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...
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 root-cumulate in the root zone. Though significant differences did appear in the early years, with trees on sour root-stocks 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 groove 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—frequented—were only 9% larger than for plots No. 2 and No. 7—infrrequently 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.

M. R. Huberty is Professor of Irrigation, University of California, Los Angeles.

S. I. Richards is Associate Irrigation Engineer, University of California, Riverside.

The above progress report is based on Research Project No. 904-D.

**DONATIONS FOR AGRICULTURAL RESEARCH**

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

**BERKELEY**

American Cyanamid Co. .......... 3 15 lbs. drums 2% exp. insecticide
For tomato insect investigations

California Cedar Products Co. .......... Copper pressure vessel
For research in wood chemistry

Chemagro Corporation .......... 1 gal. Metasystox spray concentrate
For melon insect investigations

Dow Chemical Company .......... 100# Ovotran wettable
For melon insect investigations

Mrs. Alice Eurich .......... Surgical instruments
For poultry husbandry research

**DAVIS**

Agriform Co., Inc. .......... 5 gal. sulfuric acid
For Field Station experiments

A. M. Andrews Co. .......... 25 ft. 6 inch supported vinyl sheet tubing
For studies to determine flow characteristics of tubing

Bakelite Co. ........... 80 yd. polyethylene film
For studies with canal linings

California Beet Processors .......... $3,000.00
For studies with canal linings

California Committee on Relation of Electricity to Agriculture .......... $4,125.00
For investigations of electrical applications to agriculture

California Tree Fruit Agreement .......... $1,250.00
For experimental packing of peaches for taste tests

Calphor Corporation .......... Plastic Home Watering System, 100' unit
For experimental use of poultry watering system in cage houses

Canners League of California .......... $1,500.00
For continuation of tomato breeding work

Citrus Industry Research Association .......... $750.00
For field expenses in connection with bulk-handling studies involving citrus fruits

Dewey and Almy Chemical Company .......... Cry-O-Vac Aluminum Clips
For experimental packaging of poultry products

Dow Chemical Company .......... 1 gal. Kronen weed killer
For Field Station experiments

E. I. du Pont de Nemours Co. .......... 6% gals. Quilon
For experiments of seepage loss in irrigation canals

Gulf State Asphalt Co. .......... 37 sheets asphalt canal lining;
100# hot asphalt; 15 gal. adhesive
For studies on canal linings

Ipsen Manufacturing & Supply Co. .......... 200 12" cages
For experimental poultry housing

Kalmback-Burckett Company, Inc. .......... 120# soybean seed
For Field Station experiments

National Canners Association .......... $500.00
For experimental packing of peaches for taste tests

National Science Foundation .......... $2,300.00
For cyto genetic studies in the genus Lycopersicon

Pacific Molasses Co. .......... 3 drums 10% protein-equivalent "Promol" molasses
For application to oat hay to test palatability for sheep

Shell Chemical Corporation .......... $1,200.00
For taste evaluation of crops grown with insecticides

Stockton Tallow Works Co. .......... 120# stabilized tallow
For experimental 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)

U. S. Public Health Service .......... $3,611.79
For detection and identification of diseases of the virus of vesicular disease viruses

The Upjohn Company .......... $400.00
For field and laboratory studies of mastitis ointments and related studies in mastitis

Western Condensing Co. .......... $1,200.00
For research on use of soybean products in animal feeds

**LOS ANGELES**

Brea Chemicals, Inc. .......... 100# ammonium sulfate
For turfgrass culture research

Calavo Growers of California .......... 1,000 Nabal avocado seeds
For subtropical horticulture research

California Planting Cotton Seed Distributors .......... $10,000.00
For defoliation research in cotton

Geigy Agricultural Chemicals .......... 48% DDT wettable powder
For entomological experiments in avocado grove

Wilson & George Meyer & Co. .......... 100# Hi-Fress peat moss
For turfgrass culture research

Concluded on next page