Mineral Nutritional Problems
Of Trifoliate Orange Rootstock

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The use of trifoliate orange rootstock in citrus offers some advantages including cold resistance, disease resistance, and improved fruit quality. However, it is more susceptible to zinc and iron deficiencies than are other rootstocks used for citrus, as well as nutritional complications under conditions of high phosphorus and high potassium. It seems to be less tolerant of a low magnesium supply than many other plant species; it is subject to a peculiar type of chlorosis which has never been identified, and nitrogen levels seem to influence its development of dormancy. As a rootstock, this species tends to dwarf at moderate and low temperatures but not at high temperatures, but whether or not this is related to mineral nutrition is not known.

The purpose of this investigation was to determine some causes of these mineral nutrient peculiarities. It was not the purpose of this study to determine which citrus rootstock is best for a given set of conditions, but rather to find why different rootstocks and other plant species behave as they do.

Although the citrus rootstock, trifoliate orange, is disease and cold resistant and offers good fruit quality, it is affected more by zinc and iron deficiencies than some other rootstocks, according to this report from U.C., Los Angeles. Other nutritional disorders seem to result from high potassium and phosphorus conditions, low magnesium supplies and certain nitrogen levels.

Iron chlorosis
Trifoliate orange seedlings were iron chlorotic when grown on the calcareous Hacienda loam soil. A relatively high level (40 lbs of iron per acre) of iron chelate (EDDHA) applied over a period of four months corrected the iron chlorosis and increased the iron content of leaves from 41 to 117 ppm on the dry weight basis. This level of iron chelate is too high for economical use, but in subsequent studies much lower levels were effective. A level of zinc chelate (EDTA) equal to that of iron (40 lbs zinc per acre) increased both iron and zinc contents and improved growth. Rough lemon seedlings grown under the same conditions were free of iron and zinc deficiencies. When the seedlings were grown in the noncalcareous Yolo clay loam, the trifoliate orange responded to the zinc chelate; the rough lemon did not.

Tests with radioactive iron indicated that susceptibility to iron chlorosis in trifoliate orange is related to its poor ability to absorb iron at low iron concent-
Trifoliate orange seedlings grown in sand culture with a high level of potassium (50 milliequivalents per liter) with three levels of magnesium (1, 2, and 3 respectively are 0.1, 1.0, and 10 milliequivalents per liter of magnesium).

Concentrations and also to its ability to translocate iron from roots to shoots. At high external concentrations of iron the susceptible trifoliate orange and the resistant rough lemon absorbed and translocated equal quantities of the radioactive iron. Use of radioactive zinc indicated that trifoliate orange is susceptible to zinc deficiency because of a translocation failure from roots to leaves. Total uptake for the two species was about equal, but rough lemon translocated up to about 20 times as much zinc as did trifoliate orange. Results for both iron and zinc were essentially the same, whether with seedlings or with seedlings that had been whip grafted to Valencia orange scions.

Additional studies with radioactive isotopes indicated that high calcium levels greatly depressed the absorption of zinc by both species and that a high level of bicarbonate and also of phosphate greatly depressed translocation of iron with trifoliate orange, but much less so with rough lemon. High bicarbonate had no effect on zinc translocation, but high phosphate did. High phosphate, however, depressed zinc translocation with rough lemon more than with trifoliate orange. Several metabolic inhibitors were used with the radioactive isotopes, but no great differences were found between the two plant species.

When trifoliate orange seedlings were grown in the glasshouse with high levels of potassium they were severely injured. Seedlings of other citrus rootstocks were not damaged with similar treatments. Studies were made with seedlings in sand culture and in solution culture to better characterize the different relationships involved.

At least part of the effect of high potassium appeared to be a greatly decreased content of magnesium. The plants with the high potassium levels all had severe tip dieback and considerable shoot branching from the base to give a bushy appearance. This occurred for all magnesium levels when potassium was high. High magnesium had a slight tendency to overcome the effect of high potassium. Moderately good growth and extremely poor growth were both obtained with leaf magnesium levels of around 0.04%. The major difference was that the high potassium level resulted in a toxicity beyond inducing magnesium deficiency. A high level of potassium also severely decreased the calcium contents of leaves.

The present study, still in its introductory stages, is based on the premise that knowledge of such physiological behavior will lead to the best use and control of citrus rootstocks and other plant species. For example, it may develop that desirable and undesirable characteristics are inseparably linked together.

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