

Sodium in Citrus Seedlings

varieties react differently to same concentrations of sodium nitrate in the applied nutrients in tests

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Sodium has not as yet been found to be an essential element—for health in citrus—although it frequently occurs in varying concentrations in citrus orchard soils.

In the process of root absorption of nutrient elements, considerable sodium may enter the roots. In periods of low annual rainfall, scant irrigation water, or water of poor quality, it is possible for the absorption of sodium to increase greatly and to affect growth adversely.

One of the essentials to be determined—prior to planting an orchard—is the rootstock variety that best meets every condition which may be encountered in the future. Sodium is one of the factors that frequently enters into the selection of the rootstock variety. It is of interest, therefore, to study the effects of various concentrations of sodium added in the form of sodium nitrate to the nutrient solution applied to soil cultures of various seedling varieties.

The varieties used and the sources of the seeds obtained from fruits gathered for study were: Tangelo, R21, T52, 1ABC; rough lemon, R1, T52, 1ABC; grapefruit, R4, T39, 1ABC; sweet orange—Indian orchard—R11, T44, 1ABC; and Cleopatra mandarin, R13, T50, 1ABC. These seeds were planted in the propagation chamber on March 6, 1952. The Pomeroy trifoliolate orange seed, R34, T53, 1ABC, was planted on January 9, 1952, and that of the sour orange—Spanish—R16, T9-11, 1ABC, was planted on February 20, 1952. On September 2, 1952, the seedlings of the above varieties and of Troyer citrange, R34, T5, 1ABC, were planted in the soil cultures, all of the plants having previously been pruned to a uniform size for a given variety.

The nutrient solution of Hoagland was altered by omitting sodium chloride from stock solution *A* and using half-strength *B* and full-strength *C* stock solutions. The content of minor elements in the culture solutions was in parts per million—ppm—boron, .2; manganese, .2; zinc, .2; iron, .2; aluminum, 3; copper, .25; and molybdenum, .05. To this solution was added 0, 60, 120, 180, 240, and 300 ppm sodium in the form of sodium nitrate. The nutrient solutions were applied at various times in similar quantity to each culture, and frequently distilled

Sodium Content in Roots—Below the Uppermost Lateral Rootlet—of Eight Varieties of Citrus Seedlings Grown in Soil Cultures that Received a Nutrient Solution Containing Various Concentrations of Sodium Nitrate.

Roots (all below tap rootlet)	Sodium—parts per million—ppm—added as the nitrate to nutrient applied					
	0	60	120	180	240	300
	Sodium—per cent in root dry matter					
Citrange (Troyer) .....	.04	.07	.08	.11	.10	.14
Grapefruit .....	.03	.12	.17	.22	.30	.27
Trifoliolate orange (Pomeroy).....	.04	.11	.10	.19	.25	.28
Cleopatra mandarin .....	.04	.09	.18	.19	.22	.25
Sour orange (Spanish).....	.07	.12	.18	.18	.29	.36
Rough lemon .....	.03	.10	.12	.14	.16	.21
Tangelo .....	.05	.10	.17	.22	.27	.38
Sweet orange .....	.04	.15	.20	.33	.36	.57

water alone was added to take care of transpiration losses.

Three seedlings of a given variety were used in each of six well-drained soil cultures which were grown until August 24, 1953, when the cultures were photographed and harvested.

Growth of the various seedling varieties differed considerably but in every case the tops and roots were healthy. Seedlings of the Tangelo variety made a very steep increase in growth until the 240 ppm concentration was reached.

The growth of sour orange and Cleopatra mandarin seedlings was excellent in each culture and showed a rather gradual increase, even including the sixth culture, whereas with rough lemon

seedlings, growth was quite uniform except for some increase at the higher concentrations. Citrange seedlings showed a steady improvement in growth except at the highest sodium nitrate concentration where the growth was still at a high level. The growth of sweet orange and grapefruit seedlings showed an irregular trend with a definite decline appearing at the two highest concentrations. At the two highest concentrations, the growth of Trifoliolate orange seedlings declined.

