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NUTRITIONAL STATUS OF DIFFERENT PARTS OF TREE AND FRUIT OF WASHINGTON NAVEL ORANGE AS AFFECTED BY FIVE DIFFERENT ROOTSTOCKS

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ABSTRACT: ***A field experiment was carried out during 2003 and 2004 seasons to study the effect of five rootstocks on nutritional status of Washington navel orange trees grown in Sakha Agriculture Research Station, Kafr El-Sheikh, Egypt.***

1. Root mineral content of the tested rootstocks showed that, Sour orange revealed significantly higher levels of N, Na, Zn and Cl and lower in Ca and Cu while P, K, Mg, Mn, Fe recorded moderate levels. Beside Volkamer lemon recorded higher of P, Ca, Mg and Cu but lower in K, Fe, Zn and Mn, Rangpur lime was higher in Ca, Mg, Cl and Fe but lower in N, P, Na and Mn. Troyer citrange was higher in N, K, Na, Fe, Mn and Cu but lower in Mg and Cl, Cleopatra mandarin showed higher P but lower in K, Ca, Mg and Na.

2. Washington navel orange budded on Volkamer lemon and Rangpur lime rootstock had significantly higher N, K, Ca, Mg, Fe, Zn and Cu and lower P and Na values producing leaves with moderate levels of most nutrients. Leaves on Cleopatra mandarin rootstock had lower values of N, K, Ca, Mg, Cl, and Fe with significantly higher values of Na and Mn. Sour orange and Troyer citrange rootstocks, recorded the highest values of P, and moderate values of Mg, K, Fe, Ca and Mn. On the other Side, Volkamer lemon and Rangpur lime rootstocks estimated the least N/K and highest K/Na ratios in leaves of the Scion variety, also they had higher ability to reduce (Na + Cl) accumulation in leaves of the scion, therefore, both rootstocks may be considered among salt and drought tolerant citrus rootstocks. On the other hand, Cleopatra mandarin rootstock as dwarf rootstock counted the highest N/K and least K/Na ratio in leaves. These unbalanced ratios attained by Cleopatra mandarin rootstock can make a budded scion variety sensitive to salinity and drought stresses.

3. Peel fruit of Washington navel orange budded on Volkamer lemon and Rangpur lime rootstocks had significantly higher N, K, Ca, Mg, Fe, Zn, Mn and Cu. Meanwhile, peel fruit taken from trees budded on Sour orange, Troyer Citrange and Cleopatra mandarin rootstocks gave nearly similar values of all these nutrients.

4. Fruit juice of Washington navel orange trees budded on Volkamer lemon and Rangpur lime rootstocks had significantly higher N, Mg, Ca, P and K and lower values of Na and Cl than those determined on Sour orange, Troyer citrange and Cleopatra mandarin rootstocks. Meanwhile, Fe, Zn, Mn and Cu

were significantly higher in fruit juice of Volkamer lemon rootstock, while other tested rootstocks gave nearly similar trend for these nutrients.

Key Words: ***Washington Navel orange – Citrus sineces – Nutritional status – rootstocks – volkamer lemon – Troyer citrange – Cleopatra mandarin – Sour orange.***

INTRODUCTION

The rootstocks and various nutrients influence the growth productivity, yield, quality and storage live of fruit which in turn is affected by the nutrient availability or nutrient absorbing capacity of the plant. Hence, nutrient has to be supplied as per the nutrient absorbing capacity or characteristics of the particularly rootstock used. Amount of mineral elements in the scion is greatly influenced by rootstock. Studies by El-Sayed Somaia (1999) revealed that amount of N, P, K, Ca, Fe, Mn and Zn removal by vigorous rootstocks such as Volkamer lemon and Rangpur lime was higher than dwarfing rootstock namely Cleopatra mandarin. Such conclusion finds support by Fallahi *et al.,* 1992 Kaplankiran and Tuzcu, 1994, Marathe *et al.,* 2000 and Dawood, 2000 reported that leaf N, K, Ca, Mg and Zn contents of scion on Volkamer lemon rootstock were higher than that on Sour orange rootstock. This work was to study the effect of five different rootstocks on nutritional status of different parts of tree and fruit of Washington navel orange. So, the interrelationship between scion and used rootstock was discussed in this study.

