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PERFORMANCE OF SOME NEW CITRUS VARIETIES UNDER SOUTH EL-TAHRIER DISTRICT CONDITIONS

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ABSTRACT

The performance of two lemon cultivars namely Feminello and Eureka lemon (*Citrus limon* (L.) Brum.f), four orange cultivars namely navel orange (Navelina, Navelate, Newhall and Washington navel orange (*Citrus sinensis* L. Osbeck)) and four mandarin cultivars namely seedless mandarin, thorny Clementine, thornless Clementine and Balady mandarin (*Citrus reticulata* Blanco), respectively were done at South El Tahrir research station, Beheira Gov. during 2006/2007 and 2007/2008 under similar cultural practices. Preliminary observations under the prevailing conditions indicated that Feminello lemon, Newhall navel orange, Washington navel orange and both thornless and thorny Clementine were excellent with an average 7.46, 6.87, 6.45 and 6.58 ton/fed, respectively whereas Navelina, Navelate and Balady and seedless mandarin occupied the second position. However, the vegetative growth of the promising varieties was directly proportional to root horizontal and vertical extension.

Keywords: Performance, yield, orange, mandarin, lemon, vegetative growth

INTRODUCTION

Fruit production is the main economical aspect in citriculture, which is an important agricultural activity in many countries around the world (FAO, 2006). In Egypt, citrus ranks the first among fruit crops. According to 2008 statistics, the cultivated area reached 420.7 thousand feddan produced about 3,233,448 ton. On the other hand, Washington navel orange represents over ٥0% of total orange production whereas the mandarin production is 758,105 ton with an average 8.02 ton/feddan and the lemon production is 2459 ton with an average 7.38 ton/feddan (Ministry of Agriculture 2007)

Recently, agriculture has been turned to the use of homogenous commercial highly productive cultivars. It happens often with cultivated plants (Schirarend, 1998), the long cultivation and selection of citrus varieties resulted in an unlimited number of cultivars, therefore the origin of the species which took part in their formation will be forever impossible to recognize. However, it is remarkable that the genetic origin of certain cultivated citrus remains obscure while the fruits are so easily distinguished by people (Barret and Rhodes 1976). However, adequate environmental conditions and suitable plant nutrition are two essential needs for citrus production.

At present, citrus growers and exporters need to meet local and international market as well as consumers demand and the new international standards and regulations. Therefore, introducing and evaluating the performance of new varieties that can produce sufficient production of good fruit quality are highly appreciated. This will facilitate access to the new markets and to provide reasonable profit. Moreover, introducing new varieties can help in diversifying the production, reduce the risk that might be occurred and enlarge the production seasons in order to compete with other citrus producers.

The objectives of this investigation are to evaluate tree performance of some citrus cultivars and varieties under the conditions of South El Tahrir district, Beheira Gov., North of Egypt and to diversify species for commercial production in order to provide a wide range of citrus varieties.

MATERIALS AND METHODS

This investigation was conducted at Horticultural Research Station, South El Tahrir, Beheira Gov., during 2006 to 2008. The tested cultivars were two lemon cultivars namely Feminello and Eureka lemon (*Citrus limon* (L.) Brum.f), four orange cultivars namely navel orange (Navelina, Navelate, Newhall and Washington navel orange (*Citrus sinensis* L. Osbeck)) and four mandarin varieties namely seedless mandarin, thorny Clementine, thornless Clementine and Balady mandarin (*Citrus reticulate* Blanco). Trees used in this study were, 6 years old, imported from Italy, grafted on Volkameriana rootstock and planted at 5 x 5 m apart. The trees received similar management practices.

Experimental design:

Randomized Complete Block (RCB) design was used to perform this experiment with 3 replicates; each replicate was represented by two trees. The total number of examined trees was 60 trees. Such trees were subjected to the following measurements:

Tree canopy volume

The tree canopy volume (CV) was calculated according to the equation CV=0.528*H*D2, where H: is the tree height, D: is the tree diameter (Turrell, 1946).

