# Sodium in Lemon Tree Collapse

## relationship of sodium content of root tissues to decline and collapse of lemon trees investigated

**D. R. Rodney and S. B. Boswell**

**Lemon trees** have not responded consistently to applications of any of the nutrient elements in studies at Riverside directed toward learning whether their collapse or decline is affected by nutritional factors. Neither have the trees exhibited symptoms of leaf burn usually associated with an excess of a nutrient element.

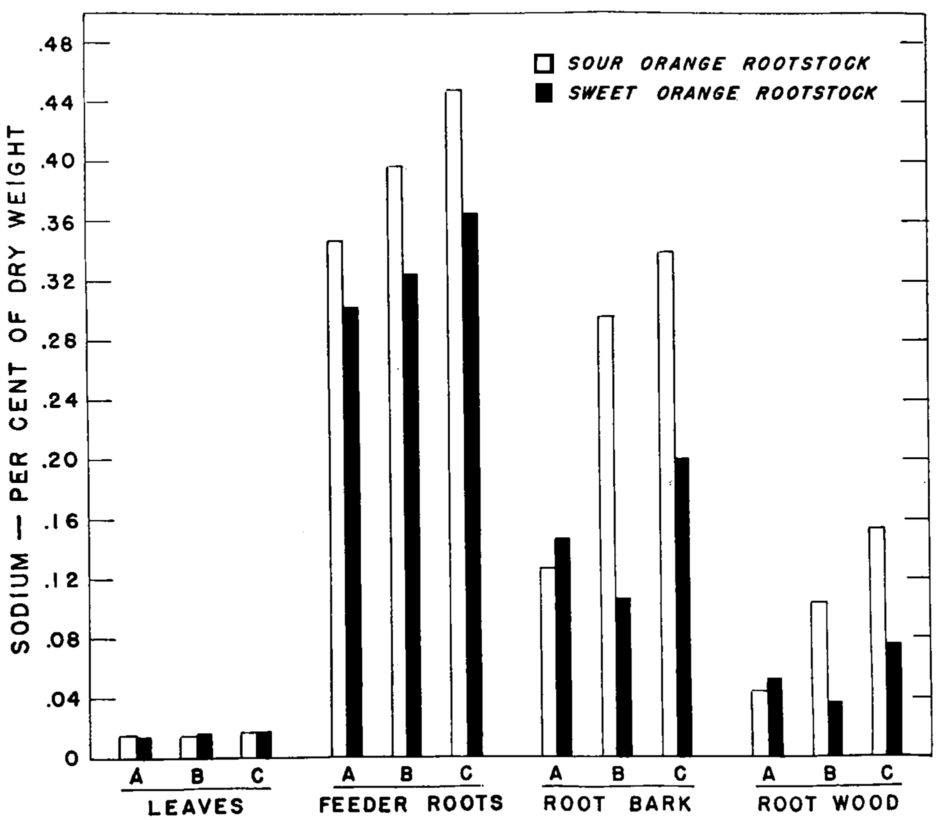
However, there has been a rather consistent trend wherein the roots of declining trees have shown a greater content of sodium than roots of healthy trees.

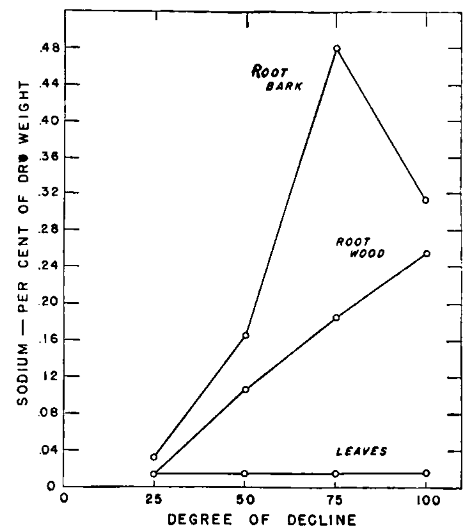
### Six Strains Compared

Further evidence along this line was recently obtained in a comparison of six different lemon strains—three Lisbon and three Eurekas—which are growing on two different rootstocks, Indian orchard sweet orange and Seville sour orange. The trees on sweet orange were planted in 1936 and those on sour orange were planted in 1940. All trees had similar cultural treatments and the same source of irrigation water. Two replications of leaf and root samples were taken from these trees in August and again in November, 1953.

