Declining Yields in Oranges

appraisal of 220 mature orange orchards in five counties indicates possible causes of downward trend in production

Paul W. Moore and Edward Nauer

Average production of southern California oranges dropped from 370 to 265 field boxes per acre—for navels—and from 290 to 265 field boxes per acre—for Valencias—over a 12-year period. Many individual orchards in Los Angeles, San Bernardino, and Orange counties—the three areas most seriously affected—showed a production decline of as much as 100 to 250 field boxes per acre during the same period.

In order to determine the causes of declining yields, a detailed survey was made of 186 orchards—both Valencia and navel—in Los Angeles, San Bernardino, Orange, and Ventura counties. In addition, 34 orchards in Tulare County in Central California—an area heretofore unaffected by declining yields—were studied. Representative orchards—poor, average, and good—were selected from all the citrus areas of each county and on all the major soil types. Orchards affected with tristeza—quick decline—were not included. A total of 157,290 trees on 1,743 acres—in the southern California counties—and of 36,255 trees on 362 acres—in Tulare County—were examined. The average age of the orchards was approximately 40 years.

Each tree—as an individual producing unit—was examined for any condition that might impair its capacity to bear. The condition was then recorded on an appraisal map. The completed map contained sufficient detailed information to make it possible to determine the bearing capacity of the orchard, as based on the number of bearing and nonbearing trees, blank spaces, areas of poor soil, and the amount and kind of disease most prevalent in the orchard.

An analysis of the survey showed that in the four southern counties, about one out of every ten trees has become nonproductive because of disease—exclusive of tristeza. The average rate of tree loss—about 0.25% per year for the life of the orchards—could account for the loss of approximately 4,200 bearing trees per year to the California orange industry.

Los Angeles County—with 16.6% of its original tree spaces classified as unproductive—showed the greatest loss. Ventura County orchards had the least percentage—4.3%—of nonproductive trees, probably because the Valencia orchards in this county were younger than in the other counties and psorosis had not progressed as far. Orange County hod 10.6% nonproducing trees and San Bernardino had 8.4%. In Tulare County, 6.0% of the trees had reached the nonproductive stage.

The principal cause of tree loss was found to be psorosis—scaly bark. About eight trees were killed by psorosis for every three trees killed by root rot and gophers. In Orange County, 10.0% of the trees showed bark symptoms of psorosis; in Los Angeles County, 8.1%; in Ventura County, 7.9% in San Bernardino County, 6.0%; and in Tulare County, 8.9%.

Of less importance were brown rot gummosis and root rot—Armillaria and Phytophthora—or gopher damage, which, combined, accounted for 0.98% tree loss in the five counties.

During the course of the survey, however, 3,511 trees were found to be in poor condition—sparsely foliated and in varying stages of dieback—due to undetermined causes. They were therefore classified, as shown in the table, under miscellaneous diseases—a total of 2.04% of the trees in the five counties studied—although it is safe to assume that they could as well be classified under suspected root and crown diseases.

The total tree loss to the industry from these diseases—both known and suspected—plus gopher damage, amounted to 3.02%. Ventura County losses were 1%; Orange County, 2.5%; San Bernardino, 2.92%; and Los Angeles County, 4.40%. Tulare County, where the citrus soils are generally heavier, more retentive of moisture, and more poorly drained than the soils of southern California, also suffered high loss—4.37%; known losses in gummosis alone amounted to 2%.

An accumulation of nonproductive diseased trees and nonbearing replacements explains part of the declining trend in production of southern California oranges. Learning how to grow better replants in old citrus soil is one of the problems of the California citrus industry. Figures collected in the San Gabriel Valley indicate that a replant Valencia tree—25–30 years old—will bear only 50% as much fruit as a tree of the same age in a virgin planting. Replant navels yielded 75% as much fruit as comparable trees in virgin plantings.

In the four southern counties surveyed, 5.7% of the total number of trees were nonbearing replants. Of the possible tree spaces, 1.17% were unplanted blanks. In the Tulare County orchards, 2.3% of the trees were nonbearing replants and 1.8% of the tree spaces were blank. The combined total of nonbearing replants and unplanted spaces accounted for a loss of 6.36% of the trees in the five counties studied.

Long-time production records, covering most of the productive life of a few orchards, suggest that root disorders begin to influence production about the time an orchard reaches maturity. During the first 20 to 25 years—when roots

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Classification of Mature Orange Trees According to Factors Impairing Their Bearing Capacity

County	Total no. trees examined	% bearing	% nonbearing	% having psorosis	% root rot and gophers	% misc. diseases*	% nonbearing replants	% blanks
Ventura	30,734	95.7	4.3	7.9	0.35	0.65	2.8	0.83
San Bernardino	58,398	91.6	8.4	6.0	0.52	2.40	5.4	1.2
Orange	42,844	89.4	10.6	10.0	1.1	1.4	6.7	1.1
Los Angeles ...	25,314	83.4	16.6	8.1	0.96	3.44	8.1	1.5
Total	157,290							
Ave. 4 So. Calif. Counties .		90.5	8.5	7.8	0.73	1.95	5.7	1.17
Tulare	36,255	94.0	6.0	8.9	2.07	2.3	2.3	1.8
Total	193,545							
Ave. All Counties		91.2	8.8	7.8	0.98	2.04	5.05	1.31

* Includes trees suspected to have root rot or girdled by gophers.