Fruit number, weight and yield:

Yield data was estimated by counting the number of fruits per tree, the average fruit weight of 30 fruits was measured then the yield per feddan was calculated in ton.

Leaf Chlorophyll content

Fresh leaf samples were taken in Aug. from the spring flush of the current season for the leaf pigments determinations (chlorophyll –a and chlorophyll -b). The pigments were extracted by acetone; then, the color absorption was measured at 662 and 644 mM for chlorophyll -a & b, respectively. The quantities of pigments were calculated as (mg/ 100g f.w.) after Fadeel (1962) using the formula of Wettstein (1957).

Root distribution:

An initial soil sample was collected at the beginning of the first season and physical and chemical properties are given in Table (1). By the end of second growing season (December, 2008) one tree represented the mean vegetative growth of each variety was selected. Soil samples were taken to represent the soil under tree canopy as follows: horizontally of the distances from tree trunk were 100, 150 and 200 cm; the depths from soil surface were

0 – 30 and 30 – 60 cm. Moreover, the samples represented the four tree directions (i.e. north, east, west and south). The average values for the four directions in each sample were calculated. Dimensions of the used auger cylinder were: 5 cm radius and 25 cm height. The soil samples were taken, then the roots were accurately separated and the maximum vertical root penetration in soil at 100 cm from tree trunk as well as the maximum horizontal root extension from tree trunk in the four tree directions were measured and expressed in cm. Moreover, root density expressed as root weight /soil weight) was determined as described by Newman (1966).

Table 1. Soil physical and chemical properties (0-60 cm soil depth)

Soil physical properties										
Sand (%)			Fine sand (%)			Silt (%)			Clay (%)	
69.50			21.00			7.10			2.40	
Soil chemical properties										
EC ml/cm	SP	SO_4	Cl^-	HCO_3	CO_3	K^{++}	Na^+	Mg^{++}	Ca^{++}	$CaCO_3$
0.70	17.00	3.72	2.88	0.54	-	0.24	3.30	0.90	2.70	1.52

RESULTS AND DISCUSSION

Figure (1) showed that air temperature as well as the relative humidity in the first season was lower than the second season. The differences were 1.5 ^oC and 1.6% for air temperature and air humidity, respectively. The minimum temperature was 12.5 and 12.8 ^oC during Jan. and the maximum was 35 and 36.5 ^oC during August in the first and second seasons, respectively. However, during the flowering period the temperature ranged from 13.7-17.5 to 14.1-18 ^oC in the first and second seasons, respectively. (Agricultural Meteorological Survey,2006 – 2008).

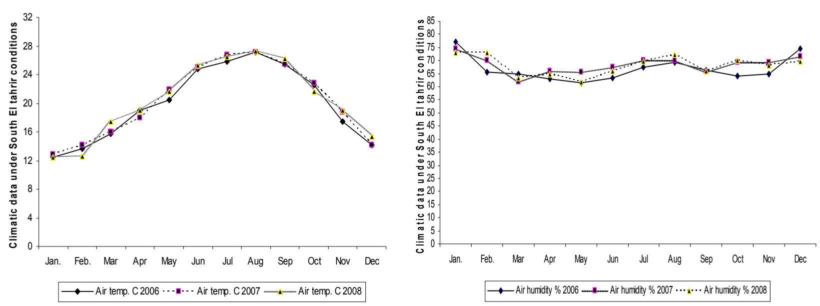

Figure (1): Climatic conditions of South El Tahrir conditions monthly during the period from 2006 to 2008

Flowering period:

Fig. (2) shows that under the climate conditions during experimental period the flowering started from the end of February and ended at the mid of April with flowering period ranged from 30-35, 35-40 and 35-45 days in the first season with lemon, orange cultivars and mandarin varieties, respectively. Whereas, the flowering period ranged from 25-30, 30-35 and 25-40 days in the second season with lemon, orange cultivars and mandarin varieties, respectively. Moreover, it is noticed that Feminello lemon has shorter flowering period than Eureka lemon while Navelina and Navelate gave the longest flowering period among orange cultivars. On the other hand, thornless Clementine resulted in the lowermost flowering period among mandarin varieties in both the experimental seasons.

