Trifoliate Orange Seedlings

effect of various soil chemical properties on growth of trifoliate orange seedlings in sandy and in loam soils

J. P. Martin, W. P. Bitters, and J. O. Ervin

Orange trees on trifoliate orange rootstock have certain desirable characteristics—smaller trees that yield well in proportion to their size; fruit of better than average quality and size; generally early fruit maturity; tolerance to quick decline; and more cold resistance than other combinations—and the trifoliate root itself is relatively resistant to gummosis and to nematodes. Because of these characteristics, the trifoliate orange is sometimes selected by growers as a rootstock for oranges.

Trees Variable

In commercial plantings, however, trees budded on trifoliate orange rootstock are extremely variable in size and appearance. Many are often affected by exocortis. Tree response has been better in some areas than in others. Nursery seedling stock has been observed to grow rapidly in some soils but very slowly and poorly in others.

Although the trifoliate orange is very sensitive to salt, seedlings have made poor growth in some soils relatively low in soluble salts. For this reason and because of increased interest in the use of trifoliate orange as a rootstock, a study was initiated to determine the influence of certain soil chemical properties other than soluble salts on growth of the seedlings.

Two soils—a Hanford loam and a Yolo sandy loam—were used for the study. They were treated so as to produce soils with varying degrees of acidity, with excess calcium—lime—and with varying amounts of sodium and potassium without the addition of salts such as chlorides, nitrates, and sulfates to the soil.

All tests were carried out in three-gallon pots and were replicated four times. The soil was fertilized with a small amount of nitrogen and phosphorus. Two seedlings were grown in each pot for approximately seven months. Radish plants and head lettuce were grown in the loam soil series for comparison with the trifoliate orange seedlings. The seedlings grew almost equally well in acid soil, through neutral soil, to soil containing excess calcium—lime. Growth was slightly better in the acid sandy soil than in the neutral and excess lime soil. This suggests that lime—calcium carbonate—as such is not highly unfavorable to the growth of trifoliate orange seedlings.

Effect of Various Soil Chemical Properties on Growth of Trifoliate Orange Seedlings in a Sandy Soil

Soil property	pH	Av. dry wt., grams* per 3-gal. pot
Acid	5.5	35
Slightly acid	6.2	34
Neutral	7.0	30
Excess lime	7.7	30
Low potassium—3%**—trace sodium	7.0	30
Low potassium—3%—8%** sodium	7.1	28
Low potassium—3%—16% sodium	7.3	26
Medium potassium—10%—trace sodium	7.0	30
Medium potassium—10%—8% sodium	7.4	26
Medium potassium—10%—16% sodium	7.5	23
High potassium—20%—trace sodium	7.2	22
High potassium—20%—8% sodium	7.4	18
High potassium—20%—16% sodium	7.5	14

* Least Significant Difference 5% = 3 grams.

** Per cent sodium and potassium = per cent of adsorbed cations, namely, calcium, magnesium, potassium, sodium, and hydrogen.

Soil Structure

The apparent greater sensitivity of the trifoliate seedlings to sodium and potassium in the loam soil may be partly explained on the basis of soil structural influences. Excess soil sodium and potassium can reduce plant growth directly through nutritional effects and indirectly by dispersing the soil particles and thus reduce aeration, water penetration, and so forth. Sodium appears to disperse the soil much more than potassium. Because there are more small particles to be dispersed, the unfavorable structural effects would normally be expected to be of greater magnitude in a fine-textured soil than in a coarse textured or sandy soil.

In the loam soil, 25% potassium plus 14% sodium—per cent of total adsorbed cations; namely, calcium, magnesium, sodium, and potassium—treatment killed the trifoliate seedlings, while radish and lettuce plants grew equally well in all treatments. This demonstrates that trifoliate orange seedlings are much more sensitive to relatively high soil sodium and potassium percentages than are other plants such as those tested.

A comparison of this study with a similar one in which sweet and sour orange seedlings were used indicates that the trifoliate orange is more sensitive to high soil sodium or potassium or both than are sweet and sour orange seedlings. For example, 7% sodium in a loam soil did not significantly reduce the growth of a first crop of sweet or sour orange seedlings while, in this study, growth of trifoliate orange in a similar soil was reduced by this same sodium percentage. In some citrus soils the concentration of potassium, sodium, or both, is sufficiently high to reduce growth of trifoliate orange seedlings, so their use as a rootstock in such areas may not be satisfactory. It is possible, however, that the reduced growth effect may be modified when a more tolerant top is budded on the trifoliate orange.

J. P. Martin is Chemist in Soils and Plant Nutrition, University of California, Riverside.

W. P. Bitters is Associate Horticulturist, University of California, Riverside.

J. O. Ervin is Laboratory Technician in Soils and Plant Nutrition, University of California, Riverside.

Effect of Various Soil Chemical Properties on Growth of Trifoliate Orange Seedlings, Head Lettuce, and Radish Plants in a Loam Soil

Soil property	Dry wt. per pot of: Trifoliate seedlings	Radish plants	Head lettuce
	gr.*	gr.	gr.
Slightly acid	19	14	12
Neutral	17	14	10
Excess lime	19	15	12
Medium potassium—6%—trace sodium	19	14	12
Medium potassium, 6, 7% sodium	13	14	10
Medium potassium, 6, 14% sodium	6	15	12
Med.-high potassium—12%—trace sodium	14	15	10
Med.-high potassium—12%—7% sodium	9	16	12
Med.-high potassium, 12, 14% sodium	5	15	11
High potassium—25%—trace sodium	5	17	10
High potassium—25%—7% sodium	2	17	10
High potassium—25%—14% sodium	plants died	15	10

* Least Significant Difference 5% = 3 grams.