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EVALUATION OF GRAFTING COMPATIBILITYAND GROWTH OF SOME NEW ORANGE CULTIVARS BUDDED ON VOLKAMER LEMON

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ABSTRACT

The present study was undertaken during the seasons of 2005/2006 and 2006/2007 to evaluate the degree of grafting compatibility, budding success percentage and seedling growth of some new orange cultivars namely; Navelina, New hall, Navelate and Washington Navel and Valencia oranges budded on Volkamer lemon.

The obtained results reveal that, budded Valencia orange on Volkamer lemon gave a higher percentage of graftage success than those obtained from the other orange cultivars under study. Furthermore, budding New hall or Navelate on the same rootstock gave vigorous seedling with higher shoot length, thickness, number of leaves and leaf area than those obtained from Navelina orange. Whereas, budding Valencia orange on Volkamer lemon gave a taller seedling than those obtained from Washington Navel orange.

In this respect, budding New hall or Navelate on Volkamer lemon presented a good seedling than obtained from Valencia, Washington Navel orange and Navelina orange which presented a lower seedling growth.

INTRODUCTION

Citrus is the most important fruit crop in Egypt since it ranks the first among all other fruits. The total area reached about 364798 feddans. The total fruitful area is about 332758 feddans with annual production about 3030244 tons. Oranges are ranking at the top among the cultivated citrus species. So, it occupied about 60.4 % from the total fruitful orange in Egypt, since it occupied about 224404 feddans with annual production of about 1940422 tons according to the Ministry of Agriculture statistics (2006).

Citrus tree is not grown on its own roots, but grown as budded plants. However, many rootstocks are used, yet in the last few years Volkamer lemon is the most common one used for citrus propagation especially in the new reclaimed soil. In this respect, Castel, (1987) reported that Volkamer lemon is lemon hybrid which as a rootstock produced vigorous trees, yielding large quantities of moderate to poòr quality fruit like rough lemon and germinate well seedlings of more growth vigor with straight trunk. But, Davis and Albirgo, (1998) presented that Volkamer lemon is not widely used as a rootstock and probably will not come into wide spread use in the near future. Furthermore, Abou-Rawash *et al.*(1995) found that Volkamer lemon seedlings are tolerant to salinity stress. Also, Dawood (1996) mentioned that Volkamer lemon tree had the highest values of vegetative growth than other citrus rootstocks. Esmaeil and Rodney (1992) recommended that, Volkamer rootstock is considered as a vigorous and resistant to tristeza. Furthermore, Khattab *et al.* (2001) reported that Volkamer lemon seedlings revealed the supremacy in their vegetative vigor over Sour orange and Troyer citrange

seedlings. They suggest an active role of the morphological aspects and biochemical constituents in the rootstocks influence the scion vigor

According to the distribution of citrus trees to virus diseases and other pathogens, the Ministry of Agriculture introduced during the seasons of 2001 and 2002 some new orange and mandarin cultivars from USA free from virus diseases with higher productivity such as, Navelina, New hall and Navelate Navel orange cultivars which were originated as bud mutation on Washington Navel orange trees.

Furthermore, Navelina navel orange is considered one of the earliest orange cultivar. Yet, Navelate navel orange is the latter one than Washington navel orange fruits.

Therefore, the present study was carried out to evaluate the degree of graft compatibility between Navelina, New hall, Navelate, Washington Navel and Valencia oranges budded on Volkamer lemon rootstock. Also, graftage success percentage, vegetative growth, percent of growth rate and nitrogen content in the leaf of seedling was undertaken in order to find out the most suitable cultivar which budded on Volkamer lemon to produce normal seedling for citrus plantation.

MATERIALS AND METHODS

This study was carried out during the seasons of 2005/ 2006 and 2006/2007 in the nursery of El-Shorouk Farm at the desert road of Cairo-Alex. to evaluate budding of some new orange cultivars on Volkamer lemon rootstock. Scions were taken from six years old trees of New hall, Navelina, Navelate, Washington Navel and Valencia orange cultivars from trees grown at El-Shorouk farm. Mother trees were healthy, virus free and any other diseases, produced high yield with good fruit quality. Seedlings of one year old of Volkamer lemon were used as a rootstocks. Thus, budwoods of scion were taken from the tree of each cultivar from non-fruiting shoots. Rootstock seedlings were budded in the first week of April during both seasons using T budding method.

From this study 60 seedlings of Volkamer rootstock divided into five groups each one containing 12 seedling used for budding one of the new orange cultivar (New hall, Navelina, Navelate) and both Washington navel orange and Valencia.

