Effect of Potash on Oranges

studies on deficiency and excess in relation to tree growth, composition and fruit quality

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To throw more light on the problem of potash fertilizer in California citrus orchards, additional research was initiated a number of years ago.

The first work consisted of studies to determine by soil analysis, the potash status of citrus orchard soils as compared with that of adjacent nonfertilized areas.

In some orchard soils the potassium was very high—presumably as a result of past manure and/or mixed fertilizer applications.

In a few areas potassium was low. Inasmuch as no certain criteria were available by which to evaluate the results of these soil tests in terms of tree behavior, it was decided to attempt to grow orange trees in water or sand cultures where the amount of potash added could be regulated.

Experimental work was begun in 1940 using a group of some 20 four-year-old orange trees. These trees were grown for a period of six years in nutrient solutions of varying potassium content such as to produce extreme potash deficiency, mild deficiency and potash excess.

Valencia orange tree showing comparatively normal appearance at earliest stage of potassium deficiency.

Effects of Deficiency

In the course of this work it was found that citrus trees are able to absorb sufficient potash from solutions containing as low as two to three parts per million of potassium, provided this supply is maintained.

At potassium levels below this concentration a mild deficiency condition gradually appeared. In order to produce acute deficiency it was necessary to deprive the tree of potassium altogether.

In the acute stage, extreme leaf curling, puckering and malformation occurred. Accompanying this was a fading of the leaves so that the trees had a distinctly yellowish appearance.

No distinctive leaf patterns as in the case of iron, zinc, and manganese deficiencies were produced. In the extreme condition there was twig and shoot dieback. New growth was weak and sparse and leaves were undersized. Blossoms in the spring were greatly reduced in number and very few fruits were produced.

In the earliest stage of potash deficiency the tree showed no leaf symptoms or other characteristic by which this condition could be positively diagnosed.

The leaves were green, new growth was healthy, blossoms were abundant; there was little if any dieback and the color of the tree was good.

Only two things were consistently noticed. In the spring, at the time of bloom, a heavier than usual drop of old leaves occurred. This, however, was not severe enough to give the tree a defoliated appearance.

The leaf fall was just a little heavier than occurs normally at this time.

Excess Supply

With excess potassium, no leaf symptoms were produced but growth was decreased and leaf abscission was accentuated.

The most outstanding symptom of excess potash was the production of rough, coarse-textured fruit.

In general, so far as tangible growth or appearance symptoms are concerned, the early stages of both deficiency and excess were not characterized by any kind of recognizable or distinctive symptom.

Since these are the conditions most likely to be met in the field, periodic—monthly, for the most part—analyses of the developing leaves were made on all of the trees in this experiment. Thus a continuous leaf analysis record for each tree over a period of years was obtained.

In preliminary work it was found that the leaf was as good an index of potassium supply as any other part of the plant.

Leaves ranging from three to six months in age are fairly constant in composition. Very young, immature leaves tend to be low. It seems to make little if any difference whether the leaves are picked from twigs bearing fruit or from twigs without fruit. Hence, in this study it was the practice to select leaves from fruit-bearing branches. In this way leaves of known age could be selected.

In general, leaves picked from trees

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Valencia orange trees showing effects of acute potassium deficiency. Note the leaf curling and malformation.

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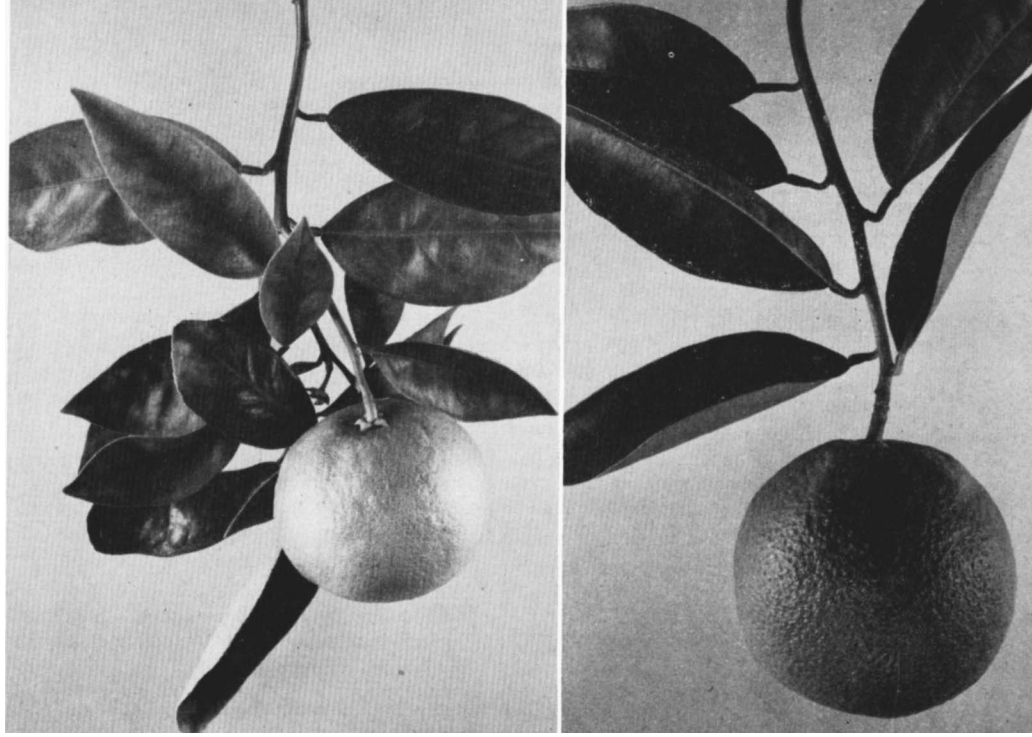
slightly deficient in potash showed from 0.26% to 0.35% potassium on a dry weight basis.

