, Westhaven, Fresno County. The objective was to determine yield responses to varying amounts of water applied in pre-irrigation and supplemental crop irrigations.

All plots were uniformly fertilized, prior to the pre-irrigation (in mid-October) by injecting NH_3 gas into the soil to a depth of 9 inches, with a 16-inch spacing, at the rate of 100 lbs nitrogen per acre. Fifteen pounds of U.S. 10 safflower variety (per acre) were drilled in two rows on each 40-inch bed, spaced 20 inches apart on December 5, 1963. The rainfall total from planting until harvest was approximately 2.5 inches.

TABLE 1. SOIL MOISTURE MEASUREMENTS BEFORE AND AFTER PRE-IRRIGATION, AND FOLLOWING HARVEST

Soil depth	Soil moisture								
		S1		S2		S3		S4	
	Before pre-irr.	After pre-irr.	After harvest	After pre-irr.	After harvest	After pre-irr.	After harvest	After pre-irr.	After harvest
Feet	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
0–4	6.11	16.45	6.39	17.81	7.60	18.50	7.39	17.04	6.74
4–8	7.33	16.95	6.67	10.31	7.09	9.51	6.61	11.13	7.26
8–12	11.79	14.50	12.14	12.71	10.98	13.52	12.48	12.59	12.19
0–12	25.23	47.90	25.20	40.83	25.67	41.53	26.48	40.76	26.19

TABLE 2. CALCULATION OF EVAPOTRANSPIRATION FOR THE VARIOUS IRRIGATION TREATMENTS

Irrigation treatments	Total water applied	Calculated evapotranspiration	Used by E.T. of total water applied	Water leached beyond 12 ft. after pre-irr.	Water that remained in soil profile after harvest
	Inches	Inches	%	%	%
S1	30.2	22.7	75.2	24.8	...
S2	33.6	30.9	92.0	6.8	1.3
S3	25.1	22.3	88.8	6.4	5.0
S4	16.3	14.6	84.5	4.9	5.9

TABLE 3. EFFECT OF IRRIGATION ON YIELD AND BUSHEL WEIGHT OF SAFFLOWER

Treatment	Pre-irr. Oct. 63	Crop irr. Apr. 14	Crop irr. May 28	Yield lbs/A	Stat. notation*	Bushel weight	Stat. notation*
S1	30.2	...	...	2,413	b	41.1	b
S2	17.9	7.9	7.8	3,039	a	41.8	a
S3	17.9	7.2	...	2,476	b	39.0	bc
S4	16.3	...	...	1,803	c	38.2	c
				C.V. – 9.33%		C.V. – 3.31%	

* Yields and bushel weights having the same letters are not significantly different at the 1% probability level.

Test plots

Individual plots were 24 ft wide and 600 ft long, replicated five times. The amount of water applied in the pre-irrigation and crop irrigations was measured through siphon tubes for each plot. The treatments and the amounts of water applied were as follows: S1, 30.2-inch pre-irrigation; S2, 17.9-inch pre-irrigation plus 7.9 inches at bud stage (April 14) and 7.8 inches at first bloom (May 28) : S3, 17.9-inch pre-irrigation plus 7.2 inches at bud stage (April 14) ; S4, 16.3-inch pre-irrigation.

The field had been cropped and treated uniformly for the previous two years (safflower in 1962 and barley in 1963). To determine the initial moisture content of the field, eight locations were selected at random, and soil samples were taken to a depth of 12 ft in one-foot increments, prior to the pre-irrigation. The moisture percentages were then converted to inches of water in the soil by multiplying the bulk density (1.4) times inches of soil. The bulk density was determined by taking core samples from two 12-foot pits dug in the field with a back hoe.

Soil sampling before the pre-irrigation, after pre-irrigation, and again after harvest made it possible to account for all the water applied through siphon tubes on the plots (by adding the inches of water in each crop irrigation to the inches of moisture found in the soil samples). In the soil samples following the pre-irrigation, it

PRACTICES YIELD IN VALLEY

C. R. POMEROY

was found that 7.5, 2.3, 1.6 and 0.8 inches of moisture percolated beyond the depth of sampling for S1, S2, S3 and S4 treatments, respectively. The soil samples taken after harvest indicated that not all the moisture applied in the 12-foot soil profile was used (except for the S1 treatment). The S1 treatment had the same moisture content as the initial soil samples before the pre-irrigation, and S2, S3 and S4 had 0.4, 1.2 and 0.9 more inches of moisture, respectively, than the initial soil samples. Therefore, not all the moisture that was added to the soil profile was used by the safflower plants.

