Seedlings on Old Citrus Soils

effect of water, acid, alkali, and alcohol leaching of old citrus soils on growth of citrus seedlings

James P. Martin

Orange, lemon, and grapefruit trees in most southern California citrus-producing areas do not grow so well when planted in soil previously cropped to citrus as when planted in a soil for the first time.

Greenhouse fertilization tests with soil from old citrus orchards and adjacent areas virgin to citrus have indicated that lack of some common nutrient element is not a primary cause of this reduced growth.

Citrus root nematodes and certain soil fungi are commonly found associated with decaying citrus feeder roots. In further greenhouse experiments, heavy fumigation of old citrus soils with carbon disulfide, ethylene dichloride, D-D, Dowfume N, Propylene oxide, and other soil fumigants has killed those nematodes and fungi and reduced or eliminated decay of sweet or sour orange seedling roots. The treatments have also increased growth of citrus seedlings 25% to 100%, but have not returned growth to the status of that in soil not previously cropped to citrus trees.

Similar fumigation of noncitrus soils has had little effect on growth of seedlings. These results suggest that harmful soil organisms constitute one factor involved in this reduced growth effect, but that another factor or other factors are also involved.

Leaching Trials

On the theory that some kind of toxin might be accumulating in old citrus soils and exerting a depressing effect on growth, it was decided to try various leaching treatments in an attempt to remove such a hypothetical toxic material.

All the soil tests were carried out by using three-gallon glazed pots and in replicas of three or five. For the first experiment both old citrus soil obtained from a grove in which the owner was experiencing difficulty in establishing satisfactory replants, and soil from an adjacent garden plot were treated as follows: *1*, no leaching; *2*, leached eight hours a day for six weeks with distilled water; *3*, leached with six gallons of ethyl alcohol per three-gallon pot and the soil allowed to dry out before planting; *4*, leached with approximately six gallons of 2% sulfuric acid per pot; *5*, leached with approximately four gallons of 2% postassium hydroxide per pot; *6*, leached with one normal ammonium chloride solution adjusted to pH 4—a medium degree of measurable acidity—until the leachate came through at pH 4.

After treatments *3*, *4*, and *5*, the soils were further subjected to a rather involved leaching treatment in order to restore a favorable nutrient balance to the soil colloids—humus and clay particles—and to free the soils of excess salts. All pots of soil then received nitrogen, phosphorus, potassium, magnesium, manganese, boron, copper, and zinc fertilizer at the time of planting.

The results of these treatments on the growth of sweet orange seedlings are re-

Continued on page 11

Effect of Various Chemical Leaching Treatments on Growth of Sweet Orange Seedlings in Old Citrus Soil.

Leaching treatment*	Plant growth per pot†				Increase or decrease of noncitrus over old citrus soil
	Old citrus soil		Noncitrus soil		
	Weight of plants, grams	Per cent increase over check	Weight of plants, grams	Per cent increase over check	
None — check	40	0	73	0	82
Distilled water	46	15	76	4	65
Ethyl alcohol	63	57	73	0	16
H_2SO_4 pretreatment, calcium saturation	74	85	71	–3	–4
KOH pretreatment, calcium saturation	75	87	75	3	0
NH_4Cl pretreatment, calcium saturation	59	47	70	–4	19

* All pots received nitrogen, phosphorus, potassium, magnesium, boron, copper, zinc, and maganese fertilizer.
† Dry weight of whole plant, including roots.

Effect of leaching old citrus soil with 2% sulfuric acid on growth of sour orange seedlings. A. Old citrus soil obtained from a citrus grove and cropped to sour orange seedlings for nine months in the greenhouse before planting; B. same soil leached with 2% sulfuric acid, the leaching followed by saturation of the soil colloids with 66% calcium, 20% magnesium, 7% potassium, and 7% hydrogen; C. same soil treated as in B and also fumigated with 12 milliliters carbon disulfide per pot; D. noncitrus soil obtained from a garden plot adjacent to old citrus orchard.

Walnut Cuttings

treatment with hormones, callusing in sand for vegetative propagation

E. F. Serr

Vegetative propagation of Paradox hybrid walnut rootstocks was successful this spring in trials carried on at Davis.

Preliminary tests with various hormones and techniques were started in 1949 to develop a practical method of propagation by cuttings.

Because of the great variation among seedlings and also because of the present shortage in supply, vegetative propagation is desirable. It would permit the selection and propagation of individual rootstocks which show high resistance to disease and nematode attack, as well as superior vigor. The actual number of these trees could then be increased rapidly.