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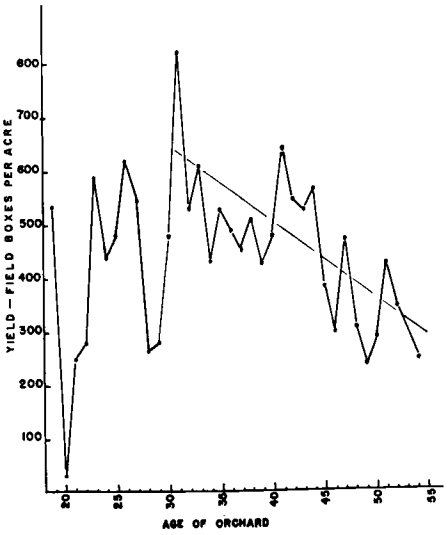
can continue to advance into virgin soil —young orchards remain in good health and increase in production. A leveling off of production characterizes the period of maturity. Roots now occupy the entire mass of the orchard soil. When root parasitic organisms begin to increase and toxins—both organic and inorganic—accumulate to damaging levels, root systems begin to deteriorate and the orchard enters a period of declining vigor. Crowding and shading out of lower limbs and sides may also contribute to the condition of decline. Senility may be another contributing factor inasmuch as—with old age—the renewal rate of bearing wood diminishes and the nonproductive wood—which the tree must support and which competes with fruiting wood for energy and nutrients —accumulates.

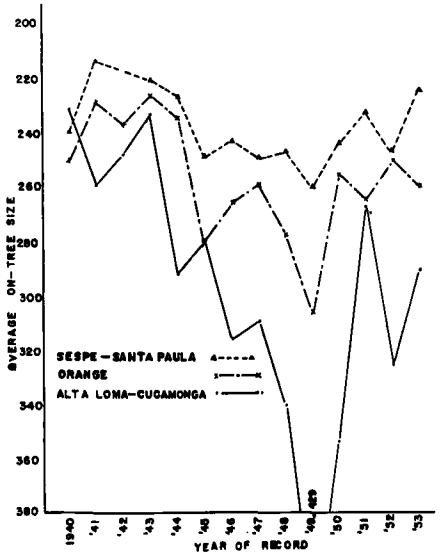
A 35-year production record of a navel orchard planted in 1898. Note how yields increased to 31 years of age, then started into a period of gradually declining production. The extremely low yield when the orchard was 20 years old was due to the destruction of the crops by the June 1917 heat wave.



In order to determine if declining production was due either to decreasing size or diminishing numbers of fruit, both yield and size data were obtained from 42 Valencia orange districts and 23 navel districts, comprising all the citrus producing areas of southern California. The data—covering a 10-year period for navels and a 14-year period for Valencias—show that 37 out of 42 Valencia districts experienced a decrease in fruit size while only five maintained a continuing normal size trend.

In the Santa Clara Valley of Ventura County, fruit sizes showed the least reduction, dropping from a four-year average of 230 to a low—over another four-year period—of 250 fruit per box. Areas most seriously affected were the foothill districts of western San Bernardino County where fruit sizes dropped from an average of about 250 to a low—for one year—of 429 fruit per box. In Escondido and the Rancho Santa Fe districts—both in San Diego County—which in most years have grown the largest Valencias in southern California—sizes decreased from about 205 fruit per box to about 250.

Comparison of fruit size trends in three southern California orange districts showing typical patterns of areas experiencing severe, moderate, and slight size reduction during the 14-year period 1940–1953.



Of the 23 navel districts studied, sizes showed a decreasing trend in 21 districts, remained nearly normal in one district, and increased in one district.

During the same period that Valencia sizes were decreasing, 24 districts had an increase in number of fruit per acre, while 16 showed a steady trend, and only two districts experienced a decline. However—throughout the 14-year period—only 18 districts showed declining production trends, as measured in field boxes per tree, while 18 other districts maintained the same production level, and six districts actually increased production.

Southern California navels fared worse than Valencias. Along with the decline in fruit sizes, numbers of fruit per acre diminished in nine districts, remained fairly constant in 11, and increased in only three. Yields, expressed as field boxes per acre, dwindled in 19 districts, remained steady in four, and increased in no district.

The problem of diminishing yield for Valencias, therefore, is primarily one of decreasing size. For navels, diminishing production has been due first of all to small sizes, but also—in certain areas—dwindling numbers of fruit per acre have accentuated the downward trend.

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much growth was obtained as in the controls. Many of the control plants were still living when survival counts were made but they were weak and produced little or no new tissue. Growth clearly revealed the difference in cold injury and indicated the increased forage production.

These freezing tests confirm observations made on the range. Whereas frost may kill back leaf tissue of fertilized plants, it results in nearly complete growth cessation in the unfertilized.

The photograph on page 5 illustrates the effect of nitrogen fertilizer on frost burn in six-weeks-old soft chess plants two days after being subjected to a single night when the temperature dropped to 30° F. The pot on the left had received four applications of supplemental nitrogen while the control on the right received none. The twisted, curled leaf tips —from the tip to 1″ down the leaf—of the control are brown and dead. The plants with added nitrogen show no frost burn.

In the field, density of ground cover and height of growth are increased by nitrogen applications. This may provide an insulating effect against frost injury to the plant bases.However, in the small pots used in the freezing studies, such insulation is negligible.

Increased root development is likely a factor in the better tolerance of fertilized field plants to drought. However, such root development in the pots is restricted and would not seem capable of producing the improved growth and recovery from injury. The physiology of these responses will be investigated further.

It is probable that the improved frost tolerance observed in these experiments can be found only in areas of mild winters where night freezing alternates with day temperatures warm enough to promote growth. Such conditions in California apparently permit the stimulation of winter forage production by fertilization without increasing the hazard of frost damage.

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