Nitrate Levels for Valencias

tree growth improved in soil and solution cultures when nitrogen was maintained at relatively high concentrations

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Maintenance of high concentrations of nitrate in soil and solution cultures induced better growth in Valencia orange trees than that produced by low nitrate levels.

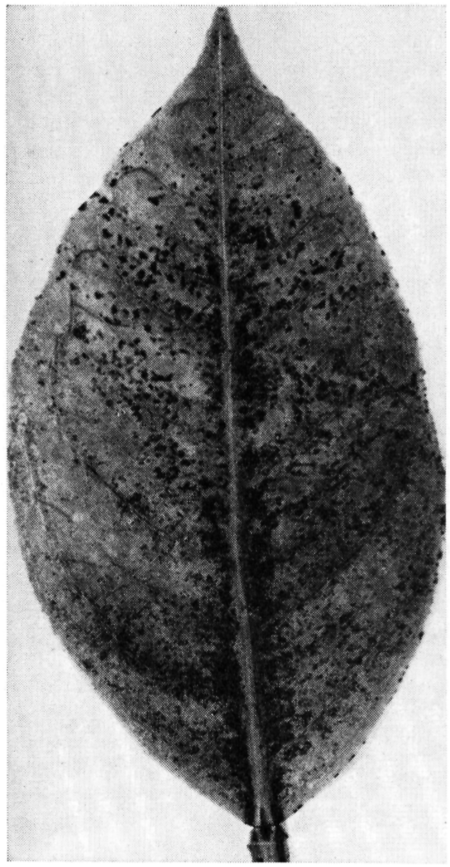
Tests were first made with Valencia trees growing in pails containing 40 pounds of air-dried sandy loam soil and provided with drainage. Two rooted-leafy-twig Valencia orange cuttings were planted in each culture. Nutrient solution—applied in large amounts and in great frequency—consisted of distilled water containing increasing concentrations of nitrate as calcium nitrate.

Fresh weights of the tops range from 403 grams to 963 grams when only various concentrations of calcium nitrate were added to the distilled water. The use of potassium and phosphate with the higher levels of nitrate greatly improved the growth of the tops and roots. The addition of a uniform concentration of potassium and phosphate to the culture solution resulted in a rapid and continued decrease in total phosphorus content in the mature green leaves.

Prior to dividing the cultures into two groups the numbers of young green Valencia oranges produced at the increasing nitrate levels were: 4, 8, 9, 13, 27, 36, and 28. In these fruits the parts per million of total phosphorus in their dry matter tended to decrease as the nitrate level increased.

Large out-of-door, well-drained soil cultures—containers 21″ in diameter by 26″ deep—were planted with Valencia orange trees on Brazilian sour orange rootstock. Large quantities of nutrient solution—up to five gallons—were added daily to maintain the nitrate concentration at a given level.

The nutrient solution consisted of distilled water to which were added—in parts per million—magnesium, 54 ppm, as the sulfate; potassium, 21 ppm, and phosphate, 52.5 ppm, as potassium dihydrogen phosphate; and potassium, 21 ppm, as the sulfate. Various concentrations of nitrate as calcium nitrate were added as well as sufficient calcium sulfate to equalize the calcium content in each culture.



Valencia orange leaf from a large out-of-door soil culture and affected by exanthema—a copper deficiency. Note the resinous excrescence.

At the outset, the range of nitrate content in the culture solutions extended from 0.6 ppm to 31 ppm. It was soon evident that growth differences were going to be relatively small and the ppm nitrate range was changed to: 25, 50, 75, 100, 125, 150, 250, 350, 450, 550, and 600.

The tests were continued after the production of several crops of fruit in order to observe whether high nitrate levels without the use of copper could induce a copper deficiency—exanthema. After several years of healthy growth during which there were almost continuous applications of nutrient solution and adequate drainage, copper was becoming a limiting factor, for very definite symptoms of exanthema appeared. This occurred first in the culture at the 600 ppm nitrate level and progressed toward cultures at lower nitrate levels until finally the culture at the 250 ppm level was affected.

In orchards the use of copper sprays, made as protective measures against brownrot infection, affords a source of copper supply. When high concentrations of nitrogen are combined with high quality irrigation water and good drainage, care must be exercised to ensure an adequate supply of copper and still not bring about an excess.