The six strains selected for sampling included one strain of Lisbon and one strain of Eureka growing and producing well on both sweet and sour orange rootstocks—the data are combined and designated as strains *A* in the bar graph on this page—two strains of Lisbon which have declined slightly on sour orange rootstocks—strains *B*—and two strains of Eureka which have declined considerably on both sweet and sour orange rootstocks—strains *C*.

**Sodium content of leaves and roots of lemon trees on sweet orange and sour orange rootstocks as related to decline. Decline is arbitrarily visually rated on a scale from 0 for normal trees to 100 for collapsed trees. On this basis, strains comprising the *A* group rated 6% decline; those in the *B* group rated 36% decline; and those in C 56% decline.**




**Sodium content of Eureka lemon trees on grapefruit rootstock as related to decline. The scale for rating decline of trees is from 0 for normal trees to 100 for collapsed trees.**

Sodium analyses of samples taken in November showed that although the leaves in all strains were practically identical with respect to sodium content, those strains with the greatest degree of decline—*C*—had definitely more sodium in the various root tissues than the strains—*A*—with the least decline.

The trees on sweet orange rootstock had generally declined to a lesser extent, and among the strains, the differences in sodium content of roots were smaller than the differences among strains on sour orange rootstock. There were also some small differences among the strains with regard to the content of phosphorus, potassium, and magnesium, but only sodium differences were associated with the decline symptoms of the trees.

In another comparison, leaf and root samples were taken in a grove in Santa Barbara County from trees in various stages of decline, ranging from slightly declined to a completely collapsed condition. The trees were all of the same Eureka strain, on grapefruit rootstocks, and nearly seven years old. In sodium content, the leaves were again all the same regardless of stage of decline, but the roots of the severely declined trees—75% to 100%—contained several times as much sodium as did the roots of the slightly—25%—declined trees.

In theory, the relatively inactive roots of the collapsed trees—100%—may actually have lost some of their mineral content through leaching and therefore have a lower sodium content than the trees 75% declined.

These data lend support to previous results obtained at Riverside indicating that relatively high sodium content of roots was associated with a high degree of decline in lemon trees. Although a high sodium content of roots has been found to be associated with trees exhibiting severe decline symptoms, this is not critical evidence that sodium is the cause of decline.

A known direct cause of tree collapse is root deterioration resulting from the girdling action of sieve tube necrosis at or near the bud union. It is possible that increased sodium absorption by roots—instead of being the cause of sieve tube necrosis—may be a result of a change in the physiology of root cells. The root cells may have become depleted of reserve carbohydrates after the sieve tube necrosis—caused by unknown factors—has reduced the movement of carbohydrates from the leaves to the roots.

The question of the relationship of sodium to decline and collapse of lemon trees is being further investigated by observing the effect of varying the amount of sodium in the soil and by periodic analyses of roots in an orchard where collapse is occurring.

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## STOCKS

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sium; the weight of the plants decreased and deficiency symptoms developed.

Stocks appear to be among those plants tolerant to sodium as well as those requiring moderate to large amounts of potassium and nitrogen.

A compilation of the information from the available experimental data suggests that 3.5% potassium in the dry leaf would appear to be a desirable amount for promoting optimum growth and flower production. However, the necessary concentration of potassium needed in the soil to maintain 3.5% potassium in the plant could not be easily determined. The reason for this seemed to be due to the influence of other cations, principally calcium, in the available fraction of the soil.

