Leaves showing boron toxicity symptoms in soybean varieties: Clark, left, Chippewa, center, and Wayne, right.

Effects of Irrigation CHEMICAL *In the*

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TABLE 1. CHEMICAL ANALYSES OF SOYBEAN LEAVES* FROM DIFFERENT LOCATIONS ON PLANTS SAMPLED JULY, 1966
(I_2 irrigation treatment)

Variety	Leaf location on plant	B	Na	Cl	K	P
		ppm	%	%	%	%
			West Side Field Station			
Chippewa	Upper	175	0.11	0.21	1.96	0.26
	Lower	262	0.04	0.58	1.18	0.18
Clark	Upper	129	0.10	0.36	2.20	0.26
	Lower	325	0.03	0.63	1.18	0.18
Wayne	Upper	125	0.14	0.18	2.15	0.26
	Lower	300	0.07	0.31	0.88	0.18
			Corcoran, California			
Chippewa	Upper	72	0.14	0.01	0.92	0.21
Clark	Upper	75	0.05	0.04	1.70	0.22

* 20 leaves per plot.

THE RECENT CUTBACKS in acreage allotments in the San Joaquin Valley have caused cotton ranchers with interests in oil-processing facilities to recognize the need for a supplemental oil crop, such as soybeans, to allow continued use of the facilities at or near capacity. Projected population increases in many parts of the world also indicate that a protein crop such as soybean could have increasing importance in meeting future food needs.

Review of early tests

Results of earlier tests at Davis, where seed was sown in a mulch in pre-irrigated plots, showed that, whereas 10 irrigations increased lodging but not yield, four irrigations did not have these effects. There were indications, however, that two properly spaced irrigations following pre-irrigation may produce reasonably good yields.

Tests were also conducted at Brawley, based on the number and timing of irrigations, with special attention to the timing of the final irrigation. Results there indicated that, while nine to 10 irrigations gave the highest yields at this location, an irrigation after the lower leaves began turning yellow (when the plants were approaching maturity), did not increase yield. These tests also indicated that, whereas excessive irrigation should be avoided during the flowering period, severe moisture stress at that time would decrease yield.

Saline sensitivity

Because soybeans appear to be sensitive to saline conditions, tests were also initiated at Brawley to study the salt tolerance of the plants. It was found that some soybean varieties were more tolerant of salt than others. Chemical analysis of plant parts from many soybean varieties showed that all plant *roots* contained about the same chloride concentration, but the *stems* and *leaves* of salt-tolerant varieties had much lower chloride concentrations than varieties susceptible to salt damage. Soybean varieties were found to be salt-tolerant either in the germination stage, in the later growth stage, or in both. Indications are that separate mechanisms may control tolerance or susceptibility during each stage.

Current test objectives

Investigations were begun in 1966 at the West Side Field Station with the following objectives: (1) to determine the yield responses of three soybean varieties to three levels of irrigation, and (2) to study the effects of the irrigation treatments on the oil and protein content of the soybeans.

Seed of three soybean varieties, Chippewa, Clark, and Wayne, were inoculated and planted in pre-irrigated beds on May 26, 1966. Three different irrigation treatments (I_1, I_2, and I_3) were set up and readings were obtained from gypsum blocks located at the 18-inch soil depth. Block readings corresponded to an estimated 2.2, 2.5, and 3.0 inches of total moisture per foot of soil at that depth at the start of irrigation treatments I_1, I_2,

Management on

COMPOSITION OF SOYBEANS

the San Joaquin Valley

Clark soybean variety, left, and Wayne variety, right, in test plots during study of irrigation management in San Joaquin Valley.

and I_3, respectively. The total moisture content of the soil at field capacity and at the permanent wilting point at this depth was calculated to be 4.0 and 2.0 inches, respectively, Gypsum blocks were also installed at the 36-inch soil depth in order to determine deeper soil moisture changes during the growing season.