MATERIALS AND METHODS

This experiment was carried out on 8 years old trees of Washington navel orange budded on five different citrus rootstocks in the experimental farm of Sakha Agriculture Research Station, Kafr El-Sheikh Governorate, Egypt during 2003 and 2004 seasons. The tested rootstocks were: Sour orange (*C. aurantium*), Volkamer lemon (*C. volkameriana*), Troyer citrange (*P. trifoliate* x *C. sinensis*), Rangpur lime (*C. aurantifolia* x *C. reticulate*) and Coleopatra mandarin (*C. reticulate*). The experimental trees were planted at 5 x 5 meters in complete randomized block design with three trees plot replicated three times for a total of nine tree per rootstock budded with Washington navel orange. Mechanical and chemical analysis of experimental field soil was done as shown in Table (1).

Table (1): Mechanical and chemical analysis of experimental field soil.

Mechanical				Chemical			Available ppm			DTPA extractable ppm				
Sand %	Silt %	Clay %	T. Clay	pH	EC	O.M %	N	P	K	Fe	Zn	Pb	Ni	Cd
9.65	32.15	58.20	Clay	8.0	3.35	1.90	18.53	7.78	273.47	20.09	9.97	0.48	0.74	0.19

In both seasons, all trees received the following fertilization program: 300 gm ammonium sulphate/tree in March and 450 gm/tree in June, 200 gm ammonium nitrite/tree and 200 gm potassium sulphate/tree in August.

In this study, four branches of 2 inches in diameter from each replicate were selected in the four direction and tagged, then all sampling materials were taken from these branches.

Determination of macro and micro-nutrients:

In mid August of both seasons 60 spring flush leaves from each replicate were sampled and washed three times with tap water, then washed again with distilled water. Samples were oven dried at 70°C to constant weight, ground, digested with H_2SO_4 and H_2O_2 according to Evenhuis and DeWaared (1980). In September of both seasons, root samples from fibrous roots were taken from each replicate, then washed several times and oven dried at 70°C at constant weight ground and digested with H_2SO_4 and H_2O_2 according to Evenhuis and Dewaared (1980). 10 mature fruit were taken at random from each tree at harvest time (in 15 December in both seasons) to extract fruit juice by using hand squeezer, juice was clarificated aired on hot plate by using low temperature, then fruit peel and juice dry mater was digested with sulphoric acid and hydrogen peroxide according to Evenhuis and Dewaard (1980).

In digested samples of leaves, peel, juice and root samples, N, P, K, Ca, Mg, Na, Fe, Zn, Mn and Cu were determined as follows:

1. **Nitrogen was determined by microkjeldahl Gunning method (A.O.A.C. 1967).**
2. **Phosphorus was determined colorimetrically using spectrophotometer at 882 U.V. according to Murrphy and Riely (1962).**
3. **Potassium and sodium were determined by flame photometer E.E.I. Model (Jackson, 1967).**
4. **Ca, Mg, Fe, Zn, Mn and Cu were determined by Perken Elemer Atomic Absorption spectrophotometer model 2380 Al According to Jackson and Ulich (1959) and Yoshida *et al.* (1972).**
5. **Chloride was determined by Silver nitrate methods due to Brown and Jackson (1955). All macro-nutrients were expressed as percent, while micro-nutrients as ppm on dry weight basis.**

- **Leaf chlorophyll content was determined by N.N. dimethyl formamide according to method of (Moran and Porath, 1980).**
- **Leaf total carbohydrates content was determined as percent on dry weight by using phenol sulphoric acid method according to Dubois *et al.* (1956). Then, C/N ratio was calculated by dividing the percentage of carbon in the carbohydrates values determined in leaves on the percentage of nitrogen in leaves.**

All obtained data were statistically analyze using a randomized complete block design according to Snedecor and Cochran (1967) and the least significant difference (L.S.D. at 5% level) was used to compare the main values.

RESULTS AND DISCUSSION

1. Root mineral content of rootstocks:

Data in Table (2) showed that, roots of Sour orange rootstock revealed high level of N, Na, Cl and Zn and lower levels of Ca and Cu content, while recorded moderate values of P, K, Fe, Mn..

Table (2): Root nutrients content of five citrus rootstocks as affected by Washington navel orange trees during 2003 and 2004 seasons.