Figure (2): The flowering period of the tested variety es under south El Tahrir conditions

Cultivars	February						March						April					
	5	10	15	20	25	30	5	10	15	20	25	30	5	10	15	20	25	30
	First season																	
Feminello lemon									●	●	●	●	●	●				
Eureka lemon							●	●	●	●	●	●	●					
New hall navel orange							●	●	●	●	●	●	●					
Navelina						●	●	●	●	●	●	●	●					
Navelate								●	●	●	●	●	●	●	●			
Washington navel								●	●	●	●	●	●	●				
Seedless mandarin						●	●	●	●	●	●	●	●	●				
Thornless Clemantine							●	●	●	●	●	●	●					
Thorny Clemantine							●	●	●	●	●	●	●	●				
Balady mandarin							●	●	●	●	●	●	●					
	Second season																	
Feminello lemon								●	●	●	●	●						
Eureka lemon						●	●	●	●	●	●							
New hall navel orange						●	●	●	●	●	●							
Navelina					●	●	●	●	●	●	●							
Navelate						●	●	●	●	●	●	●						
Washington navel							●	●	●	●	●	●	●					
Seedless mandarin					●	●	●	●	●	●	●							
Thornless Clemantine						●	●	●	●	●								
Thorny Clemantine					●	●	●	●	●	●	●	●						
Balady mandarin					●	●	●	●	●	●	●							

Generally, it was clear that the flowering period in the first season for all the tested cultivars and varieties was longer than the second season. This can be attributed to extending of cool weather which resulting in heavy spring bloom and the fact that air temperature regulates flowering intensity and duration (Davies, 1997). This is true because the climate conditions in the first season showed lower air temperature than the second season as previously showed in Fig. (1). Moreover, the obtained data showed longer flowering period in descending order for oranges, mandarin and lemon tress, respectively. These results are agree with Chung and Hong, (1981) who stated that in subtropical climates, orange, mandarin, acidic species such as lemon flower response to cold winter temperatures by extending its flowering period.

Tree canopy volume:

Data presented in Figure (3) show that tree canopy volume of Feminello lemon was significantly higher than Eureka lemon in both seasons. Newhall navel orange trees have significantly higher tree canopy volume if compared to other orange cultivars. However, Navelina orange gave the lowermost canopy volume in both seasons. The results showed no significant difference between Navelate and Washington navel orange cultivars in both the experimental seasons.

Although Newhall navel orange trees are somewhat less vigorous than Washington navel orange (Hodgson, 1967) but under the experimental conditions they were more vigorous. In contrary, it resulted in the best results concerning tree canopy volume compared to the other tested orange cultivars. It is also noted that Navelina trees are lacking in vigor, semi-dwarfed in comparison with Washington navel orange trees. Moreover, McCarty (1985) reported that the name of Navelina variety was presumably referring to the small tree. However, the results indicated that Navelate trees are reported to be vigorous and slightly larger than Washington navel orange trees. Our results are in agreement with Hodgson, (1967).

Among mandarin trees, the seedless mandarin as well as thornless Clementine gave the highest values of tree canopy volume without significant differences between them in comparison with the thorny Clementine and Balady mandarin in both the two experimental seasons. Generally, the obtained results are in line with reports by USDA, (2009).