During this study the degree of combinability between the tested scions and rootstock was determined and presented as follows:

Budding success percentage :

It was recorded after one and three months from grafting during the two seasons and expressed as average of four replicates per each budding.

Growth vigor of seedling :

After one year from the budding the following parameters were determined :

1- Average shoot length and thickness :

It was determined in each budding seedling for each replicate and the average was estimated.

2- Number of leaves per seedling :

It was expressed by counting the number of leaves per each seedling and the average was estimated.

3- Budded seedling leaf area (cm^2) :

Samples of ten leaves from each replicate were taken randomly to measure the length and width to estimate leaf area according to Chou (1966) using the following equation :

$$\text{Leaf area } cm^2 = {}^1/_3 \times \text{leaf length} \times \text{leaf width}$$

4- Budded seedling growth rate :

It was estimated by measurement the length of the shoot at the beginning of growth and after one year later to estimate the growth rate using the following equation according to Abd EL-Metaal, (1998).

$$\text{Growth rate} = \frac{\text{Final length} - \text{Initial length}}{\text{Initial length}} \times 100$$

5- Budded seedling leaf N content :

Leaf samples from each cultivar were collected, washed and oven dried to constant weight. Nitrogen was determined using micro- Kjeldahl according to Chapman and Pratt, (1978).

6- Budded seedling weight :

Samples of budded seedling from each replicate after one year from budding were taken to determine average root and vegetative growth in order to present average seedling weight.

Statistical analysis :

The obtained data were statistically analyzed using randomized complete design according to Gomez and Gomez (1984), and the main from each cultivar were compared using Duncan (1955).

RESULTS AND DISCUSSION

Budding of Navelina, New hall, Navelate, Washington Navel and Valencia orange on Volkamer lemon was carried out in order to present the successful compatibility and seedling growth of these cultivars. The obtained data can be explained and discussed as follows:

Budding success percentage :

Budding success percentage which presented as index for the degree of scion and rootstock compatibility was previously confirmed by several investigators (Rouse, 1988; Williamson *et al.*, 1992 and Guindy *et al.*, 1995).

In this respect, data from Table (1) reveal that budded Valencia orange on Volkamer lemon gave a higher significant percent of budding success after one or three months from budding than obtained from the other cultivars. Yet, no significant difference in the percent of budding success was obtained from Navelina, New hall and Navelate compared with Washington

Navel orange. Whereas, Navelate orange produced a lower percentage of budding success. The data also indicated that the percentage of budding success was higher of all cultivars after one month (at May) than after three months (at July) from grafting. Since, moderate temperature and highly relative humidity are major factors related to success of grafts Ram, (1997).

Table (1): Budding success percentages of some new orange cultivars budded on Volkamer lemon.

Orange cultivars	One month			3 months		
	2005	2006	Mean	2005	2006	Mean
Navelina navel	74.3	76.2	**75.3 b**	49.6	50.1	**49.9 b**
New hall navel	72.8	75.9	**74.1 b**	50.2	49.8	**50.0 b**
Navelate navel	70.2	74.3	**72.3 b**	47.8	48.2	**48.0 b**
Washin. navel	73.9	76.4	**75.2 b**	53.4	46.5	**49.9 b**
Valencia	81.2	86.4	**83.8 a**	61.4	58.2	**59.8 a**
L.S.D at 5%	**1.85**	**2.04**	**----**	**1.62**	**1.74**	**----**

These results agree with those reported by Rouse (1988) who found that four weeks after budding date were sufficient to evaluate budding success. Furthermore, Samaan *et al.* (2000) reveal that grafts were considered successful when the budwood was still green for 21 days after budding and then started sprouting and continued growth till 2 month old.

Vegetative growth :

Average shoot length, thickness, number of leaves/shoots and leaf area were measurements to present the growth of budded seedlings after one year from budding.

1- Average shoot length and thickness :

Data from Table (2) revealed that budded New hall and Navelate orange on Volkamer lemon produced nursery seedling with longer and thicker shoots than those obtained from the other orange cultivars budded on the same rootstock. Moreover, Valencia orange gave a higher significant shoot length than those obtained from Washington Navel or Navelina orange. Since, the later gave a lower significant shoot length than the other orange cultivars. Whereas, budding Navelate and New hall gave a higher significant shoot thickness, but Navelina and New hall oranges presented a thinner shoot than the other orange cultivars.