Rootstock	N %	P %	K %	Ca %	Mg %	Na %	Cl %	Fe ppm	Zn ppm	Mn ppm	Cu ppm
	2003										
Sour orange	1.83	0.194	1.235	1.555	0.221	0.277	0.184	207	91.2	81.9	20.2
Volkamer lemon	1.42	0.200	1.191	1.719	0.238	0.250	0.160	181	72.0	72.3	24.5
Troyer citrange	1.78	0.187	1.336	1.680	0.216	0.278	0.133	216	89.0	95.0	25.5
Rangpur lime	1.29	0.172	1.246	1.716	0.230	0.231	0.180	230	90.8	69.7	20.0
Cleopatra mandarin	1.48	0.203	1.156	1.554	0.201	0.233	0.153	206	90.2	81.2	21.0
L.S.D. 5%	0.07	0.012	0.013	0.020	0.002	0.003	0.010	14.02	4.90	4.64	2.07
1%	0.10	0.017	0.018	0.028	0.003	0.004	0.014	19.32	6.76	6.39	2.82
	2004										
Sour orange	1.73	0.186	1.226	1.557	0.224	0.256	0.175	194.4	86.14	72.1	19.6
Volkamer lemon	1.39	0.195	1.190	1.698	0.231	0.243	0.151	178.4	66.54	63.0	22.5
Troyer citrange	1.69	0.179	1.327	1.668	0.221	0.260	0.122	213.8	80.51	80.0	23.7
Rangpur lime	1.35	0.172	1.233	1.714	0.229	0.230	0.173	224.2	85.17	63.4	18.6
Cleopatra mandarin	1.45	0.195	1.149	1.562	0.208	0.236	0.142	193.3	81.48	71.9	18.2
L.S.D. 5%	0.06	0.007	0.008	0.069	0.004	0.005	0.025	7.025	5.20	4.50	2.50
1%	0.08	0.010	0.011	0.095	0.006	0.007	0.035	10.10	7.20	6.20	3.50

Besides, Volkamer lemon rootstock recorded higher values of P, Ca, Mg and Cu and lower K, Fe, Zn and Mn. On the other hand, Rangpur lime gave the highest values of Ca, Mg, Cl, Fe, Zn and lower N, P, Na and Mn. Troyer citrange rootstock was higher in N, K, Na, Fe, Mn and Cu with lower values in Mg and Cl. Cleopatra mandarin recorded higher values of P and lower values of K, Ca, Mg and Na. These results clear that, both macro and micro-nutrients in root of all tested rootstocks were not consistent in their trend. These results were true in both seasons. These results agree with those of Saad-Allah *et al.,* 1985, Azab 1995 and Dawood 1996. These results reflexed the ability of a given rootstock to absorb macro- and micro nutrients via its roots. So, the obtained values herein put light on the interrelationship between scion and the tested rootstock and may explain the vigorous effect of Volkamer lemon and Rangpur lime rootstocks and also, the dwarfing effect of Cleopatra mandarin rootstocks. Moreover, data in Table (3) supports this conclusion.

2. Effect of rootstock on leaf mineral contents and some organic-substance:

a. Leaf mineral content in scion leaves:

Data in Table (3) showed that, the highest values of N, K, Ca, Mg, Cl, Fe, Zn and Mn in leaves of Washington navel orange were recorded on Volkamer lemon and Rangpur lime rootstocks when compared with those on the other

tested rootstocks, the differences were significant in most cases in both seasons. On the other hand, both rootstocks recorded lower values of P and Na without significant differences between them. These results clear that, Volkamer lemon and Rangpur lime rootstocks had higher ability to increase N, K, Ca, Mg, Fe, Zn and Mn absorption via their roots. Similar results were obtained by Kaplankiran and Tuzcu 1994, Abou-Rawash (1995), Marathe *et al.,* 2000 and Dawood, 2002. They reported that leaves N, K, Ca, Mg, Fe, Zn and Mn contents of Washington navel orange budded on Volkamer lemon and Rangpur lime were higher, but had lower values of Na and Cl in their leaves. On the other hand, Cleopatra mandarin rootstock detected the least values of N, P, K, Ca, Mg. Fe, Zn and Cl and the highest values of Na in leaves of the scion variety. As for Sour orange rootstock, data in Table (3) showed that, leaves contained the highest values of P, Cu, while recorded moderate values of Mg, K, N, Fe, Zn, Cl and Mn.