Moisture blocks

Moisture block readings indicated that the Clark variety required more moisture than either of the other two soybean varieties. The Clark soybeans also grew considerably taller and had a larger leaf area than the other varieties. All varieties reduced the soil moisture content at the 36-inch depth to a lower level under irrigation I_1 than they did under irrigations I_2 and I_3. Total inches of water applied in the 12-inch preplanting irrigation and subsequent irrigation treatments were: I_1 = 17, I_2 = 27, and I_3 = 34 inches. Treatment I_1 consisted of one 5-inch irrigation; I_2, three irrigations of 5, 4, and 6 inches; and I_3, five irrigations of 5, 3, 5, 4, and 5 inches, following the pre-planting irrigation.

Soybean yields (adjusted to 13% moisture) obtained from the irrigation treatments are shown in graph 3. The Wayne variety appeared to be more responsive than Chippewa or Clark to the selected irrigation treatments in this study. Good quality soybeans were obtained from all varieties with irrigation treatments I_2 and I_3. Under irrigation treatment I_1 the beans were shriveled and small.

Graphs 4 and 5 show the relationships between the irrigation treatments and pounds of protein and oil produced per acre for the three soybean varieties. The Wayne variety produced considerably more protein and oil per acre than the other two varieties at the two higher irrigation levels.

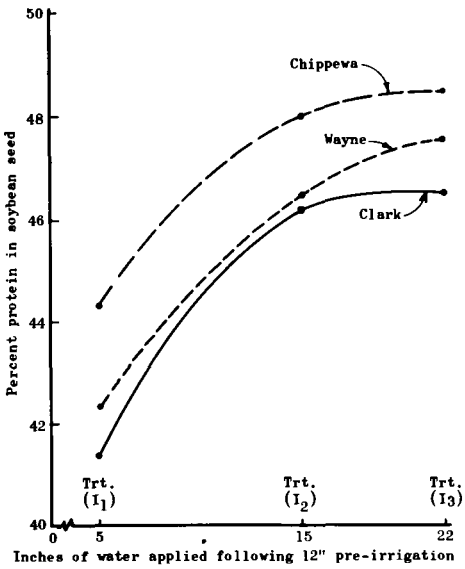
Relationships between the irrigation treatments and percentage of protein and oil are shown in graphs 1 and 2 for the three soybean varieties. Although seed yield of the Chippewa variety was generally lower than Wayne and Clark, it was somewhat higher in percentage of protein at all irrigation levels. The percentage of oil was considerably lower for Clark than for Chippewa and Wayne at the more frequent irrigation levels. Earlier reports have shown an inverse relationship between the oil and protein percentage in soybean seeds. Now it appears that irrigation practices may influence this relationship.

Boron

Yields were apparently limited in this area by the moderately high amount of boron in the irrigation water and soil. Previous work at the West Side Field Station (WSFS) indicated that leaching reduces the concentration of this element in the soil, at least temporarily. However, under conditions of this test, there was considerable damage to the lower (older) leaves due to boron accumulation by the plants. Table 1 shows the chemical composition of soybean leaves from the upper and lower part of the plants sampled at the WSFS in July, 1966. Chemical analy-

ses of leaf samples showed that the boron (B) content ranged from 125 to 325 ppm. Previous research suggests that these concentrations may be expected to reduce yields by as much as 25%. Marked differences were observed in the boron as well as chlorine (Cl) content of the leaves at the WSFS when compared with those sampled at the Corcoran location. Yields at Corcoran for the varieties Chippewa and Clark were 7 to 8 bushels per acre higher than at the WSFS. The difference in plant concentrations of boron and perhaps chloride at the two locations may have been a big factor in the yield differences obtained. Sodium (Na), potassium (K), and phosphorus (P) contents of the leaves appeared to be at tolerable or satisfactory levels in the leaves analyzed, except for the potassium content of Chippewa from Corcoran, which appeared to be low and was approaching a deficiency level.

GRAPH 1



Relationships of irrigation treatments with three soybean varieties on percentage of protein in soybean seed, graph above, and percentage of oil in soybean seed, below.