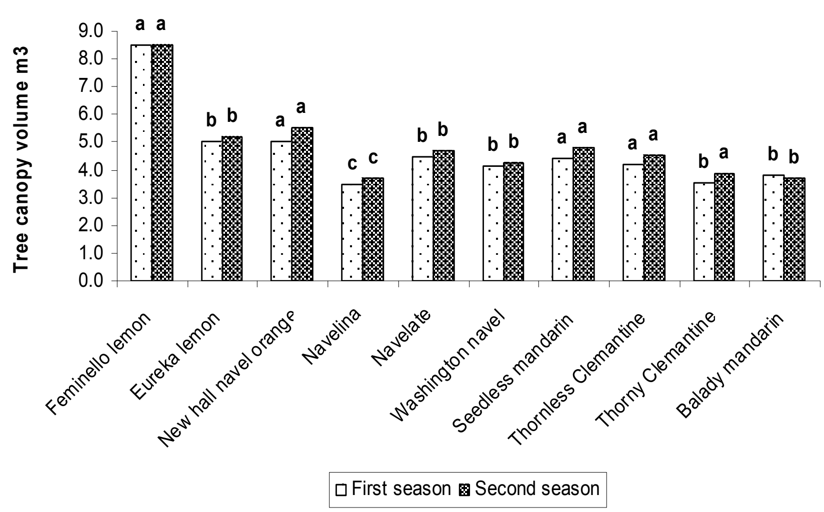

Fig.3 Tree canopy volume m^3 of studied varieties

Means followed by the same letter are not significantly different at P =0.05 (Duncan test)

Root distribution:

Horizontal root extension showed significant differences for all the tested cultivars (Table 2). Feminello lemon resulted in higher horizontal and vertical root extension values and showed significant difference in root density in the soil depth from 0 - 30 cm from soil surface while the differences were not significant in the soil depth from 30 – 60 cm compared to Eureka lemon.

On the other hand, Navelate and Washington navel orange trees gave the highest horizontal and vertical root extension values in comparison with Newhall and Navelina. Among tested orange cultivars, Navelate orange trees gave the highest root density in 0 – 30 cm soil depth followed by Washington navel orange without significant difference between them. However, Newhall and Navelina navel orange showed significant difference and gave the lowest values of root density in the soil depth (0 – 30 cm) whereas the difference was insignificant in the depth of (30 – 60 cm). In this respect, Washington navel orange gave the highest value of root density in the soil depth 30 – 60 cm among all orange cultivars.

Among mandarin varieties, seedless mandarin and thorny Clementine record the highest horizontal roots extension followed by thornless Clementine and Balady mandarin. On the other hand, both thorny and thornless Clementine cultivars resulted in higher values than seedless and Balady mandarin cultivars and showed significant difference. On the other hand, thorny Clementine gave the highest values of root density in 0 – 30 cm of soil depth whereas thornless Clementine resulted in the lowest values. In the depth (30-60 cm), there was no significant difference between seedless mandarin and thornless Clementine.

In this respect, the horizontal root extension and root density were directly proportional to the obtained tree canopy volume (Castle and Krezdorn, 1977). These results are in line with the previously obtained results of tree canopy volume in fig 3. Moreover, traveling distance of feeder roots, horizontally or vertically was reduced remarkably and its intensity shifted upward. This could be due to the use of drip irrigation system (Minessy *et al*,1971).

Table (2): Horizontal and vertical roots extension in cm and root density as g root/g soil at 0-30 & 30-60 cm from soil surface

Cultivars	Root extension (cm)		Root density (g root/g soil)	
	Horizontal	verticale	0-30 cm	30-60 cm
	Second season			
Feminello lemon	145.0 a	56.7 a	1.65 a	0.25 a
Eureka lemon	130.0 b	50.0 a	1.50 b	0.30 a
New hall navel orange	148.3 b	46.3 b	0.51 c	0.03 c
Navelina	138.3 c	46.7 b	0.81 b	0.03 c
Navelate	190.8 a	46.3 b	1.56 a	0.22 b
Washington navel	180.0 a	50.0 a	1.50 a	0.50 a
Seedless mandarin	192.8 a	40.0 b	1.05 b	0.09 c
Thornless Clemantine	127.5 b	55.0 a	0.40 c	0.09 c
Thorny Clemantine	160.8 a	48.3 a	1.27 a	0.18 b
Balady mandarin	115.0 c	35.0 b	1.05 b	0.30 a

Means followed by the same letter are not significantly different at P =0.05 (Duncan test)

Fruit number and weight

Table 3 shows that Feminello lemon gave higher number of fruit per tree as well as fruit weight than Eureka lemon. However, the difference was significant in both the experimental seasons. Concerning orange cultivars, New hall and Washington navel orange resulted in higher fruit number per tree followed by Navelina and Navelate cultivars without significant difference between each of them in the first and second seasons. The only exception was in the second season between New hall and Washington navel orange where the difference in fruit number was significant. However, the same trend was obtained for fruit weight in both seasons.