As for Troyer citrange rootstock, data in Table (3) showed higher values of P, Ca and Na and lower values of N, K, Mg, Fe, Zn and Cu when compared with Sour orange rootstock, the differences were significant in most cases in both seasons.

As for Cleopatra mandarin rootstock, the results show that, Cleopatra mandarin rootstock recorded least values of N, P, K, Ca, Mg, Fe, Zn and Cl and highest values of Na and Mn in leaves of the scion variety, the differences were significant in most cases.

Table (3): Leaf nutrients content and some nutritional balance of Washington navel orange trees as affected by five citrus rootstocks during 2003 and 2004 seasons.

Rootstock	N %	P %	K %	Ca %	Mg %	Na %	Cl %	Fe ppm	Zn ppm	Mn ppm	Cu ppm	N/K ratio	K/Na ratio	Na + Cl%
	2003													
Sour orange	2.49	0.170	1.64	3.59	0.534	0.292	0.186	94.5	23.0	29.2	11.3	1.518	5.616	0.478
Volkamer lemon	2.76	0.153	1.87	3.91	0.666	0.243	0.218	117.0	25.7	65.0	14.2	1.476	7.695	0.461
Troyer citrange	2.40	0.183	1.57	3.65	0.502	0.307	0.247	89.3	22.7	25.2	9.3	1.529	5.114	0.554
Rangpur lime	2.65	0.160	1.82	3.84	0.624	0.262	0.188	123.8	28.4	35.3	11.3	1.456	6.946	0.450
Cleopatra mandarin	2.36	0.158	1.50	3.45	0.478	0.363	0.152	84.6	23.0	46.0	10.3	1.573	4.132	0.515
L.S.D. 5%	0.04	0.017	0.02	0.07	0.031	0.023	0.015	0.8	1.2	1.7	N.S	0.07	0.29	0.002
1%	0.06	0.024	0.03	0.10	0.043	0.031	0.022	1.13	1.7	2.5	N.S	0.09	0.41	0.003
	2004													
Sour orange	2.29	0.178	1.67	3.56	0.539	0.289	0.188	97.8	22.1	28.2	12.1	1.371	5.779	0.477
Volkamer lemon	2.70	0.158	1.90	3.86	0.676	0.243	0.218	119.4	24.4	67.0	15.1	1.420	7.819	0.461
Troyer citrange	2.21	0.198	1.61	3.66	0.509	0.307	0.249	93.9	21.9	26.3	10.3	1.372	5.244	0.556
Rangpur lime	2.57	0.168	1.84	3.86	0.627	0.261	0.190	126.3	26.7	34.2	12.3	1.396	7.049	0.451
Cleopatra mandarin	2.17	0.164	1.62	3.47	0.490	0.362	0.167	86.9	21.9	47.4	11.3	1.339	4.475	0.529
L.S.D. 5%	0.10	0.013	0.06	0.06	0.015	0.006	0.017	8.0	N.S	7.6	2.6	N.S	1.80	0.002
1%	0.13	0.019	0.09	0.08	0.021	0.008	0.023	11.1	N.S	10.5	3.6	N.S	2.48	0.003

These results were true in both seasons. So, these levels can explain the dwarf effect of this rootstock. The obtained results are in line with those reported by Fallahi *et al.,* 1992, Mansour *et al.,* 1993 and Dawood, 2001.

Also, data in Table (3) showed higher values of K/Na ratio and lower values of Na + Cl and N/K values of Washington navel orange on Volkamer lemon and Rangpur lime rootstocks when compared with other tested rootstocks. Contrary, Cleopatra mandarin rootstock recorded higher values of N/K and Na + Cl and lowest values of K/Na ratio. Other tested rootstocks recorded intermediate values of these nutritional ratios.

So, these results could explain the vigorous effect of both rootstocks and their good ability to grow well under saline and alkaline soils. While, these results also clear the dwarf effect of Cleopatra mandarin rootstock and proved that it will be unsuitable under the same conditions of this experiment.

