

Declining Citrus Root Systems

relationship of root systems to top growth and production investigated in citrus orchard rejuvenation program studies

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The decline of citrus root systems is one of the more serious current problems in production and fruit size. During the past few years, quantitative information has been accumulating on the extent of citrus root decline and its relationship to growth and production.

It is quite difficult to evaluate the growth of the root system since it occurs beneath the soil surface. In general, the grower does not adjust or correct any faulty or inadequate practices that affect the roots until indications by the top predicate it. The trees are irrigated when the soil appears to be dry or when the tree begins to show a need or, more often, when the scheduled irrigation time arrives. Similarly, fertilizers are applied at a given time of the year, at a specified rate, and so forth. Thus, most management practices are routine, with particular attention being given to the condition of the root system only as it immediately affects the top.

When things go seriously wrong in an orchard, the tree responds rapidly enough so that the condition is observed and an attempt is made to correct the trouble. However, in many experiments involving trees, changes—good or bad—usually take place slowly and may not show up until the following season or even later. In declining orchards, many changes have come about gradually without being noticed. Conversely, the recovery of declining orchards—once the key to the solution has been found—will not occur immediately or over a period of a year or even two years. However, the general opinion seems to be that root rejuvenation will be followed by improved top growth, and increased production will result. This assumes that a declining root system is the basis of a lot of the trouble.

To obtain more information on the relationships of root rejuvenation, improved top growth, and increased pro-

duction, 22 mature navel and Valencia orchards in the major citrus areas of San Diego, Orange, Riverside, San Bernardino, Los Angeles, Ventura, and Tulare counties were chosen for study. The orchards ranged from very high—901 field boxes per acre—to very low-yielding groves—238 field boxes per acre.

The high-producing groves—grouped as those yielding above 500 field boxes per acre for the previous 5-year average—were chosen from a group of 40. The orchards of the low-producing group were obtained predominantly from a 440-orchard study made a few years ago. Most of the low-producing groves had declined—for some reason that was not apparent—over a 5–10 year period.

In sampling a given orchard, 90 samples were taken to characterize the root conditions. Fifteen 4"-diameter auger holes were dug 3' deep under each of 15 trees that were chosen diagonally across the field. These holes were placed at a position directly out from the trunk and approximately 1' back from the furrow. Another set of 15 holes was dug 3' deep in the center furrow between trees. Previous sampling had shown the bulk of the feeder root system to be present in this depth. All samples were separated into 1' depths, the soil screened, and the roots approximately $\frac{1}{16}$ " or less were cleaned and weighed.

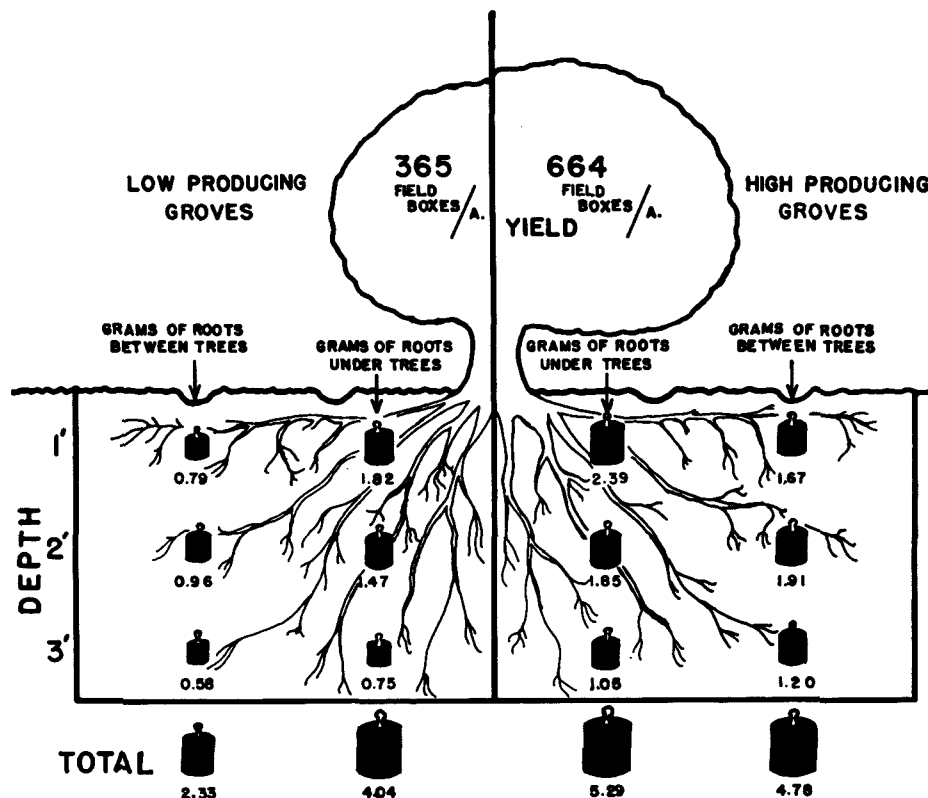
Comparing the amount of roots under a tree with those out in the furrow was expected to establish a general rule that might be used to evaluate the orchards with good or declining root systems. By such a comparison it was thought that soil types could more readily be excluded and an indication of trouble would be a decrease in the amount of roots in the irrigated middles as compared to those under the tree.