Leaves from trees markedly deficient in potassium and showing the type of puckering and malformations described previously had a potassium content ranging from 0.14% to 0.24%.

Leaves from trees showing injury from excessive potash showed potassium ranging from 2.15% to 3.63%. It would thus appear that values in between these extremes, that is from about 0.35% to 2% can be regarded as representing ample but not excessive supplies of this element.

Many hundreds of leaf samples have been analyzed from commercial orchards following this work and the great majority show potassium values ranging from 0.4% to 1.5%.

In no case have we obtained values greater than 2%, and in only a few instances have we found orchards where the level was below 0.4%.



Twig and fruit (left) from tree moderately deficient in potash contrasted with fruit (same age) from tree receiving ample potash. Note difference in both size, rind texture, and in characteristics of foliage.

Variable Supply

Each year the fruit from each tree was counted, weighed, graded as to rind texture and other external characteristics. Measurements were made on diameter, thickness of rind and percentage of juice characteristics.

Fruit from trees lacking in potash was small in size but otherwise of good quality.

The rinds tended to be smoother in general than fruit from trees receiving ample potash and the fruit from the trees injured from excessive potash had very coarse rinds.

The juice from the low-potash fruit was slightly lower in acid than the fruit from the amply supplied trees but was of good total solid content and acceptable flavor. The chief effect of lack of potash on fruit therefore was in the matter of size.

The decrease in average size of fruit was found to hold not only for the fruit from trees acutely deficient in potassium, but also for the fruit from the trees which were so slightly deficient in this element that no visible symptom of potash lack could be seen.

The results of leaf analysis and soil survey in these tests give no evidence of a potash lack in most California citrus soils. This suggests some other reason or reasons for small fruit sizes.

Some of the orchards sampled, where small sizes are an acute problem, have a much higher potash level in both leaves and soil than in other orchards where sizes are good.

In a number of orchards manures have been consistently used over a period of years. This practice has substantially increased the potash content of both the soil and citrus trees without apparently affecting fruit sizes.

It thus appears improbable that increasing the potash of a soil already sufficiently supplied will improve fruit sizes.

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fruits and from those that did not. These young trees are now growing in an experimental block at the University Farm at Davis. They have produced crops whose black-end performance is closely correlated with that of the original trees.

The disease has never been observed on Beurré Hardy even when this variety was on the same clonal stock as the Bartlett which had severe black-end.

Rootstock

All the foregoing point to the fact that the black-end condition is closely related to the rootstock of the individual tree.

A number of investigations have been conducted in the laboratory.

The distribution of lenticels from the stem to the calyx end has been studied. Certain morphological and histological features have been investigated. The pH and acidity of various sections of fruit with and without black-end have been determined as well as the seasonal pH changes of fruits on French and Japanese stocks. In the latter case the samples were divided into those from trees that did not produce black-end and those that did.

The buffer capacities of juice from black-end and normal fruit have been compared. The sugar content of mature pears from Japanese stocks with and without black-end and from French rooted trees has been determined. Certain ash constituents of leaves and fruit have been studied.

A block of selected Japanese clones on their own roots, whose black-end history is known, is now being grown at Davis for further basic study of this disorder.

It may be stated that this disorder, so far as the California pear industry is concerned, is now largely only of academic interest.

Pear Acreage Down

The severe losses suffered from fireblight in 1930, the prevalence of hard-end, and economic conditions during the early thirties resulted in the removal of most pear orchards propagated on oriental rootstocks.

As of 1946 there were 37% fewer bearing pear trees in California than in 1933, leaving a comparatively small acreage where hard-end is a problem.

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