None of the leaves of the seedlings showed obvious symptoms of injury. The primary purpose of the experiment was: to note whether accumulations of sodium occurred in the leaves and roots and bore any relation to the concentration of

Marked increase in the growth of Tangelo citrus seedlings in soil cultures that receive a nutrient solution containing increasing concentrations of sodium nitrate: 0 to 300 ppm sodium.



Sodium and Potassium Content in Leaves of Eight Varieties of Citrus Seedlings Grown in Soil Cultures that Received a Nutrient Solution Containing Various Concentrations of Sodium Nitrate.

Mature leaves and their location		Sodium—parts per million—ppm—added as the nitrate to nutrient applied																																			
		0						60						120						180						240						300					
		Potassium—per cent in leaf dry matter												Sodium—per cent in leaf dry matter																							
Citrange (Troyer)	all	3.15	2.55	2.63	2.48	2.61	2.40	.10	.06	.06	.10	.06	.14																								
Grapefruit	all	3.52	3.43	3.43	3.46	3.36	3.42	.03	.04	.09	.07	.16	.09																								
Trifoliolate orange (Pomeroy)	all	2.39	2.54	2.49	2.75	2.41	2.45	.07	.06	.07	.08	.07	.13																								
Cleopatra mandarin	(upper	2.40	2.44	2.32	2.35	2.55	2.55	.05	.07	.06	.06	.05	.10																								
	(lower	2.22	2.32	2.13	2.08	2.14	2.40	.05	.09	.07	.11	.13	.08																								
Sour orange (Spanish)	(upper	1.94	1.76	1.96	1.98	1.86	1.82	.05	.06	.06	.05	.07	.03																								
	(lower	2.44	2.24	2.29	2.48	2.35	2.03	.04	.07	.05	.04	.07	.08																								
Rough lemon	(upper	2.79	2.61	2.86	2.56	2.56	2.46	.04	.06	.08	.05	.05	.07																								
	(lower	2.67	2.59	3.04	2.57	2.75	2.44	.09	.08	—	.07	.08	.08																								
Tangelo	(upper	2.88	3.15	2.94	2.78	2.65	2.45	.03	.10	.12	.14	.20	.28																								
	(lower	2.83	3.05	2.85	2.49	2.39	2.34	.12	.14	.15	.19	.25	.35																								
Sweet orange	(upper	3.40	3.30	3.11	2.93	3.22	2.86	.04	.06	.07	.04	.02	.12																								
	(lower	3.51	3.28	3.37	3.12	3.06	2.71	.03	.05	.10	.05	.06	.09																								

sodium applied to the soil; whether absorbed sodium had any effect on the content of potassium in the leaves and roots; and finally whether the sodium and potassium content in the mature leaves of the upper half of each culture differed from that in the leaves of the lower half.

The sodium and potassium contents in the leaves are shown in the table on this page. Of the cultures that received sodium nitrate in the nutrient solution, the leaves of both the upper and lower halves of the Tangelo seedlings contained the greatest sodium concentrations of

any of the seedling varieties—leaves of the lower half of each Tangelo culture contained a greater percentage of sodium than those of the upper half. The sodium values for the leaves of this variety increase as the concentration of sodium nitrate in the nutrient solution increased.

The data in the table on this page show the generally low and nonuniform values for sodium in the various seedling leaves and the lack in most cases of a relationship of these values to the concentration of sodium nitrate added to the soil.

The leaves of the upper and lower halves of the sweet orange and Tangelo seedlings are of interest for they show generally decreasing potassium percentages as the concentration of sodium nitrate applied to the cultures is increased. Leaves from the upper halves of the sour orange-Spanish have lower potassium values than those from the lower halves, whereas leaves from the upper halves of the Cleopatra mandarin and Tangelo cultures have slightly higher potassium values than those from the lower halves.

In the table on page 12, the sodium content in the roots increases as the concentration of sodium nitrate added to the nutrient increased. The dry matter of sweet orange rootlets contained higher percentages of sodium than those of any of the other seedling varieties to the nutrient of which sodium nitrate was added. Of the seedling variety cultures that received sodium nitrate in their nutrient, the rootlets of the citrange plants contained the lowest sodium percentages. It was found that the increasing percentages of sodium in the dry matter of the rootlets had no appreciable effect on the rootlet potassium percentages.

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