Irrigation Tests with Oranges

effects of various irrigation practices on growth and production of citrus trees subject of studies

M. R. Huberty and S. J. Richards

Improper irrigation can reduce navel orange yields by 30% to 40%—under conditions where tree growth and vigor are only slightly influenced—according to results obtained in a long-term experiment at Riverside.

Irrigation requirements and methods vary throughout the citrus-growing sections; so results of experimental work carried on at one location may not be applicable to another. Nevertheless, it is desirable to know the effects of various irrigation practices on growth and production of citrus trees.

A Washington navel orange grove of approximately 10 acres, planted in June, 1930, has been under various irrigation treatments since 1934. Half of the trees are on sour and half on sweet rootstocks. The soil is a Ramona sandy loam having a slightly consolidated subsoil. Both winter and summer cover crops were grown during the first three years, and then only winter crops until 1948. Summer weeds were controlled by cultivation, usually disked. Under this practice, a marked cultivation pan developed. Since 1948, the grove has been under nontillage, with oil spray for weed control. The normal traffic in the grove has compacted the surface soil, but in the furrows nearest the trees where this compaction has not occurred, infiltration of irrigation water is good.

Furrow irrigation has been practiced with some variation in the number of furrows used. The furrows are 200′ long and are on an average grade of about 2%. Irrigation water is from the Santa Ana River and ground water basin, and is of good quality, with less than 600 ppm—parts per million—of dissolved salts. While the local growers have irrigation water supplied only at scheduled intervals, water storage facilities on the Citrus Experiment Station made it possible, with few exceptions, to have water available on demand for the irrigation of plots.

Throughout the life of the orchard, the amounts of fertilizer applied have been relatively low. Organic matter was applied whenever it was available.

In the early years of the experiment, the treatments were designed to study the effect of timing the irrigation applications and, with another series of plots, to measure the effect of irrigating so as to wet different amounts of the soil occupied by the root systems.

The table in this column gives the results of a series of treatments based on average yields from selected tree rows over a ten-year period.

The first two treatments show the effects of the frequency of irrigation. The plots receiving frequent irrigation applications—an average of 6.5—were irrigated when the surface foot of soil had reached the wilting percentage as based on periodic soil moisture samplings. The guide for timing the infrequent applications was not always the same but, in general, it was based on soil moisture and some measure of tree response such as fruit size or leaf water deficit. As a soil moisture guide, the soil was allowed to reach the wilting percentage to a depth of three feet.

The timing of irrigations for the treatments labeled 40% and 80% was also determined when the surface foot of soil reached the wilting percentage. An attempt was made to wet 40% and 80% of the root zone of the trees. This was accomplished by increasing the number of furrows and running the water longer in the center furrows for the 80% treatment.

It was evident that the most efficient use of water was made when the water was confined to the smaller volume of soil.

As between the plots said to be frequently irrigated—average 6.5 irrigations—and the infrequently irrigated plots—3.3 irrigations—the difference in yield was highly significant. The reduction in yield was relatively large compared with the other tree growth measurements.

Under the conditions of this experiment, relatively large water applications in the 80% treatment did not result in increased production. A study of the root distribution made in 1951 showed that only about 15% of the feeder roots were below a depth of 30″, and less than 4% of the roots were found below 42″. Rate of soil moisture absorption, as measured by soil sampling, showed a higher percentage of roots in the lower depths in 1940 than those reported above. This indicates that water moving beyond a depth of three feet is largely wasted.

Had these experimental plots been located in an area where soil salinity is a problem—or where the irrigation water was high in soluble material—it is very likely that on plots where water

Concluded on page 15

Average Production for All the Plots of Test Field S-3.

Year	Yield—lbs./tree	Oranges/tree
1948	154	604
1949	260	530
1950	137	302
1951	166	492
1952	212	679
1953	238	586

Average Yields of Selected Rows and Water Used Over a 10-year Period.

Treatment	Yield lbs./tree	Average Irrigation Season: Surface inches	Average Irrigation Season: Irrigations No.
frequent	221	34.7	6.5
infrequent	182	27.4	3.3
40%	219	20.5	6.7
80%	198	29.5	5.3

Effects of Irrigation Interval on Yields for Navel Oranges.