GRAPH 2

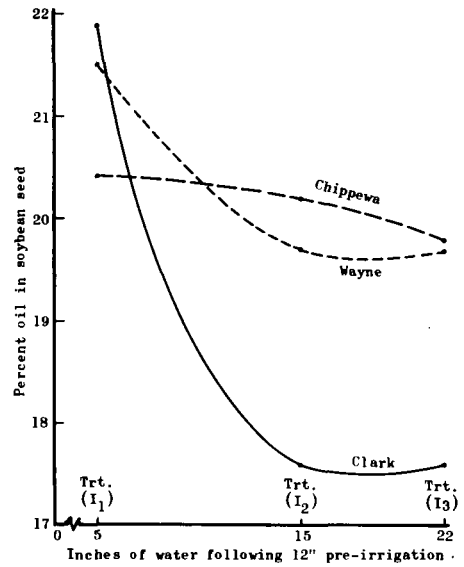


TABLE 2. SOIL AND WATER ANALYSES FROM SOYBEAN EXPERIMENT AT THE WEST SIDE FIELD STATION IN 1966
Soil (1:1 extract)

Soil depth	B	Na	Cl	ECxIO^{-3}
	ppm	m.e./l	m.e./l	
0 to 1 ft	1.1	5.8	1.2	0.86
1 to 2 ft	1.5	5.1	1.2	0.75
2 to 3 ft	1.4	5.8	1.6	0.81
		Irrigation water		ECxIO^{-6}
	1.4	8.3	3.3	1250

Gross value

The relationship between gross value per acre and irrigation treatments was similar to that found between yield and irrigation shown in graph 1. With the higher levels of irrigation, the value from the increase in percentage of protein was more than enough to offset the decrease in percentage of oil, and accounted for more of the average gross value per acre. However, considering the cost of well water at this location, the I_2 irrigation treatment was the most profitable of the three treatments used in this study.

A wider range of irrigation treatments and fewer soybean varieties are being tested in the 1967 study. Varietal plot size has been increased to facilitate harvesting with larger equipment. Plant leaf samples are being collected during the growing season for chemical analyses, especially for boron and chlorine content.

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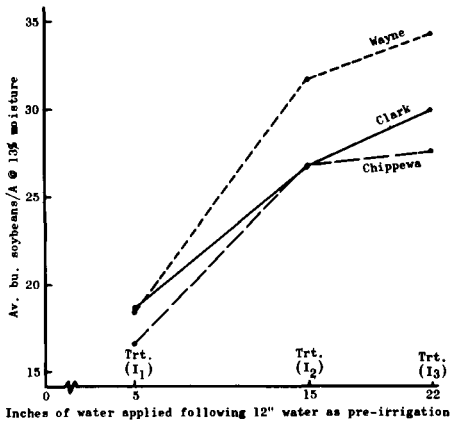
Annual reports on irrigation studies with soybeans—submitted over the past 10 to 12 years by R. T. Edwards, O. P. Gautam, and P. F. Knowles, U. C., Davis—were utilized in the preparation and conduct of these investigations.

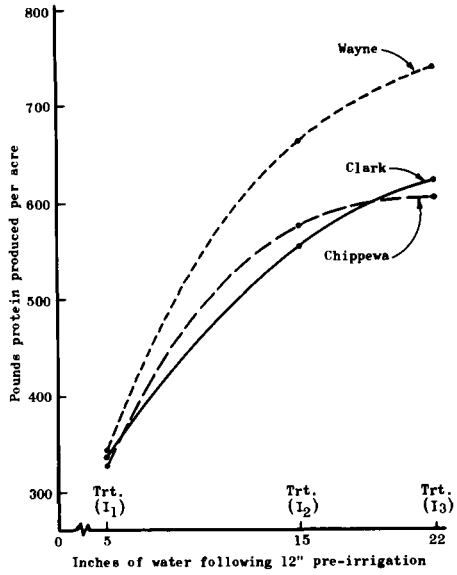
GRAPH 3

RELATIONSHIP BETWEEN SOYBEAN YIELDS AND IRRIGATION TREATMENTS
(Average of six replications)



GRAPH 4

RELATIONSHIP BETWEEN PROTEIN PER ACRE AND IRRIGATION TREATMENTS
(Average of six replications)



GRAPH 5

RELATIONSHIP BETWEEN OIL PER ACRE AND IRRIGATION TREATMENTS
(Average of six replications)