This data go in line with those obtained from Jimenz (1987) who mentioned that Volkamer lemon and Rough lemon gave a heavy higher vegetative growth. Also, Cedeno *et al.* (1994) indicated that Valencia scion was more compatible with both Cleopatra mandarin and Sour orange rootstocks.

Table (2): Average shoot length and thickness of seedling of some new orange cultivars.

Orange cultivars	Average shoot length (cm)			Average shoot thickness (mm)		
	2005 / 6	2006 / 7	Mean	2005 / 6	2006 / 7	Mean
Navelina navel	32.2	36.7	34.5 d	4.7	4.5	4.6 c
New hall navel	46.9	49.3	48.1 a	6.4	6.3	6.4 a
Navelate navel	45.1	46.4	45.8 b	6.6	6.5	6.6 a
Washin. navel	40.1	44.6	42.4 c	5.9	5.8	5.9 b
Valencia	41.8	46.3	44.1 b	5.8	5.9	5.9 b
L.S.D at 5 %	2.48	2.04	1.87	0.268	0.257	0.289

2- Number of leaves / shoot :

It is clear from Table (3) that New hall, Navelate and Valencia oranges budded on Volkamer lemon produced a higher significant number of leaves per shoot than those obtained from Navelina or Washington Navel orange. Thus, the differences among these cultivars were unpronounced during both seasons under study. Likewise, the data presented that average number of leaves was increased as leaves per shoot increased.

3- Leaf area :

It is obvious from Table (3) that both New hall and Valencia orange gave a higher significant leaf area than those obtained from the other orange budded seedlings cultivars. Whereas, Washington Navel and Navelate cultivars produced a lower leaf area than those obtained from Navelina orange. Since, this cultivar produced a lower significant leaf area than the other orange cultivars budded on Volkamer lemon. That is not unexpected since, Navelina orange produced shorter and thinner shoot than those obtained from the other orange cultivars.

Table (3): Average number of leaves and leaf area of seedling of some new orange cultivars.

Orange cultivars	No. of leaves / shoot			Leaf area (cm^2)		
	2005 / 6	2006 / 7	Mean	2005 / 6	2006 / 7	Mean
Navelina navel	29.1	30.7	29.9 b	22.5	24.4	23.5 c
New hall navel	31.3	35.9	32.6 a	31.9	33.5	32.7 a
Navelate navel	34.6	35.2	34.9 a	30.8	30.5	30.7 b
Washin. navel	30.5	28.4	29.5 b	30.8	30.3	30.6 b
Valencia	32.9	34.8	33.9 a	31.4	32.1	31.8 a
L.S.D at 5 %	2.07	2.05	1.74	1.12	1.28	1.64

4- Growth rate :

Growth rate presented the changes in shoot length from the initial growth till one year later. In this respect, data from Table (4) showed that Navelate orange budded on Volkamer lemon gave a higher significant growth rate than the other orange cultivars. Furthermore, budded New hall presented nearly similar growth to those obtained from Washington Navel and Valencia oranges on Volkamer lemon. Since, no significant differences in growth rate were obtained when these cultivars were budded on Volkamer lemon during both seasons. Whereas, budded Navelina orange on Volkamer lemon gave lower significant values of growth rate than the other orange cultivars. This is may be due to that, this cultivar produced a lower shoot length than the other orange cultivars. Similar results were obtained by Monteverde (1989) who stated that Valencia orange trees grafted on Volkamer lemon showed a rapid and vigor growth.

5- Leaf N content :

Data from Table (4) showed the content of nitrogen in the leaves of orange cultivars which budded on Volkamer lemon. From this data it is clear that no significant effect on the content of nitrogen was obtained. Yet, budding Navelate orange gave a somewhat increment of nitrogen content than the other orange cultivars. Furthermore, Valencia, Washington Navel and New hall orange gave similar values of nitrogen content in the leaves but almost higher than those obtained from Navelina orange cultivar. Similarly, Abd El-Metaal (1998) found significant differences in nitrogen content between all rootstocks. These results agree with those obtained by Embleton *et al.* (1983) and Reuther *et al.* (1985).

Table (4) : Average growth rate and leaf nitrogen content of seedling of some new orange cultivars.