The amount of feeder roots extracted between trees—4.78 grams—compared favorably with those found under the trees—5.29 grams—in the high-producing group with an average yield of 664 field boxes per acre.

Among the low-producing groves, with an average yield of 365 field boxes per acre, there were only about half—2.33 grams—as many roots in the middles as the 4.04 grams under the trees. These values represent the total amount of

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A comparison of the average fresh weight of feeder roots found in 11 low and 11 high producing orange orchards. Sample holes, 4" in diameter, were dug to a depth of 3' at positions under and between trees, as indicated by the arrows.



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fore the October soil samples were taken. There was little or no change in soil salinity from May to October, during which period the trees developed collapse symptoms.

Because the sodium concentrations in the roots of all trees in the 36-tree plot were relatively low when the trees were healthy and large increases in concentrations occurred later—only in those trees that developed symptoms of collapse—it is apparent that the high con-

centrations in the roots of affected trees were the result of the condition of the trees and not the primary cause.

There is no indication that soil salinity has been a contributor to the deterioration of the lemon trees in this orchard. Neither the total salts nor the percentage of sodium in the water-soluble salts is above that generally found in the soil from citrus orchards of good production, and there was no significant change in these factors during the period when the trees developed symptoms of collapse.

These observations suggest that some conditions—perhaps the low carbohy-

drate level in the roots due to sieve-tube necrosis near the bud union—had altered either the permeability of the root cells or some other mechanism controlling the absorption or exclusion of sodium.

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The above progress report is based on Research Project No. 1544.

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roots in the 0-3' total, the amounts of roots found under the trees of the low-producing orchards were somewhat reduced. Several of the individual orchards, nevertheless, had as many roots under the trees as the high-producing group. Average values in the high-producing groves—under the trees—were 2.39 grams at the 1' depth, 1.85 grams at the 2' depth, and 1.05 grams at the 3' depth. Between trees the values were 1.67 at 1', 1.91 at 2' and 1.20 at 3'. In the low-producing groves the average values under the trees were 1.82 at 1', 1.47 at 2', and 0.75 at 3'. Between trees, the values were 0.79, 0.96, 0.58 at the 1st, 2nd, and 3rd foot depths.

Plotting the data—relating yield in field boxes per acre to the amount of roots found under the trees in the 0-3 foot depth—revealed the correlation to be rather poor, indicating that the amount of roots found under the trees may vary widely for any given yield. However, if the amount of roots extracted in the 0-3 foot depth between trees are plotted in the same manner, the correlation is calculated to be highly significant.

The Amount of Feeder Roots Extracted From Samples Taken in 22 High- and Low-Producing Orange Orchards. Positions 0'-3' Deep Both Under and Between Trees in the Furrow Are Compared With Their Respective Yields.

No.	High-Producing Groves			Low-Producing Groves		
	Yld.	Roots 0'-3'		Yld.	Roots 0'-3'	
	box/acre	gms.	gms.	box/acre	gms.	gms.
1	901	5.29	6.28	519*	4.19	1.20
2	729	7.33	5.69	500	7.67	3.56
3	728	3.19	4.83	435	2.90	1.59
4	711	8.03	3.32	414	2.55	2.71
5	673	3.33	4.12	393	3.73	2.26
6	646	6.58	7.91	351	5.60	3.07
7	643	4.99	4.73	330	4.47	2.34
8	610	6.24	5.71	280	4.65	3.75
9	575	4.50	2.16	279	3.32	1.50
10	574	2.50	2.87	278	1.27	1.16
11	518	6.25	4.99	238	4.14	2.54
Av.	664	5.29	4.78	365	4.04	2.33

* This grove had declined in yield considerably over a number of years. Therefore, it was included in the low group rather than misrepresent it in the data as a high-producing orchard.

This means—within limits—that the more feeder roots found in the irrigated middles, the higher were the yields obtained. In several high-producing orchards the amounts of roots found between trees actually exceeded those found under the trees.

It can be expected that yield is more

dependent upon the feeder roots between trees because it is principally that area from which the tree obtains most of its water and nutrients during the growing season. A decrease in the amount of the roots, between trees, therefore, bears a direct relationship to the productiveness of the tree. Similarly, a greater proportion of the roots under the trees are inactive during the summer months in many orchards due to a lack of moisture.

The significance of this data can be more appreciated when it is realized that there are numerous factors, other than root decline, influencing yield, many of which are beyond the grower's control.

In summary, the problem of the declining root system is recognized, but the primary cause of this condition is not known. However, the evidence does suggest that the damage occurs principally on that portion of the root system where irrigation water is applied. If the roots in this area can be improved, probably increased production will result.

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Left—Each dot in the graph represents the average amount of roots—weighed fresh—extracted from 15 4"-diameter holes 3' deep. Right—each dot in the graph represents the average amount of roots—weighed fresh—extracted from 15 4"-diameter holes 3' deep.