These conclusions agree with the those of Zekri and Parasons 1992 they found that the accumulation of both Na^+ and Cl^- to a toxic level could be the main factor causing nutrient imbalance and reducing growth in some citrus rootstocks grown under different salinity levels.

b. Some organic substances in scion leaves:

Data in Table (4) clear that leaves of Washington navel orange budded on Volkamer lemon and Rangpur lime rootstocks recorded the least values of C/N ratio whereas Cleopatra mandarin rootstock recorded higher values of C/N ratio, while Troyer citrange and Sour orange rootstocks recorded intermediate values of C/N ratio. Apparently, the narrow C/N ratio may be attributed to the relative higher N absorption via the root of Volkamer and Rangpur lime rootstock and the depletion of carbohydrate level during the most active vegetative growth period of both rootstocks. On the other hand, high C/N ratio recorded for Cleopatra mandarin as a dwarf rootstock could be explained in the same direction. These results are in line with those reported by Maatouk *et al.,* 1988, Gallasch and Dalton 1989 and Azab 1995. That higher protein levels usually encourage building new vegetative growth leading to depletion of carbohydrates. Moreover, Azab 1995 reported that the vigorous rootstocks such as Volkamer lemon and Rangpur lime had lower C/N ratio as compared with other tested rootstocks. However, higher C/N ratio means carbohydrates accumulation, this accumulation may be due to relative inhibition of growth resulted by Cleopatra mandarin as dwarf rootstock for the scion varieties.

As for leaf chlorophyll content, data in Table (4) recorded higher values of total chlorophyll content in leaves of Washington Navel orange budded on Volkamer lemon, Sour orange and Rangpur lime rootstocks than other tested rootstocks, the differences were significant in most cases in both seasons. Data in Table (3) assure the increasing of N and Mg values in leaves of Washington navel orange budded on Volkamer lemon and Rangpur lime rootstocks.

Table (4): Some organic-substances in scion leaves as effected by different rootstocks in 2003 and 2004 seasons.

Rootstock	Chlorophyll			Total carbohydrate	C/N ratio	Yield Kg/tree
	A	B	Total			
2003						
Sour orange	36.54	14.28	50.82	10.36	4.16	7.82
Volkamer lemon	36.25	14.38	50.63	10.18	3.69	17.39
Troyer citrange	36.20	13.87	50.07	10.37	4.32	10.38
Rangpur lime	36.33	13.82	50.15	10.27	3.88	15.16
Cleopatra mandarin	35.72	14.40	50.12	10.67	4.52	3.78
L.S.D. 5%	N.S	0.16	0.45	0.14	0.06	0.07
1%	N.S	0.23	0.63	0.21	0.09	0.10
2004						
Sour orange	40.52	20.55	61.07	10.48	4.58	13.29
Volkamer lemon	41.02	21.08	62.10	10.24	3.79	28.54
Troyer citrange	40.03	19.79	59.82	10.49	4.75	14.91
Rangpur lime	40.88	21.45	62.33	10.38	4.04	24.98
Cleopatra mandarin	37.61	18.10	55.71	10.80	4.98	5.75
L.S.D. 5%	N.S	2.05	3.26	N.S	0.33	1.04
1%	N.S	2.83	4.50	N.S	0.45	1.43

Contrary, the reduction of total chlorophyll of Cleopatra mandarin and Troyer citrange rootstocks could be explained by a depletion of some nutrients absorption (N, K, Ca, Mg, Fe and Mn). These results are in line with those reported by Levitt, 1980 and Behboudian *et al.,* 1986.

Also, data in Table (4) showed that Washington navel orange variety budded on Volkamer lemon and Rangpur lime rootstocks gave the highest values of yield (kg/tree) followed by Troyer citrange rootstock, while, Cleopatra mandarin rootstock gave the least values of yield in both seasons. The differences were significant in all cases, these results were true in both seasons.

3. Effect of rootstocks on fruit peel mineral contents:

Data in Table (5) showed that, fruit peel of Washington navel orange budded on Volkamer lemon content had higher values of N, K, Ca, Mg, Na, Fe, Mn and Cu and lower values of P, Cl and Zn content. As for Rangpur lime rootstocks, data recorded higher values of N, P, K, Ca, Mg, Fe, Zn and Mn and lower values of Na and Cl content of fruit peel in both seasons.

As for Sour orange rootstock, data showed intermediate values of N, P, K, Ca, Mg, Fe, Zn and Cu content of fruit peel. On the other hand, fruit peel recorded lower values of Na and higher values of Cl contents in both seasons. As for Troyer citrange rootstock, fruit peel had higher values of P, Ca, Na, Zn, Mn and lower values of N, K, Mg, Fe, and moderate values of Cl in both seasons when compared with other rootstocks. While, Cleopatra mandarin rootstock recorded higher values of fruit peel content of Na, Zn, Mn and lower values of N, P, K, Ca, Mg, Cl, Fe and Cu. Similar results were reported by Ennab, 2003 and Protopadakis *et al*. (1998).

