

Effect of Different Rootstocks on Growth and Leaf Nitrogen in Young Citrus Cultivars

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ABSTRACT

In this preliminary report, bud-take, growth measurements and leaf nitrogen level in young citrus rootstock seedlings and their combinations with 'Washington' navel, 'Valencia' and 'Hamlin' oranges, 'Clementine' mandarin and 'Prior Lisbon' lemon as tops were compared. All cultivars on rough lemon gave the highest bud-take. 'Prior Lisbon' lemon scored the highest success of bud-union regardless of the stock. Among the five rootstocks studied, rough lemon followed by 'Rangpur' lime induced the most vigorous scion growth. By the end of the second year in the field, the 'Clementine' on 'Cleopatra' mandarin was the only superior combination in growth when compared with the sour orange stock. In general, 'Troyer' citrange was the least vigorous in all combinations. Leaf nitrogen level was highest in two-year-old nursery grown budlings of 'Hamlin' orange on 'Rangpur' lime and 'Valencia' orange on rough lemon among all nine orange combinations. This was also true for the 'Prior Lisbon' on 'Rangpur' lime.

INTRODUCTION

The sour orange is known to be the standard rootstock used for citrus plantings in Libya. There are no experimental findings to support the complete dependence on this rootstock in growing different citrus cultivars under local conditions (8). In addition, with the appearance of the tristeza virus disease in the Mediterranean basin, it becomes necessary to use a tristeza resistant rootstock as a possible replacement for the sour orange.

A citrus rootstock research program was initiated at the University of Tripoli Farm at Sidi El-Mesri to evaluate some selected rootstocks known to be successful in other citrus producing areas of the world (2,4,5,6,10,11). No doubt, work of this nature needs time and effort to suggest any reliable recommendations, as the results of any rootstock trials vary from place to place due to the soil and environmental influences if not for the interactions occurring with the scion cultivars, including the virus problems (4,5,6,10).

This is a preliminary report on the performance, in the nursery and in the field, of five different citrus rootstocks and the response of five scion cultivars budded on them.

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MATERIALS AND METHODS

Seeds of sour orange *Citrus aurantium* L., rough lemon *C. jambhiri* Lush., 'Rangpur' lime *C. limonia* Osbeck and 'Troyer' citrange [*Poncirus trifoliata* (L.) Raf. X *C. sinensis* (L.) Osbeck] were planted in the seed-bed in April, 1969. The seedlings were transplanted to the nursery row in late March, 1970. Seedlings of 'Cleopatra' mandarin *C. reshni* Hort. ex. Tan. were set-out in September, 1969. Nursery budding on these seedlings was done in late March, 1971 and late September of the same year, according to the size and vigor of the seedlings or for any rebudding required. The registered budwood material used in this study was comprised of the 'Parent Washington' navel, 'Campbell Valencia' and 'Hamlin' sweet orange *C. sinensis* (L.) Osbeck, the 'Clementine' mandarin (Algerian Tangerine) *C. reticulata* Blanco and the 'Prior Lisbon' 14-18 lemon *C. limon* L. The budded plants were transplanted to the field in late February and late September, 1972. The soil in the permanent place is a deep sandy loam, known to be relatively high in calcium carbonate and of a pH around 7.8.

For the orange cultivars, a randomized block design was adopted with three replications for each scion/stock combination. Every replicate contained four trees lined in a straight row. The 'Clementine' mandarin and the 'Prior Lisbon' lemon were established in two separate adjacent blocks. Each scion/stock combination consisted of eighteen trees per plot with two replications.

Growth evaluation was based on the calculated stem cross-sectional area from diameter measurements. The seedling plants were measured at 25 cm above the ground level; the budded trees at 5 cm below and above the bud-union. These measurements were taken at the time of budding; March, 1971, and repeated annually thereafter.

Nitrogen determinations were made on leaves 5-7 months old, taken from nursery-grown budlings. The micro-Kjeldahl method of analysis was used (9).

All plants were subjected to the same cultural practices either in the nursery or in the field.

RESULTS AND DISCUSSION

This experiment was located in an environment typical of the center of the citrus growing area in Libya.

Bud-Take

The percentage of bud-take for different scion/stock combinations (Table 1) showed a range from 100% bud-take for 'Prior Lisbon' lemon on rough lemon to 0% for 'Clementine' mandarin on 'Troyer' citrange. The superior scion/stock combinations in percentage of bud-take were 'Prior Lisbon' lemon on rough lemon (100%), 'Washington' navel orange on rough lemon (89%), 'Clementine' mandarin on rough lemon (85%), 'Prior Lisbon' lemon on 'Rangpur' lime (82%) and 'Valencia' orange on rough lemon (77%). Among the stocks, rough lemon gave the highest percentage of bud-take (84%) followed by 'Rangpur' lime (46%) and sour orange (42%). The means for scion cultivars, 'Prior Lisbon' lemon scored the highest bud-take on the different rootstocks (75%) followed by 'Washington' navel orange (50%). From unreported data, 'Cleopatra' mandarin and 'Troyer' citrange seedlings of the same plots in the nursery gave nearly 90% bud-take when budding was practiced on 3-year-old seedlings. This indicated that to achieve better success, these two rootstocks may require at least one more growing season in the nursery row than rough lemon, 'Rangpur' lime or sour orange.