As shown by the table of correlation coefficients on page 10, calculated from the data of the field survey, the total potassium present in the plant was not correlated with the ammonium acetate extractable soil potassium—a coefficient of .050 in the top leaves; .094 in the bottom leaves. Thus it is possible for the extractable soil potassium to be high but the plant potassium to remain low or the extractable soil potassium to appear low and the plant potassium to be high.

The calcium-potassium ratio in the soil, however, produced a highly significant coefficient— −.708—as did the cation-potassium ratio— −.706—when compared with the potassium content of the lower leaves. These ratios, by comparison, greatly influenced the absorption of potassium by the plant. A high ratio—of calcium to potassium—was associated with low plant potassium and a low ratio with high plant potassium. Therefore, excessively high calcium in the presence of moderate to low potassium may decrease potassium absorption sufficiently to induce potassium deficiency. Under such circumstances as these, the soil potassium measurement alone would not necessarily reflect a true picture of the potassium needs of the plant. Sodium and calcium in the plant were found to be significantly correlated with sodium and calcium in the soil.

The value of soil analysis in predicting the availability of soil potassium for stocks appears to be indicated by the calcium-potassium ratio more than any other measurement used.

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## BURNS

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character of incendiary fires in the foothill range area has changed somewhat in the last eight years.

| Size acres | Costs of controlled burns per acre | | | Cost of wildfire suppression per acre |
|---|---|---|---|---|
| | To permittee | To state | Total cost | |
| 40 | $2.95 | $.70 | $3.65 | $5.50 |
| 80 | 2.50 | .55 | 3.05 | 4.60 |
| 120 | 2.10 | .50 | 2.60 | 3.80 |
| 160 | 1.75 | .40 | 2.15 | 3.10 |
| 200 | 1.45 | .35 | 1.80 | 2.45 |
| 240 | 1.15 | .30 | 1.45 | 1.95 |
| 280 | .95 | .25 | 1.20 | 1.55 |
| 320 | .75 | .20 | .95 | 1.20 |
| 360 | .60 | .20 | .80 | 1.00 |
| 400 | .50 | .15 | .65 | .85 |
| 440 | .45 | .15 | .60 | .80 |
| 480 | .45 | .20 | .65 | .85 |
| 520 | .45 | .20 | .65 | 1.00 |
| 560 | .55 | .25 | .80 | 1.25 |
| 600 | .65 | .30 | .95 | 1.60 |
| 640 | .80 | .40 | 1.20 | 2.05 |

The study clearly demonstrated that firing of brushlands with no plan or effort thereafter to maintain an open cover to favor invasions of desirable herbaceous vegetation is likely to be wasteful of time and money. Moreover, burning of inferior sites, such as those occupied by chamise or manzanita where the soil is thin and the slopes are steep, as is often done, is seldom profitable for livestock grazing.

There is still much room for better management of burned areas, such as reseeding for soil protection and for increasing forage yield; proper grazing use; and treatment to control seedlings and sprouts, though there is a definite trend toward an improvement of this situation. As more information becomes available, through research presently in progress, the acreage of unmanaged burns should decrease.

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## KHAPRA BEETLE

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surface deposit of 1,000 micrograms per square centimeter of DDT, malathion, lindane, aldrin, dieldrin, parathion, chlordane, methoxychlor, DDD, and allethrin.

In the use of admixed dusts, 40 days were required to kill 90% of the larvae confined on wheat treated with eight ppm — parts per million — malathion dust, and at two ppm only 26% were killed. Similar experiments on the adults of rice weevil, granary weevil and lesser grain borer when exposed nine days to wheat treated with two ppm malathion dust resulted in 100% kill.

In the fumigation experiments, several times as much acrylonitrile or methyl bromide was required to kill 95% of the larvae as was required to kill adults of the rice weevil, granary weevil and lesser grain borer.

Both the contact and fumigation tests were conducted on larvae collected at Imperial in early March 1954, and these may have been overwintering larvae which are possibly more resistant to insecticides than the more active larval stages.

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