The initial symptoms of copper deficiency frequently go undetected. Gum blisters or pockets may occur on the young twigs, often later accompanied by a brownish resinous excrescence. After a time the underside of a leaf may also be covered with this resinous material. One of the first symptoms seen in the test

Results of Varying Nitrate Levels

Fresh weights of tops of rooted leafy-twig Valencia Orange cuttings grown in soil with distilled water containing various concentrations of nitrate as calcium nitrate alone and with uniform potassium and phosphate added with the nitrate

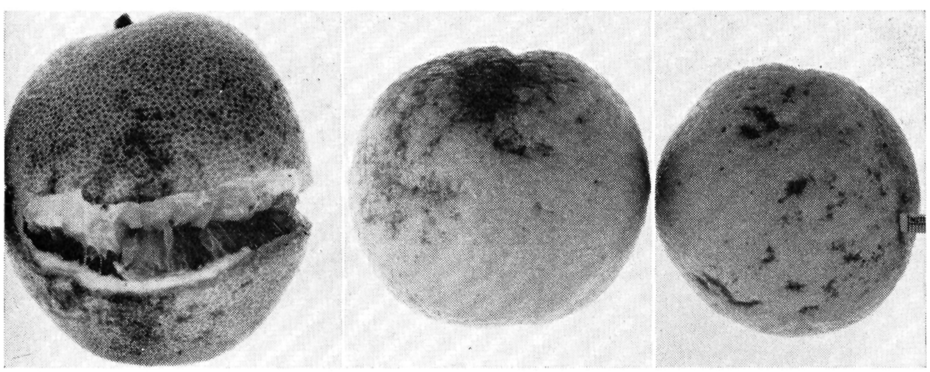
Concentration of nitrate in distilled water; parts per million	No potassium or phosphate in culture solution			Potassium and phosphate in culture solution		
	Fresh weights of tops; grams	Fresh weights of roots; grams	Total phosphorus in dry matter of mature green leaves; parts per million	Fresh weights of tops; grams	Fresh weights of roots; grams	Total phosphorus in dry matter of mature green leaves; parts per million
50	403	283	2600	498	356	6360
75	659	487	2920	311	186	4480
100	720	520	4460	264	133	3200
150	501	300	1860	748	480	1930
250	853	493	2620	879	548	1830
350	923	492	1520	996	547	1320
450	963	527	1520	1280	702	1350

trees was the oval-shape and silver to yellow color of the fruit; the surface of the peel appeared as if rasped by red mite and the oil glands were conspicuous. In advanced stages brownish to nearly black resinous spots or areas appeared on the surface of the peel. When severely affected, the spots form triangular-shaped checks or splits that may become quite extensive.

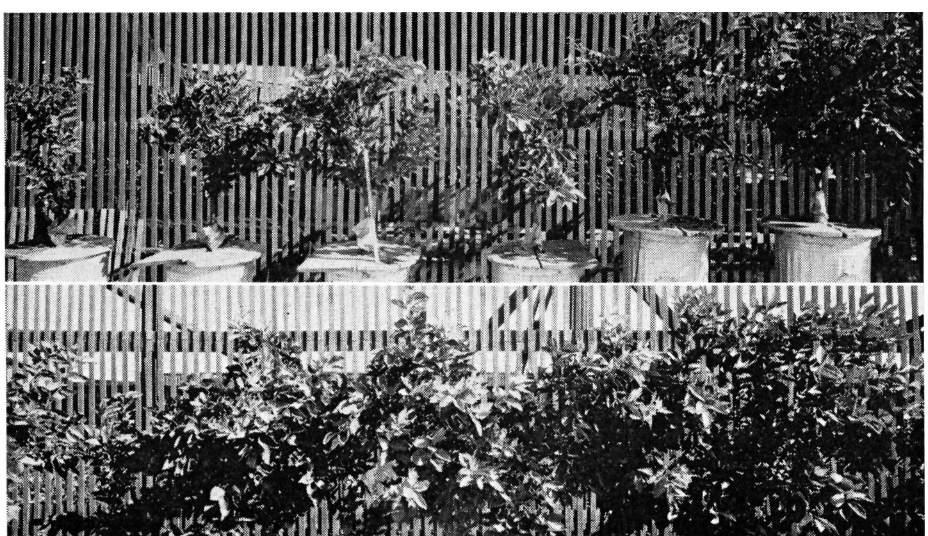
In some affected Washington navel orange orchards practically all of the fruit may split into halves at the navel end. After the trees are sprayed with copper, the succeeding crop may show few if any split fruit, though some fruit may show slight gum formation or off shape or color. When only a very few fine black resinous spots occur on the peel, it is extremely difficult to diagnose. A cut across the fruit at midway between stem and tip end may reveal the presence of gum inside the apex of the pulp segments.