The first success was obtained this spring by treatment of hardwood cuttings with naphthaleneacetic acid and callusing in sand before planting.

Two hundred forty hardwood cuttings were made in early March. Small lots were treated with varying strengths of the hormones naphthaleneacetic acid, indole-3-n butyric acid and alpha-2,4,5-trichloro phenoxypropionic acid. Some were planted directly in the greenhouse and others in the lath house. Part were inverted in sand to develop a callus before being planted in the rooting medium, which was made up of one third sifted loam, one third sand and one third peat moss. In all, 48 different methods of treatment were tried with five cuttings in each lot.

The only lot in which any of the cuttings developed roots was the lot where the basal one and one half inches of the cutting was first soaked for 24 hours in a solution of naphthaleneacetic acid made up at a concentration of 200 parts of the acid per million parts water. The cuttings in this lot were then inverted, covered with river sand and placed in the greenhouse where the temperature was held at about 70° F and the sand kept moist for callusing. A fair to good callus had developed after one month on 80% of these cuttings. They were then planted in large, well-drained cans of the rooting medium and placed in the lathhouse. All lots were irrigated frequently.

On June 6, when all the cuttings were examined, two of the lot of five cuttings handled as described were found to have developed roots. They had also made two to four inches of top growth and were apparently in healthy growing condition. All other cuttings failed to develop roots, although a few were still alive.

This preliminary test gives promise of eventual large-scale vegetative propagation of walnut rootstocks from individual trees. It also indicates the possibility of more rapid build-up of nursery supplies of walnut trees on Paradox roots, now in greater demand than nurserymen can supply. These results must be considered preliminary because of the small number of cuttings in each test. Large-scale trials are planned for next season.

E. F. Serr is Associate Pomologist, University of California College of Agriculture, Davis.

The trials covered by this program report were conducted by Marshall R. Wanzer, an advanced student in Pomology, under the direction of E. F. Serr.

CITRUS

Continued from page 3

corded in the table on page 3. The treatments, although drastic, did not significantly affect growth of seedlings in the noncitrus soil. The plants in the noncitrus check pots were 80% larger than those in the old citrus check pots. All treatments except leaching with distilled water significantly increased growth in the old citrus soil series. The potassium hydroxide and sulfuric acid treatments completely eliminated the growth inhibiting factors in the old citrus soil.

Similar results were obtained with sour orange seedlings.

Additional Tests

In another experiment the acid leaching procedure was repeated on an old citrus soil made very unfavorable to the growth of citrus seedlings by additional cropping to sour orange seedlings in the greenhouse for nine months. The important results of this experiment are partly illustrated in the photographic illustration on page 3.

Seedlings in the noncitrus soil made more than five times the growth of those in the old citrus soil. Tomato plants on the other hand grew just as well in the untreated old citrus soil, as in the noncitrus control soil.

Fumigation of the old soil with carbon disulfide increased growth by approximately one third. The acid leaching treatment, however, completely overcame the growth retarding factors in the old soil. Fumigation of the leached soil with carbon disulfide exerted no effect on seedling growth.

Similar experiments were carried out using a medium quartz sand which was cropped to sour or sweet orange seedlings for 18 months in the greenhouse.

The 18 months' cropping to citrus seedlings greatly retarded the growth of a second planting of sweet orange seedlings.

Weekly watering of fresh sand cultures of orange seedlings with leachings from old sand cultures reduced growth by approximately one third.

Leaching of previously cropped sand with distilled water increased growth while leaching with sulfuric acid followed by distilled water produced growth comparable to that in the fresh sand.

Previous cropping of sand to sour orange seedlings had a greater retarding effect on subsequent growth of sweet orange seedlings than did previous cropping to sweet seedlings.

In consideration of the results of these and previous experiments, it seems that in addition to detrimental organisms, an organic toxic material gradually builds up in soils cropped to citrus trees. This hypothetical toxic material could originate by slow excretion from the citrus roots or could be produced by microorganisms growing on root surfaces or dead root material.

If such a material is a factor in causing reduced growth in second or third planting citrus orchards, it is apparently specific for citrus trees inasmuch as other plants grow well in old citrus soils. It is not readily leached from a normal soil by water, but may be partly removed from a very sandy soil by leaching.

The acid or alkali leaching treatments suggest that it is soluble in or destroyed by sufficiently strong acid or base solutions.

The fact that the reduced growth effect gradually builds up and persists in citrus soil indicates that it is resistant to decay by soil organism or is only slowly destroyed by them.

Further studies on possible toxic material are under way to determine the validity of this hypothesis.

James P. Martin, Assistant Chemist, University of California College of Agriculture, Riverside.