The evapotranspiration (E.T.), or the amount of moisture extracted from the various depths, is summarized in tables 1 and 2. The percentage of E.T. of the total water applied was highest for the S2 treatment. The amounts of moisture extracted from the top 4 ft of soil (see table 2), in treatments S2 and S3 indicate that the bulk of the roots were in that zone. Treatment S2 suggests that to obtain maximum yields, adequate moisture needs to be available in the top 4 ft of soil during the reproductive stages of the safflower development.

To follow the depth-of-wetting and extraction patterns by the safflower roots, electrical resistance gypsum blocks were installed on March 11. The blocks were set at 2-, 4-, 6-, 8-, 10-, and 12-foot depths at ⅓ the distance from each end of each plot in three of the five replications. Readings were taken at weekly intervals during the growing season and the block readings were averaged for each treatment. The 2- and 4-, 6- and 8-, and 10- and 12-foot depths were averaged and plotted on graphs 1, 2, 3, and 4. The higher the reading, the more moisture that was available to the plants.

The highest yield was obtained in treatment S2, where two crop irrigations were applied. The lowest yield was harvested in treatment S4, where only a 16″ pre-irrigation was applied (tables 1 and 3). Yields were obtained by harvesting a 14-ft swath through the full length of each plot in the five replications. The grain was transferred from the combine into a portable scale for weighing, and subsamples were obtained for bushel weight determinations. Yields in treatments S1 and S3 did not significantly differ and their consumptive use of water was approximately the same. Bushel weight was significantly higher in treatment S2.

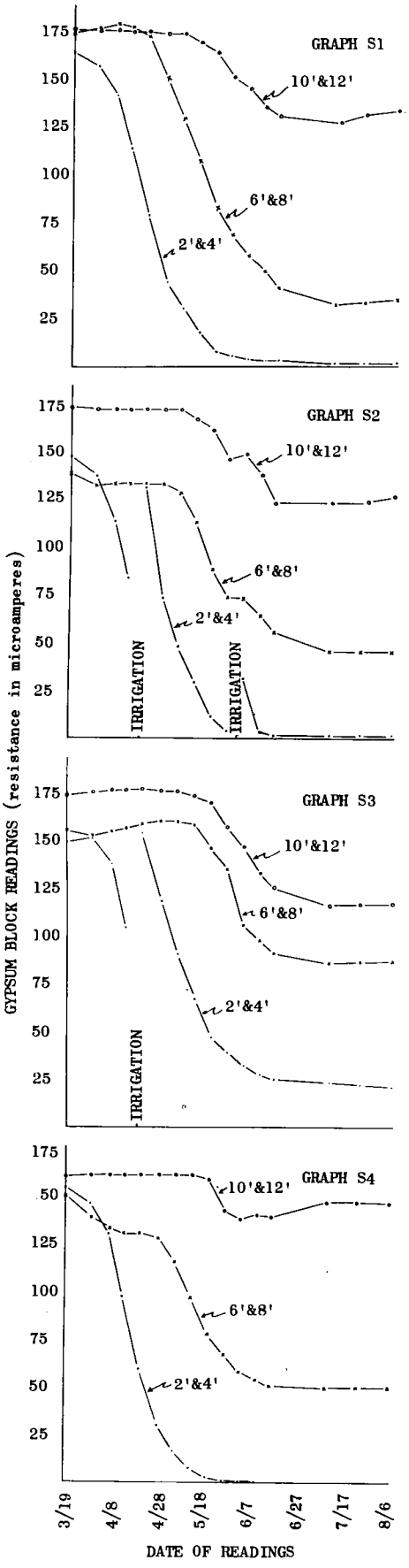
Deep rooted

Safflower is a deeply rooted crop and will extract moisture from as deep as 12 ft as shown in this study; for maximum yields (in most areas of the San Joaquin Valley), supplemental crop irrigations are essential.

Many growers have been reluctant to irrigate safflower because of fear of root rot. Recent studies indicate that, with presently available varieties, root rot injury can be minimized by growing the plants on raised beds and irrigating before any drought symptoms appear. In other words, irrigation is necessary before plants show visible stress. No root rot was observed in any of the treatments reported in this study.

B. B. Fischer is Farm Advisor, Fresno County; H. Yamada is Laboratory Technician IV, University of California West Side Field Station, Five Points; and C. R. Pomeroy was Irrigation Specialist and Superintendent, West Side Field Station, (now with Rockefeller Foundation in India). Don A. Patterson and Jim Fisher of Boston Ranch, Westhaven, assisted in conducting this experiment.

AVERAGE GYPSUM BLOCK READINGS FOR S1, S2, S3, AND S4 TREATMENTS, SAFFLOWER IRRIGATION TRIAL, FRESNO COUNTY



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141