The plot yields are given as per cent of the yearly average for an entire 10-acre block.

Year	Rootstock	Plot 2	Plot 7	Plot 3	Plot 6
		6-week irrigation		3-week irrigation	
1948	sweet	63%	71%	100%	105%
	sour	69	80	107	104
1949	sweet	93	98	106	110
	sour	91	93	103	109
1950	sweet	66	61	94	128
	sour	65	87	112	159
		3-week irrigation		6-week irrigation	
1951	sweet	99	121	53	85
	sour	98	113	74	106
1952	swt.	109	145	67	71
	sour	95	113	76	76
		6-week irrigation		3-week irrigation	
1953	swt.	108	131	108	124
	sour	100	122	112	120

ORANGES

Continued from page 8

was added in excess of the amount used by the trees, the trees would have shown a favorable response. Under such conditions, the excess water would remove undesirable salts which would otherwise accumulate in the root zone.

There is no significant difference between yield of sweet and of sour rootstock in the long-run experiment, even though significant differences did appear in the early analysis. This is due to the superiority of trees on sweet rootstock in the early years, with trees on sour rootstock being the better yielders in later years.

Many growers have irrigation water supplied at scheduled intervals only. In recognition of this, the plots which were under the frequent treatment were later watered on a three-week schedule, and the plots which were infrequent were changed to a six-week irrigation interval. More water was added per irrigation on the six-week plots so that the seasonal total did not differ by more than 25%.

The calendar schedule for these plots was maintained for three years—1948 to 1950. During this period, the yields were greater for the plots on the three-week schedule. In order to have a better comparison of the relative effects of irrigation during the 1951 and 1952 seasons, the irrigation schedules were reversed, and in 1953, the treatments were reversed to those of the 1948–1950 period.

It is generally recognized that irrigation is only one of the factors influencing crop production. The table in column one on page 8 gives the average production for the entire 10-acre block, including all of the irrigation treatments and both sweet and sour stocks.

During the crop years 1948 to 1950, there were no planned changes in any of the irrigation treatments or grove management practices, yet these years included the greatest variation in crop production.

To show the relative effects of changing the irrigation practices, the plot yields resulting from the various irrigation practices are given in the table in column three on page 8. Plots No. 2 and No. 7 had a history of 16 years where infrequent irrigation schedules resulted in a considerably lower yield, yet the trees responded and produced up to the grove average on the first year that the irrigation schedules were reversed. For the years 1949 and 1953, some factor other than interval of irrigation—possibly climatic conditions—was such that 3- and 6-week irrigation intervals did not result in significant yield differences.

In addition to yield records, trunk-size measurements were made annually as an index to tree growth. In 1950, the records show that after 15 years of differential treatments, the average cross-sectional areas of the trees on plots No. 3 and No. 6—frequently irrigated—were only 9% larger than for plots No. 2 and No. 7—infrequently irrigated. This difference in size did not limit the yield of the trees of plots No. 2 and No. 7, since their production was greater for 1951 and 1952 when the irrigation treatments were reversed.

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Gifts to the University of California for research by the Division of Agricultural Sciences accepted in August, 1954

BERKELEY

American Cyanamid Co. ....3 15# drums 2% exp. insecticide
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California Cedar Products Co. ....Copper pressure vessel
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Chemagro Corporation ....1 gal. Meta-Systox spray concentrate
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Dewey and Almy Chemical Company.......Cry-O-Vac Aluminum Clips standard size—10#—4,000
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National Canners Association $500.00
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National Science Foundation $2,300.00
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Pacific Molasses Co...3 drums 10% protein-equivalent "Promol" molasses
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Shell Chemical Corporation $1,200.00
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Stockton Tallow Works Co. ....1200# stabilized tallow
For nutritional experiments with swine

Sugar Research Foundation, Inc. $2,500.00
For research on effect of various types of sugars on canned cling peaches (1st quarterly payment)

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LOS ANGELES

Brea Chemicals, Inc. ....100# ammonium sulfate
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Concluded on next page