Table 1 Percentage of "take" of five citrus cultivars budded on five different rootstocks.

Rootstock	% Bud-take of scion cultivar ¹					Mean for stock
	Wash. navel orange	Valencia orange	Hamlin orange	Clementine mandarin	Lisbon lemon	
Sour orange	44.5	48.8	28.1	18.5	73.7	42.7
Rough lemon	89.4	77.6	70.6	85.3	100.0	84.6
Rangpur lime	54.6	12.3	47.2	34.2	82.8	46.2
Cleopatra mandarin	24.6	4.8	0	1.3	73.4	20.8
Troyer citrange	39.5	4.4	1.7	0	47.1	18.5
Mean for scion	50.5	29.6	29.5	27.9	75.4	

¹ Each value represents a number ranging between 50 and 100 buddings.

Growth

The cross-sectional area of the stem as used by Batchelor and Rounds (2) was taken as an indication of tree growth in this report. Growth of rough lemon seedlings was significantly superior to all other rootstocks tested at all ages (Table 2). The cross-sectional area of rough lemon stem, on the fifth year from seeding, was 1.64 times that of 'Rangpur' lime and 3.11 times that of sour orange. The 'Rangpur' lime seedlings were evidently of higher vigor than 'Cleopatra' mandarin, 'Troyer' citrange and sour orange. The differences between the three latter stocks were insignificant. This indicated that, under prevailing environmental conditions, both rough lemon and 'Rangpur' lime are more vigorous and rapid growing rootstocks than sour orange. These findings are in agreement with many previous reports in other citrus growing areas (4,5,6).

Table 2 Differences in growth of five citrus seedling varieties used as rootstocks.

Seedling	Stem cross-sectional area in cm ² at different ages ¹			
	2 Years	3 Years	4 Years	5 Years
Sour orange	0.35	2.01	2.55	7.50
Rough lemon	1.02	5.15	11.58	23.33
Rangpur lime	0.72	2.60	6.56	14.25
Cleopatra mandarin	0.47	1.56	2.66	10.12
Troyer citrange	0.29	1.17	3.14	9.57
L.S.D. at 1%	0.06	0.40	0.95	2.44

¹Measurements taken at 25 cm above ground level.

Effect of Rootstock on Scion Growth

The data in Table 3, shows that rough lemon stock induced the most vigorous growth in 'Prior Lisbon' lemon scion followed by 'Rangpur' lime rootstock. However, no appreciable difference was noticed between these two stocks, but they were significantly superior in inducing vigorous growth in the 'Prior Lisbon' lemon compared to the three other stocks: sour orange, 'Cleopatra' mandarin and 'Troyer' citrange. It is also worthy

Table 3 Growth of 'Prior Lisbon' lemon budded on five different citrus rootstocks compared with the seedling stocks; measurements taken two years after budding (end of first season in field).

Rootstock	Stem cross-sectional area in cm ²			
	Scion (5 cm above union)	Budded stock (5 cm below union)	Seedling stock (25 cm above ground)	% Difference in stock measurements ¹
Sour orange	4.56	4.52	2.55	+77
Rough Lemon	7.94	10.46	11.58	-10
Rangpur lime	6.16	6.93	6.56	+6
Cleopatra mandarin	2.35	2.55	2.66	-4
Troyer citrange	2.16	2.32	3.14	-26
L.S.D. at 1%	0.77	1.07	0.95	

¹Calculated as (budded stock-seedling stock) divided by seedling stock × 100.

Table 4 Growth of some citrus cultivars budded on three different rootstocks.