Table (5): Fruit peel nutrients content of Washington navel orange trees as affected by five citrus rootstocks during 2003 and 2004 seasons.

Rootstock	N %	P %	K %	Ca %	Mg %	Na %	Cl %	Fe ppm	Zn ppm	Mn ppm	Cu ppm	Peel thickness (cm)
	2003											
Sour orange	0.090	0.081	0.774	1.519	0.147	0.029	0.040	13.25	2.42	6.14	4.09	0.48
Volkamer lemon	0.105	0.073	0.884	1.645	0.184	0.038	0.025	16.19	2.13	7.29	5.17	0.52
Troyer citrange	0.086	0.090	0.721	1.561	0.139	0.034	0.038	12.76	2.30	6.54	3.48	0.39
Rangpur lime	0.100	0.085	0.857	1.645	0.171	0.029	0.037	17.13	2.46	7.57	4.20	0.49
Cleopatra mandarin	0.084	0.074	0.707	1.476	0.131	0.035	0.033	11.78	2.59	6.54	3.81	0.48
L.S.D. 5%	0.002	0.003	0.004	0.014	0.006	0.006	0.005	0.06	0.004	0.06	0.13	0.03
1%	0.003	0.004	0.006	0.020	0.008	0.008	0.006	0.08	0.006	0.08	0.17	0.04
	2004											
Sour orange	0.098	0.078	0.761	1.532	0.146	0.030	0.040	12.82	2.23	6.36	3.80	0.45
Volkamer lemon	0.108	0.071	0.871	1.667	0.183	0.038	0.025	15.87	2.24	7.09	4.81	0.54
Troyer citrange	0.094	0.084	0.730	1.557	0.137	0.034	0.038	12.11	2.40	6.28	3.16	0.38
Rangpur lime	0.104	0.074	0.848	1.638	0.171	0.030	0.037	16.78	2.63	7.84	3.82	0.46
Cleopatra mandarin	0.094	0.073	0.698	1.468	0.130	0.036	0.030	11.47	2.75	6.36	3.49	0.45
L.S.D. 5%	0.006	N.S	0.052	N.S	0.021	0.002	0.004	2.34	0.15	1.01	0.89	0.02
1%	0.009	N.S	0.072	N.S	0.029	0.004	0.006	3.23	0.21	1.39	0.23	0.04

Also, data in Table (5) showed the highest values of peel thickness recorded for fruit taken from trees budded on Volkamer lemon and Rangpur lime rootstocks. Also, peel analysis recorded the highest values of K, Ca and Mg than other tested rootstock (Table 5). Contrary, the lowest values of peel thickens were recorded for fruit on Sour orange and Troyer citrang rootstocks, which contained the lowest level of K, Ca and Mg than on other tested rootstocks. On the other hand, Cleopatra mandarin rootstock recorded intermediate values of peel thickness and recorded intermediate values of K, Ca and Mg content of fruit peel. This conclusion in one side puts light on the influence of the tested rootstock on peel physical characteristic and also juice quality, on the other side, explaining the interrelationship between scion and the used rootstock.

4. Effect of rootstocks on fruit juice mineral content:

Data in Table (6) showed that, N, K, Ca, Mg, Fe, Zn, Mn and Cu levels in juice of Washington navel orange fruits budded on Volkamer lemon had significantly higher values than those on the other tested rootstocks. As for Rangpur lime rootstock, fruit juice contained higher values of N, P, Ca, Mg, Fe, Zn, Mn with significant differences in most cases in both seasons. Troyer citrange rootstock gave higher values of P, K, Ca, Na, Cl content in both seasons contrary, Cleopatra mandarin rootstocks recorded lowest values of N, P, K, Ca, Mg, Cl, Fe, Zn, Mn and Cu for fruit juice than those on the other tested rootstocks while, contained higher values of Na with significant differences in most cases. These results are in line with those reported by Ennab, 2003 and Protopadakis *et al.,* 1998.

In conclusion, the values obtained for juice of Washington navel orange fruits assure the higher ability of some tested rootstocks than others concerning absorbing and uptake of nutrients via their roots.