Orange cultivars	Growth rate %			Nitrogen %		
	2005 / 6	2006 / 7	Mean	2005 / 6	2006 / 7	Mean
Navelina navel	69.9	89.8	**80.1 c**	2.26	2.38	**2.32**
New hall navel	104.9	125.6	**115.3 b**	2.34	2.64	**2.49**
Navelate navel	122.5	145.7	**134.2 a**	2.55	2.92	**2.74**
Washin. navel	94.9	137.7	**115.5 b**	2.31	2.72	**2.52**
Valencia	105.7	120.3	**118.0 b**	2.36	2.78	**2.57**
L.S.D at 5 %	**16.05**	**16.02**	**11.67**	**N.S**	**N.S**	**N.S**

6- Budded seedling weight :

Data from Table (5) presented the weight of budded seedling root and vegetative growth and weight after one year from budding. From this data it is obvious that New hall or Navelate orange budded on Volkamer lemon produced seedlings with higher fresh weight than those obtained from the other orange cultivars. Also, these cultivars presented a higher weight of root and vegetative growth (leaves and stem). These increments agree with those obtained for the values of both shoot length and thickness (Table 2).

Furthermore, seedlings of Valencia orange were more in its weight than those of Navelina and Washington Navel orange. Whereas, the weight of Navelina seedling was significantly lower than those obtained from the other orange cultivars. So, this cultivar presented a lower root and vegetative weight than the obtained from the other cultivars.

Table (5): Average of seedling weight, root weight and weight of vegetative growth of some new orange cultivars.

Orange cultivars	Seedling weight			Root weight			Vegetative growth weight		
	2005/6	2006/7	Mean	2005/6	2006/7	Mean	2005/6	2006/7	Mean
Navelina navel	53.5	55.2	**54.4 d**	18.7	19.2	**18.9 c**	34.8	36.0	**35.4 d**
New hall navel	73.2	76.8	**77.5 a**	26.6	25.4	**26.0 a**	51.6	51.4	**51.5 a**
Navelate navel	76.2	77.6	**76.9 a**	24.8	25.6	**25.2 a**	51.4	52.0	**51.7 a**
Washin. navel	67.9	66.8	**67.4 c**	23.4	22.9	**23.2 b**	44.5	43.9	**44.2 c**
Valencia	73.2	72.4	**72.8 b**	24.4	24.8	**24.6 a**	48.8	47.6	**48.2 b**
L.S.D at 5 %	**3.24**	**3.06**	**3.17**	**1.81**	**1.72**	**1.92**	**2.18**	**2.22**	**2.19**

With regard to the weight of both root and vegetative growth of seedlings, the data also reveal similar trend to those obtained from seedling weight. Yet, the weight of vegetative growth was nearly double to those obtained from root weight. In this respect, Selim *et al.* (1976) confirmed the useful usage of trunk circumference and other growth characters as a good measure for graft compatibility.

From the present study, it is clear that budding New hall or Navelate orange on Volkamer lemon produced vigor seedling than those obtained from Navelina orange. Since, these cultivars produced a higher shoot length, thickness, number of leaves and their area. Yet, Navelina orange gave a lower effect in this respect. Furthermore, budding Valencia orange on Volkamer lemon produced a higher shoot length and weight of seedlings than those obtained from budding Washington Navel on the same rootstock.

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تقييم درجة توافق و نمو شتلات بعض أصناف البرتقال الحديثة المطعومة على أصل الفولكاماريانا

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أجريت هذه الدراسة خلال عامى ٢٠٠٥-٢٠٠٦ ، ٢٠٠٦-٢٠٠٧ لتقييم مدى توافق و نجاح التطعيمات وكذا نمو شتلات بعض أصناف البرتقال الحديثة مثل النافالينا- نيوهول و النافاليت و كذا البرتقال أبو سرة و الصيفى المطعومة على أصل الفولكاماريانا.

ولقد أوضحت النتائج أن تطعيم البرتقال الصيفى على أصل الفولكاماريانا أعطت أعلى نسبة نجاح للتطعيمات مقارنة بباقى أصناف البرتقال الأخرى. علاوة على ما سبق فإن تطعيم البرتقال نيوهول و كذا النافاليت أنتجت شتلات قوية النمو و ذلك من خلال زيادة طول و سمك الفرخ وكذا عدد الأوراق و المساحة الورقية مقارنة بتلك المتحصل عليه فى صنف النافالينا فى حين أن تطعيم البرتقال الصيفى على أصل الفولكاماريانا أعطت شتلات قوية النمو عن تلك الناتجة عن تطعيم البرتقال أبو سرة.

مما سبق يتضح أن تطعيم أصناف البرتقال نيوهول والنافاليت على أصل الفولكاماريانا أعطت شتلات قوية النمو عن تلك الناتجة من تطعيم كل من البرتقال الصيفى وكذا أبو سرة والبرتقال النافالينا الذى أعطى أقل نمو للشتلات الناتجة.