Rootstock	Stem cross-sectional area in cm ²						Mean Budded stock
	Seedling stock	Wash. navel orange	Valencia orange	Hamlin orange	Clementine mandarin	Lisbon lemon	
<i>One year after budding; at time of field transplanting</i>							
<i>Stock Measurements</i> (5 cm below bud-union)							
Sour orange	2.01	1.09	1.79	1.96	1.21	2.14	1.64
Rough lemon	5.15	3.40	4.01	4.75	2.78	3.84	3.76
Rangpur lime	2.60	2.87	2.75	3.43	2.04	2.43	2.70
L.S.D. at 1%	0.75	0.53	0.55	0.55	0.50	0.42	
Mean	3.25	2.45	2.85	3.38	2.01	2.80	
<i>Scion Measurements</i> (5 cm above bud-union)							
Sour orange	—	0.72	1.33	1.56	0.62	1.99	1.24
Rough lemon	—	2.04	2.24	2.66	0.99	2.84	2.15
Rangpur lime	—	1.86	1.77	2.41	0.93	2.24	1.84
L.S.D. at 1%		0.40	0.43	0.50	0.28	0.42	
Mean for scion		1.54	1.78	2.20	0.85	2.36	
<i>Two-year after budding; end of first season in field</i>							
<i>Stock Measurements</i>							
Sour orange	2.55	2.24	2.96	3.70	—	—	2.97
Rough lemon	11.58	6.61	7.74	8.66	—	—	7.67
Rangpur lime	6.55	5.47	5.19	5.81	—	—	5.49
Mean	6.90	4.77	5.30	6.06			
L.S.D. at 1% for scion/stock combinations - 1.55							
L.S.D. at 1% for scion or stock means - 1.20							
<i>Scion Measurements</i>							
Sour orange	—	1.82	2.35	2.95	—	—	2.37
Rough lemon	—	4.87	5.31	6.42	—	—	5.53
Rangpur lime	—	3.91	3.91	4.56	—	—	4.13
Mean for scion		3.53	3.86	4.64			
L.S.D. at 1% for scion/stock combinations - 1.50							
L.S.D. at 1% for scion or stock means - 1.18.							

to note that the trunk cross-sectional area was larger for budded over unbudded sour orange seedlings which indicates that the 'Prior Lisbon' lemon scion stimulated the growth of the sour orange rootstock; about 77% more than the unbudded seedlings.

From Table 4, the rough lemon and 'Rangpur' lime compared with the sour orange as rootstocks for the five citrus cultivars gave indications that in all combinations, the rough lemon induced the most vigorous growth in all scion tops followed by the 'Rangpur' lime. Response to sour orange was least significant among all cultivars. This was true in both seasons reported.

Scion growth measurements taken at the end of the second year in the field (Table 5), indicate that the 'Prior Lisbon' lemon on rough lemon stock gave the most vigorous combination followed by the 'Valencia' and 'Hamlin' oranges on the same stock. These last two orange cultivars on 'Troyer' citrange were the least vigorous among all 25 combinations tested. On the average, the 'Rangpur' lime stock was the second best followed by the sour orange. The latter appeared to have a more invigorating effect on 'Prior Lisbon' lemon, 'Washington' navel and 'Hamlin' orange tops than the 'Cleopatra' mandarin stock. However, the 'Clementine' responded better on 'Cleopatra' mandarin than on sour orange stock.

Table 5 Growth of five citrus cultivars budded on five different rootstocks; measured three years after budding (end of second season in field).

Rootstock	Scion cross-sectional area in cm ²					Mean for stock
	Wash. navel orange	Valencia orange	Hamlin orange	Clementine mandarin	Lisbon lemon	
Sour orange	5.56	4.41	7.65	4.95	9.08	6.33
Rough lemon	12.01	13.46	12.57	9.19	14.19	12.28
Rangpur lime	10.46	8.04	10.24	8.09	12.13	9.79
Cleopatra mandarin	3.46	4.34	3.37	6.51	6.70	4.88
Troyer citrange	3.60	2.72	2.93	3.37	6.51	3.82
L.S.D. at 1%	1.29	1.28	1.30	2.04	0.96	
Mean for scion	7.02	6.59	7.35	6.42	9.72	
L.S.D. at 1% for scion or stock means - 1.19						

Table 6 Percentage of leaf nitrogen in nursery-grown citrus budlings compared with the seedling rootstocks.

Rootstock	Orange Cultivar			Mean for stock	Lisbon lemon	Seedling stock
	Wash. navel	Valencia	Hamlin			
Sour orange	2.59	2.46	2.54	2.53	2.33	2.50
Rough lemon	2.57	2.74	2.51	2.61	2.44	2.33
Rangpur lime	2.55	2.61	2.93	2.70	2.58	2.41
Cleopatra mandarin	—	—	—	—	2.29	2.47
Troyer citrange	—	—	—	—	2.36	2.40
L.S.D. at 1%		0.16			0.14	0.15
Mean for scion	2.57	2.60	2.66			
L.S.D. at 1% for orange scion or stock means - 0.10						

Leaf Nitrogen Level

No correlation was observed between leaf nitrogen level and growth vigor in budded or seedling rootstocks grown under uniform conditions in the nursery. In Table 6, the rough lemon seedlings — the most vigorous — were the lowest in leaf nitrogen (2.33%), whereas the sour orange — the least vigorous — was the highest (2.50%). No differences were noticed between the other three stock seedlings. The 'Rangpur' lime appreciably induced higher nitrogen level in the leaves of budded 'Prior Lisbon' lemon (2.58%) compared to all other stocks. This was valid with 'Hamlin' orange budded on the same stock (2.93%) compared with all other orange combinations. The 'Valencia' orange on rough lemon was the second best. On an average basis, the 'Rangpur' lime rootstock apparently has a beneficial effect in increasing leaf nitrogen level in orange scions.

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