Regarding mandarin cultivars, thornless Clementine and seedless mandarin resulted in highest fruit number per tree whereas thorny Clementine and Balady mandarin gave the lowest values without significant difference between them in the first and second seasons. However, thorny Clementine and Balady mandarin resulted in the higher fruit weight followed by seedless mandarin and thornless Clementine with significant difference between them.

In this respect, it is noted that the number of fruit per tree is conversely proportional to the fruit weight in the tested mandarin varieties. The obtained results are in line with (Sayed, *et al*, 2007) and confirmed the published information from the originated area where those varieties are introduced.

Table (3): Number of fruits per tree and fruit weight in (g) of studied varieties

Cultivars	Av. fruit number/tree		Av. fruit weight (g)	
	First season	Second season	First season	Second season
Feminello lemon	162.3 a	168.7 a	255.3 a	267.3 a
Eureka lemon	155.0 b	153.0 b	200.0 b	225.0 b
New hall navel orange	105.0 a	121.7 a	320.0 a	318.0 a
Navelina	86.0 b	97.7 c	250.0 b	260.0 b
Navelate	84.3 b	98.0 c	240.0 b	245.0 b
Washington navel	105.0 a	107.0 b	320.0 a	315.0 a
Seedless mandarin	227.0 a	236.3 a	138.7 b	149.3 b
Thornless Clemantine	256.3 a	267.7 a	138.7 b	147.7 b
Thorny Clemantine	134.7 b	134.7 b	157.3 a	163.3 a
Balady mandarin	130.0 b	135.0 b	150.0 a	152.0 a

Means followed by the same letter are not significantly different at P =0.05 (Duncan test)

Yield

Concerning yield/feddan in ton, Table (4) illustrates that the difference was significant in the first season while it was insignificant in the second season between Feminello and Eureka lemon. Among orange cultivars, Newhall and Washington navel orange gave the best results without significant difference between them while Navelina and Navelate resulted in the lower values without significant difference in both experimental seasons. However, we found that the fruits of Newhall mature slightly earlier and slightly smaller in size than Washington navel orange. The same results were true with Navelina variety where the fruits are somewhat smaller than Washington navel orange whereas Navelate fruit matures two to three weeks later than Washington. Results in hand are considered to be highly promising. The obtained results are in line with McCarty (1985).

Regarding mandarin varieties, thornless and thorny Clementine resulted in higher yields without significant differences in the first and second season followed by seedless mandarin. Balady mandarin gave the lower values among the other tested mandarin varieties. However, although great tree vigor does not insure heavy production, it was provided a large bearing surface. Conversely, a small tree, even though a heavy bearer, can not produce large amounts of fruit because of its restricted bearing surface.

Table (4): Yield/fed. in ton of the tested varieties in the first and second seasons

Cultivars	First season	Second season
Feminello lemon	7.62 a	7.30 a
Eureka lemon	7.20 b	7.38 a
New hall navel orange	6.28 a	7.45 a
Navelina	5.05 b	5.89 b
Navelate	4.52 b	5.67 b
Washington navel	6.50 a	6.40 a
Seedless mandarin	5.51 b	6.19 b
Thornless Clemantine	6.23 a	6.93 a
Thorny Clemantine	6.23 a	6.93 a
Balady mandarin	4.50 c	4.80 c

Means followed by the same letter are not significantly different at P =0.05 (Duncan test)

Leaf Chlorophyll contents:

Fig. 4 demonstrates the results of chlorophyll a and b development. The results showed significant differences in both chlorophyll a and b values in first and second seasons. Generally, the values of chlorophyll a and b in the first season were higher than in the second season. The obtained results may be due to the differences in climatic conditions especially weather temperature that shows increments in the second season than in the first season (fig.1). Berry and Björkman, (1980) found that as the ambient temperature increases, increasing vapor pressure deficit normally results in water stress and stomata closure.

