Citrus Rejuvenation Studies

three basic soil treatments used in orchard investigations to determine best conditions for root growth and development

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Declining root systems comprise one of the most serious problems in southern California in citrus production and fruit size. Therefore, a station-wide citrus rejuvenation project was initiated in 1953.

Seven orchards in southern California that were declining in production were selected for detailed studies. Three basic treatments—irrigation, soil fumigation, and wood shaving mulch—were started for the purpose of providing more optimum conditions for root growth and development. The treatments were:

A. Sprinkler irrigation, fumigation—with nematocide, D-D, at the rate of approximately 70–120 gallons per acre, depending on soil conditions—and mulch.

B. Furrow irrigation, fumigation as in treatment *A.*

C. Sprinkler irrigation.

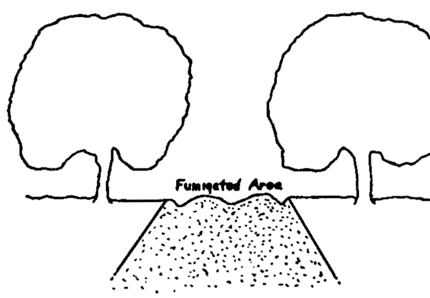
D. Sprinkler irrigation, mulch.

E. Sprinkler irrigation, fumigation as in *A* and *B.*

BX. Furrow irrigation, one middle chiseled 12″ deep.

X. Growers' current practice.

The harvest data obtained from four navel orange orchards in the spring of 1955 were the first obtained from fruits set and developed under the influence of the soil treatments. Since the treatments were installed—at various times from May 1953 until April 1954—some changes in tree health, production, fruit size, and fruit quality have been detected which are believed to be the result of the treatments.



A schematic diagram of the soil and root area affected by fumigation.

Orchards irrigated by furrows were selected to compare the effects of sprinkler irrigation and to facilitate the use of mulch. A portable, low—8″ above ground—type of sprinkler was used except in one orchard where there was a permanent overhead system. The portable sprinklers were placed so that practically the entire area of soil between the trees was irrigated and the skirts of the trees were wet to a height of about 3′.

Approximately equal amounts of water were used for sprinkler and furrow irrigation. The schedule for each system has remained the same, so the only practical difference was the much larger area of soil and larger volume of roots irrigated with sprinklers.

The sprinkler system appears to have increased fruit production. The over-all average field box yield of trees irrigated with sprinklers was 5.24 field boxes per tree compared with 4.10 boxes per tree from furrow irrigated trees.

Although the differences in average fruit diameter failed to be significant in two orchards, sprinkler irrigation appeared to have increased fruit size also.

A 20 fruit sample was collected from each of the plots for quality determinations. The fruits were carefully selected for size, using only those which fit snugly in a 220 packing size ring. In all orchards there was a strong tendency for the soluble solids content to be higher in the fruit from furrow irrigated trees—12.1%—than in fruit from trees irrigated with sprinklers—11.4%—but the differences were statistically significant only in the orchard at Highland.

The total acid content of fruit samples—size 220—followed a trend very similar to that of the soluble solids content, in that furrow irrigated trees produced fruits slightly higher in total acid than did the sprinkler irrigated trees, but in no instance was the difference in total acid large enough to be statistically significant.

Apparently the amount of water readily available to the tree had a direct influence on the production and size of the navel oranges. The trend toward higher soluble solids content and smaller average diameter of fruits from the furrow irrigated plots seems to indicate that the

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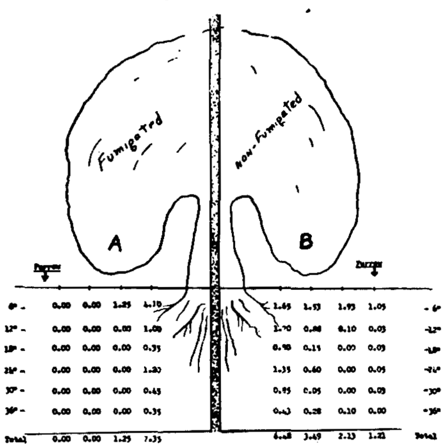
The root system of citrus showing the condition in one orchard under trees in fumigated A and nonfumigated B treatments. The data presented is the average amount of feeder roots, in grams fresh weight, extracted from a cylinder of soil 4″ in diameter and 6″ deep, at the location and depths indicated.



Effect of Citrus Grove Rejuvenation Treatments on Production of Navel Oranges. Production expressed as field boxes. Yields obtained January to April, 1955.

Location	Sprinkler irrigation: Soil fumigation: Mulch A	Sprinkler irrigation: Soil fumigation: No mulch E	Sprinkler irrigation: No soil fumigation: Mulch D	Sprinkler irrigation: No soil fumigation: No mulch C	Furrow irrigation: Soil fumigation: Chiseled B	Furrow irrigation: No soil fumigation: Chiseled BX	Furrow irrigation: No soil fumigation: Not chiseled X	L.S.D.* 5%	L.S.D.* 1%
Redlands	5.2	5.5	6.6	6.8	5.0	6.8	4.4	1.4	1.9
Claremont	6.1	6.8	7.1	6.1	3.1	4.5	..	1.5	2.0
Highland	6.1	6.9	7.2	6.6	4.5	6.1	6.2	1.3	1.7
Riverside**	1.9	1.8	2.3	2.2	1.2	1.9	..	0.39	0.51
Average	4.8	5.2	5.8	5.4	3.4	4.8	..	0.78	1.08

Comparison of average yield (all orchards combined)

	Field boxes		Field boxes	L.S.D. 5%
1. Sprinkler irrigation	5.24	Furrow irrigation	4.10	0.9
2. Mulch	5.30	No mulch	5.30	n.s.
3. Soil fumigation	4.47	No soil fumigation	5.33	0.8

* Least significant difference.