Prior to the appearance of exanthema symptoms collections of mature leaves and fruit were made. The water soluble as a per cent of the total calcium in the leaf dry matter increased gradually from 36.60% to over 50% as the nitrate level was increased, whereas the magnesium solubility was always above 80%. The total phosphorus content—parts per million—in the leaf dry matter at the increasing nitrate levels were: 7600, 3200, 2110, 1910, 2440, 1200, 1300, 1100, 1630, 1050, and 1160, and at a later date were: 7850, 3370, 2600, 1800, 2670, 1340, 1380, 1240, 2170, 1280, and 1390.

The dry matter of the outer portion of the Valencia orange peel always contained a higher percentage of total phosphorus than did that of the inner portion. At the 100 ppm nitrate level the values were: inner, 600, outer, 900; at the 150 level, 500 and 750; at the 350 level, 510 and 780; and at the 550 level, 490 and 700. Calcium in the whole peel decreased from 0.93% to 0.44% as the nitrate level was increased.



Various stages in the appearance of Valencia orange fruit from trees in large out-of-door soil cultures that received a nutrient made with distilled water and containing high concentrations of nitrate and no copper. Note the range of intensity in the resinous excrescence on the surface of the peel, the prominence of the oil glands and the tendency of fruit to split open.



Growth of Valencia rootstocks grown in nutrient solution which contained: upper, left to right, 25, 50, 75, 100, 125, and 150; and lower, left to right, 250, 350, 450, 550, and 600 parts per million nitrate in the form of calcium nitrate.

Valencia orange trees on Brazilian sour orange rootstock were also grown outdoors in six solution cultures, each of 29-gallon capacity. The nutrient solution consisted of distilled water containing: magnesium, 54 ppm, as the sulfate; sodium, 7 ppm, as the chloride; potassium 42 ppm, as the sulfate; phosphate, 15 ppm, as calcium acid phosphate and the minor elements including copper. Calcium nitrate—to furnish 100, 250, 500, 750, and 1000 ppm of nitrate—and calcium sulfate to equalize the calcium, were added to the culture solutions.

The pH—relative acidity-alkalinity—and concentrations of nitrate in each culture were checked every week and the culture solutions were renewed each month, distilled water being used at all times. For a period of three years records were kept of the cubic centimeters of the *B* solution—calcium nitrate stock solution used in Hoagland's nutrient solution—required to maintain the nitrogen level. The totals were: 4926, 6415, 5728, 5954, and 4945 at the increasing nitrate levels, the highest nitrate absorption occurring at the 250 ppm nitrate level in the culture solutions.

Phosphorus Content in Valencias

Concentration of nitrate (p.p.m.)	No. of fruit in sample	Total phosphorus in dry matter (p.p.m.)			
		Inner peel	Outer peel	Whole peel	Whole pulp
100	12	310	430	350	820
250	14	280	400	380	770
500	13	280	440	410	750
750	14	380	540	440	1045
1000	12	430	720	620	1390

The fresh weights of the tops above the bud unions were: 1215, 2235, 1337, 1342, and 1350 grams at the increasing nitrate levels. Comparable data for the roots below the uppermost rootlet were: 3235, 5665, 4470, 4680, and 2635 grams fresh weights and 1227, 1538, 1510, 1459, and 1013 grams dry weights.

An analysis of the fruit produced in solution cultures maintained at the various nitrate levels, showed that an increased concentration of nitrate in the nutrient solution was accompanied by increased contents of total phosphorus in the peel and pulp, suggesting that with increases in the nitrate levels an adequate available supply of phosphate becomes important.

These soil or solution cultures made their best growth when the nitrate supply was of relatively high concentration.

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