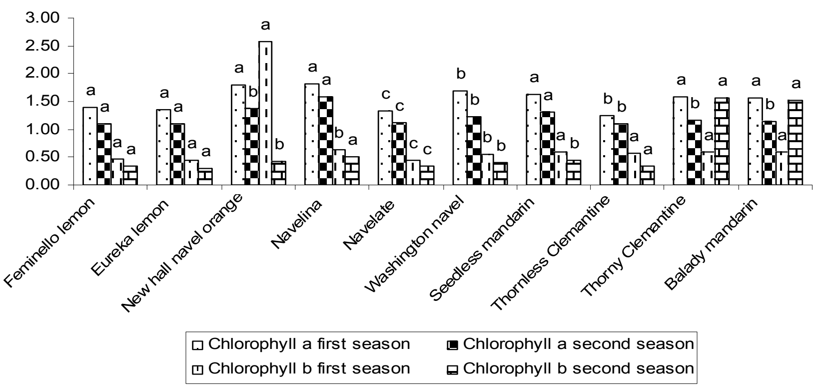

Figure (4): Leaf chlorophyll a & b contents in both first and second seasons

Means followed by the same letter are not significantly different at P =0.05 (Duncan test)

Moreover, Photosynthesis, which is a major process determining a plant's vegetative growth, is a heat-sensitive (Björkman *et al.*, 1980). However, changes in chlorophyll has shown reduction when the temperature increase.

Generally, the results revealed that the tested cultivars were promising in terms of vegetative growth and yield. They can be cultivated in areas similar to the experimental climate conditions. In addition, they provide a wide range of diversity to citrus varieties collection. We also noticed that some of the tested cultivars behave in different way of their origin such as Navelina navel orange that gave better tree canopy volume. Moreover, climate change should be taken into consideration when introducing new varieties and/ or cultivars. However, these cultivars need more precise investigations to evaluate some other morphological traits, fruit set and quality.

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سلوك بعض أنواع الموالح الجديدة المنزرعة تحت ظروف منطقة جنوب التحرير

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تم تقييم اداء صنفين من الليمون الاضاليا (*Citrus limon* (L.) Brum.f) هى صنف فيمينيلو و اليوريكا و اربعة اصناف من البرتقال ابوسرة (*Citrus sinensis* L. Osbeck) هى نافيلينا و نافيليت و نيوهول و البرتقال الواشنجطن و اربعة اصناف من اليوسفى (*Citrus reticulata* Blanco) هى اليوسفى عديم البذور واليوسفى كليمانتين ذو الاشواك و اليوسفى كليمانتين عديم الاشواك و اليوسفى البلدى وذلك تحت ظروف محطة بحوث جنوب التحرير خلال عامى ٢٠٠٦/٢٠٠٧ و ٢٠٠٧/٢٠٠٨ فى ظروف ادارة زراعية متماثلة. وقد اوضحت النتائج ان الليمون الاضاليا فيمينيلو و البرتقال ابوسرة نيو هول و اليوسفى كليمانتين ذو الاشواك و عديم الاشواك اعطوا نتائج مبشرة من حيث متوسط المحصول 7.46 و 6.87 و 6.45 و 6.58 طن للفدان على الترتيب بينما جاءت اصناف البرتقال ابوسرة النافيلينا والنافيليت واليوسفى البلدى فى المرتبة الثانية. فضلا عن ذلك فقد تناسب النمو الخضرى تناسبا طرديا مع الانتشارالراسى والافقى للمجموع الجذرى للاصناف المبشرة.
مفتاح الكلمات سلوك – المحصول – البرتقال – اليوسفى- الليمون – النمو الخضرى

قام بتحكيم البحث

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