Table (6): Fruit juice nutrients content of Washington navel orange trees as affected by five citrus rootstocks during 2003 and 2004 seasons.

Rootstock	N %	P %	K %	Ca %	Mg %	Na %	Cl %	Fe ppm	Zn ppm	Mn ppm	Cu ppm
	2003										
Sour orange	0.093	0.027	0.042	0.030	0.042	0.021	0.0057	0.0031	0.0141	0.017	0.057
Volkamer lemon	0.116	0.025	0.048	0.032	0.051	0.019	0.0066	0.0041	0.0153	0.043	0.068
Troyer citrange	0.090	0.031	0.040	0.031	0.040	0.023	0.0076	0.0031	0.0133	0.016	0.047
Rangpur lime	0.116	0.028	0.033	0.036	0.048	0.020	0.0058	0.0042	0.0170	0.022	0.055
Cleopatra mandarin	0.092	0.025	0.027	0.029	0.039	0.030	0.0049	0.0028	0.0134	0.030	0.048
L.S.D. 5%	0.004	N.S	0.003	0.001	0.003	0.002	0.0004	0.0003	0.0003	0.003	0.003
1%	0.005	N.S	0.005	0.002	0.005	0.003	0.0005	0.0005	0.0005	0.004	0.004
	2004										
Sour orange	0.100	0.029	0.043	0.030	0.042	0.023	0.0060	0.0034	0.0150	0.020	0.060
Volkamer lemon	0.118	0.026	0.049	0.033	0.053	0.019	0.0070	0.0041	0.0166	0.049	0.075
Troyer citrange	0.095	0.033	0.041	0.031	0.040	0.025	0.0080	0.0032	0.0148	0.019	0.050
Rangpur lime	0.111	0.028	0.034	0.033	0.049	0.021	0.0061	0.0044	0.0181	0.025	0.060
Cleopatra mandarin	0.094	0.027	0.028	0.029	0.038	0.030	0.0053	0.0030	0.0149	0.035	0.055
L.S.D. 5%	0.013	N.S	0.007	N.S	0.010	0.003	0.0011	0.0005	0.0011	0.007	0.005
1%	0.018	N.S	0.010	N.S	0.013	0.005	0.0015	0.0007	0.0015	0.010	0.008

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الحالة الغذائية لأجزاء مختلفة من الشجرة والثمرة لأشجار البرتقال أبوسرة المطعوم على خمسة أصول مختلفة

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أجريت هذه الدراسة خلال عامى ٢٠٠٣ ، ٢٠٠٤م على أشجار البرتقال أبوسرة عمرها ٨ سنوات والمطعومة على خمسة أصول مختلفة هى الفولكاماريانا والترويرسيترنج وليمون الرانجبور واليوسفى كليوباترا والنارنج والتى تم زراعتها فى مزرعة التجارب البحثية بسخا . كفرالشيخ . مصر. وذلك لدراسة الحالة الغذائية لأجزاء مختلفة من الشجرة (أبوسرة) المطعومة على خمسة أصول مختلفة وقد أوضحت النتائج أن:

١- محتوى الجذور من العناصر لم يحدد أتجاه ثابت وذلك بالنسبه للأصول المختبرة ولكن بعض العناصر كانت مرتفعة والبعض الآخر منخفض مثال ذلك النارنج أعطى قيم مرتفعة من النيتروجين والفوسفور والبوتاسيوم والصوديوم والمنجنيز ولكن انخفض مستوى الكالسيوم. بالنسبه لأصل الفولكاماريانا سجل قيم مرتفعة من الفوسفور والكالسيوم والماغنيسيوم والنحاس وانخفض فى الحديد والزنك والمنجنيز ، بالإضافة إلى ذلك ليمون الرانجبور أعطى قيما عالية من الكالسيوم والماغنيسيوم والكلور والحديد بينما سجل قيم منخفضة من النيتروجين والفوسفور والمنجنيز أما أصل اليوسفى كليوباترا فقد سجل قيما مرتفعة من الفوسفور وانخفض مستوى البوتاسيوم والكالسيوم والماغنيسيوم والصوديوم وكانت هذه النتائج مؤكدة إحصائيا.