** Very low yield owing to freeze injury and heavy black scale prior to treatment installation.

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difference in fruit size was principally a difference in water content of the fruit. However, the percentage juice content of the fruit does not substantiate this suggestion, as there was no detectable difference in juice content.

There are indications that more frequent—and possibly smaller—irrigations might be beneficial in some of the orchards. The greatest reduction in production and fruit size and the greatest increase in soluble solids of fruits from furrow irrigated trees were in the two orchards which had the largest fluctuations in moisture between irrigations. The majority of the tensiometers in these two orchards exceeded the maximum reliable reading—750 centimeters of water—preceding each irrigation in 1954, whereas the tensiometer readings of the other orchards seldom reached the 750 centimeter limit between irrigations. The loss from split fruit was much more severe in the orchards which were dry before each irrigation, and the number of split fruits was approximately 25% higher in the furrow irrigated portion of these orchards than in the sprinkler irrigated portion.

There was visual evidence that the vegetative condition of orange trees in at least three of the orchards was improved by sprinkler irrigation. The sprinkled trees produced a more vigorous spring flush than those irrigated with furrows and in at least one of the orchards there was a marked difference in type of bloom. The furrow irrigated trees produced a very profuse bloom, most of which was borne on very short spring growth, often with no new leaves adjacent to the fruit; whereas the bloom on the sprinkled trees was sparse—predominantly a single terminal blossom on a 4″–6″ leafy shoot. The average diameter of fruit was larger and production averaged at least one field box per tree higher in these sprinkled plots than in the furrow irrigated plots.

Fumigation of the soil on one side of established orange and lemon trees with 70 to 120 pounds of the nematocide DD per acre was expected to reduce production temporarily even though the fumigant was applied at least 5′ from the tree trunk. A few months after fumigation, soil auger samples showed that roots in the middles—between tree rows—1″ or more in diameter, were black and decaying. Nematode counts showed that the fumigation had effectively reduced the population of the citrus nematode in the fumigated area. One year after fumigation, a small amount of root regrowth—about 6″–8″—into the fumigated soil had occurred.

The first year's records show that the fumigated trees were affected sufficiently to reduce the average production by 0.9 of a field box, as compared to nonfumigated trees. This difference in production was statistically significant. After the first year the fruit from fumigated trees tended in most plots to be smaller than fruit from nonfumigated trees but these differences were not significant.

Some of the trees in the fumigated plots appeared to have a less dense canopy of foliage one year after fumigation than other nonfumigated trees; yet this difference was not consistent in all plots.

The use of sprinkler irrigation in conjunction with soil fumigation appeared to reduce the injurious effects of the fumigation. This would appear to emphasize the importance of applying irrigation water in such a manner as to make use of as many roots as possible in order to obtain the maximum production from the trees.

The physical and biological soil properties associated with a wood shaving mulch may have a considerable influence on the trees by providing a better environment and, as a result, a better root system. Not only may the mulch be promoting a condition that favors the growth of beneficial organisms but it may also be producing healthier roots which can better compete with pathogenic organisms. However, the mulch as yet has produced no detectable effect on production or general condition of the aboveground portion of the trees.

In July 1955, new root growth was observed extending—several inches in some cases—up into the lowest layers of mulch. Most new root growth was at the inside edge or bottom of the furrow nearest the tree.

If the declining condition of the orchards is due to poor roots, it is probably too early to expect differences in the aboveground portions of the trees until they have had an opportunity to improve their root systems.

The results reported here are only preliminary and do not suggest any changes in orchard practices.

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Lewis H. Stolzy, Assistant Irrigation Engineer, University of California, Riverside, cooperated in the irrigation studies.

The application of the soil fumigant and evaluation of citrus nematode control were made by R. C. Baines, Plant Nematologist, University of California, Riverside.

DRIFT

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other 20% of the days with this short time reversal, the calms preceding the wind shift were shorter than one hour and did not show up in the compilation of hourly directions, but a conspicuous low velocity slowdown at sunrise was registered.

The pattern of a weak air flow from the north in the early morning on about 60% of all days—and with velocities never exceeding 4mph—can be put to good use by aircraft operators. Because the occurrence of a north wind following the early lull is so frequent, aircraft spraying should begin on the south border of a field with the pilot working north into the developing wind. If susceptible crops are located on the north border of the field being sprayed, the pilot should stop the northward passes over the field shortly before the northerly air flow will be overcome by the dominant southerly flow. According to observations made in the summer of 1954, the temporary north winds last as follows: about 90% until 10 a.m., PST, and about 80% until 11 a.m. Only about 50% of them last till noon. The rest of the summer days when this phenomenon did not occur, about 35% of the winds were southerly and 5% northerly throughout a 24-hour period.

Data obtained during one summer period must be considered preliminary. However, spot climate stations were operated again during the 1955 season near Grimes and at other places in the rice area, and further information will be gathered in 1956. A three-year period will permit more reliable conclusions.

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Personnel of Agricultural Engineering made the studies and recommendations of aircraft spray equipment and also developed the continuous wind direction and velocity attachments for the spot climate recorder.