٢- أشجار البرتقال أبوسره المطعومة على أصلى الفولكاماريانا وليمون الرانجبور أحتوت أوراقه على تركيزات عالية معنويا من النيتروجين والبوتاسيوم والكالسيوم والماغنيسيوم والحديد والزنك والنحاس وتركيز منخفض من الفوسفور والصوديوم. أما أصلى الترويرسيترانج والنارنج فقد أحتوت أوراق الأشجار المطعومة عليها على أقل تركيز من النيتروجين والبوتاسيوم والكالسيوم والماغنيسيوم والكلورو الحديد وتركيز عالى من الصوديوم والمنجنيز. أما أصل اليوسفى كليوباترا فقد أحتوت أوراق أبوسرة على تركيز عالى من الصوديوم والمنجنيز فقط بينما انخفض تركيز باقى العناصر الكبرى والصغرى.

٣- سجل أصلى الفولكاماريانا وليمون الرانجبور أقل القيم لنسبة N/K و $Na^+ + Cl^-$ وأعلى القيم لنسبة K/Na فى أوراق الأشجار المطعومة عليها لذا فإن الأصلين يمكن اعتبارهما من بين الأصول التى

تتحمل ظروف الملوحة والجفاف. وعلى العكس من ذلك فقد سجل أصل اليوسفى كليوباترا أعلى القيم لنسبة N/K و Na + Cl وأقل القيم لنسبة K/Na فى أوراق الأشجار المطعومة عليه مما يجعل الأشجار المطعومة عليه حساسة لظروف الجفاف والملوحة أما باقى الأصول المختبرة فقد سجلت قيم متوسطة من هذه النسب.

٤- أحتوت أوراق أبوسره المطعوم على أصل يوسفى كليوباترا على قيم عالية معنويا من كل من الكربوهيدرات الكلية ونسبة C/N فى حين احتوت الاوراق التى على اصلى الفولكاماريانا وليمون الراجبور على اقل قيم من الكربوهيدرات الكلية وكذلك النسبة بين الكربوهيدرات والنتروجين C/N. أما بالنسبه لأصل الترويرسيترنج فقد احتوت الأوراق على قيم متوسطة من الكربوهيدرات الكلية ونسبة C/N ومن ناحية أخرى احتوت الأوراق التى على أصول الفولكاماريانا والرانجبور والنارنج على مستويات عالية من الكلورفيل أ ، ب ومجموعهما عن باقى الأصول والفروق كانت مؤكدة احصائيا.

٥- النتائج المتحصل عليها تفسر جزئيا الزيادة فى المحصول فى الأشجار المطعومة على أصلى الفولكاماريانا وليمون الرانجبور عن باقى الأصول حيث سجل أصلى الفولكاماريانا وليمون الرانجبور أعلى القيم فى المحصول يليهم الترويدسيترنج ثم النارنج أما أصل اليوسفى كليوباترا فقد سجل أقل القيم.

٦- الثمار المأخوذة من أشجار البرتقال أبوسره المطعومة على أصلى الفولكاماريانا وليمون الرانجبور أحتوت قشرتها على تركيز عالى من النيتروجين ، البوتاسيوم ، الكالسيوم ، الماغنيسيوم ، الحديد ، الزنك ، المنجنيز والنحاس بينما الثمار المأخوذة من أشجار طعمت على أصول النارنج والترويدسيترنج واليوسفى كليوباترا أحتوت على تركيزات منخفضة ومتقاربة القيمة فى كل العناصر الغذائية المقدرة وهذا يفسر زيادة سمك القشرة فى ثمار كلا الأصلين حيث أحتوت على قيم عالية من الماغنيسيوم والزنك والبوتاسيوم فى قشرة الثمار.

٧- أحتوى عصير الثمار المأخوذة من الأشجار المطعومة على أصلى الفولكاماريانا وليمون الرانجبور على تركيزات عالية من النيتروجين والماغنيسيوم والكالسيوم والفوسفور والبوتاسيوم وتركيزات منخفضة من الصوديوم والكلور عن الأشجار المطعومة على النارنج والترويدسيترنج واليوسفى كليوباترا بينما الحديد والزنك والنحاس والمنجنيز مرتفعين فى عصير الثمار المأخوذة من أشجار طعمت على أصل الفولكاماريانا بينما الأصول الأخرى (ليمون الرانجبور . النارنج . الترويدسيترنج . اليوسفى كليوباترا) أعطت قيما متقاربة وهذه النتائج تلقى الضوء على التأثير المتبادل بين الطعم والأصل المستخدم تحت ظروف هذه التجربة.