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LIME TREE PERFORMANCE UNDER TOSHKA REGION ENVIRONMENTAL CONDITIONS

BY

Ibrahim M. A.; Soaad A., Mohamed; El-Fangary, M. A., and Salem, S.E.
Hort. Res. Inst. (HRI), Agri. Res. Cent. (ARC), Egypt.

ABSTRACT

The present study was carried out during two successive seasons 2005 and 2006 on 6- years old nucellar lime trees (*Citrus aurantifolia* L.) grown in sandy soil in two different regions: 1) Toshka Region represented by the experimental farm of Abo Sombol Research station and 2) the new lands at Nubaria region, El-Behira Governorate represented by a private farm at Ali Ben Abi-Taleb. The trees were planted at 5 × 5m apart in both farms under drip irrigation system. Different vegetative growth parameters, leaf chlorophyll content, flowering aspect, yield per tree and fruit quality were recorded.

Generally, the results illustrated that Toshka lime trees were much vigor. They had the highest number of leaf, lager leaves, the highest leaf density, the same number of twigs produced with less length. Moreover, the canopy volume of Toshka lime trees was larger with longer trees compared to the lime trees in Nubaria region.

Moreover, Toshka lime trees began and ended blooming earlier with shorter blooming duration and higher sex ratio than these of Nubaria region.

Further more, tree production (yield kg/tree and No. of fruits/ tree) was higher in those grown in Toshka region than those of Nubaria region. While, there was no significant difference between the two regions concerning tree yield efficiency

However, lime trees partially influenced negatively by Toshka environmental conditions as they had the lowest chlorophyll content (A & B), acidity and vitamin C content comparing to Nubaria limes trees.

Overall, lime tree shows potential under Toshka distinguishing climate makes it capable to be one of the promising citrus varieties may be introduced to expanding citrus plantation in such prospective region. Though, further studies need to be done to overcome the partial negative impact of these environmental conditions.

Key words: Lime trees, Toshka region, Nubaria region, extreme environmental conditions, vegetative growth and fruit quality.

INTRODUCTION

Positive changes in the agriculture sector have been recently noticed in Egypt either in the cultivated land, production and productivity. The cultivated land amounted 6, 8.5 and it has been expected to amount 15 million feddan in 1960, 2003 and by 2017, respectively (FAO, 2003).

Toshka region is a part of the mega project for developing the south valley (around 3.5 million feddan). It is hopped to be cultivated by 2017 year. The region characterized by very hot temperature with absolute accumulated temperature of 6400 $\pm$ 1.5 $hr.d^{-1}$, evaporation rate of 20 $\pm$ 2 mm. d^{-1} and with wind speed of 3 $\pm$ m.s d^{-1}. Center lab for agricultural climate (Fig. 1)

Although most species of citrus trees grow well in different climatic zones ranging from humid, moderate, semi-arid and arid zones (Parson, 2000). Lime trees (*Citrus aurantifolia*) grow only in a narrow climate belt of extremely hot conditions free from

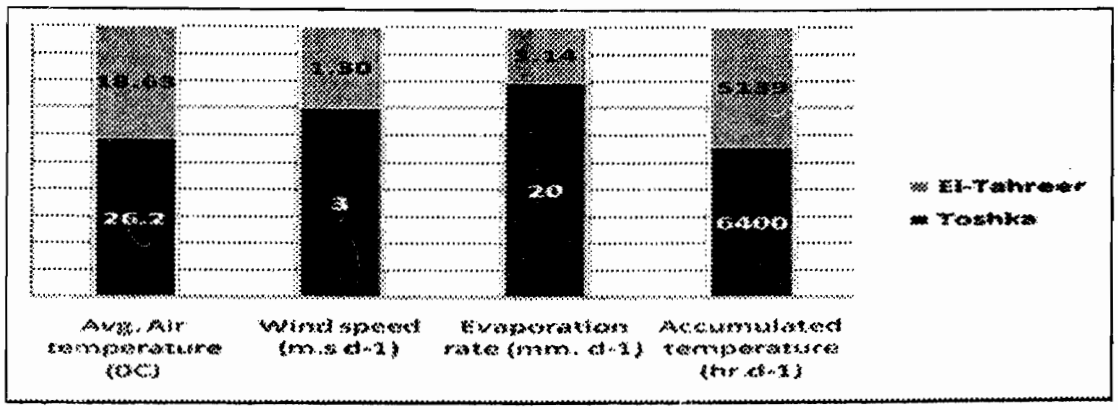
frost hazard (Saunt, 1990). So, it is clearly that, some fruits have more specific adaptation limitations than others as seen by their specialized areas of production (Sherman and Beckman, 2003). Therefore, the elements and mechanisms whereby endogenous and environmental stimuli affect fruit growth are being interpreted and this knowledge may help to provide tools that allow optimizing production and fruit quality with enhanced nutritional value, the ultimate goal of the Citrus Industry (Domingo, *et al*, (2007).

The study of lime habit under Toshka region conditions (represented by the experimental farm of Abo Sombol Research Station) comparing with Nubaria region conditions (represented by a private farm at Ali Ben Abi-Taleb farm) will evaluate its behavior trying to find out the main feature of the management practices that may be taken in consideration for managing the lime trees under such new virgin conditions of Toshka.

Thus, this study was intended to figuring out the habits of vegetative growth, flowering, yield and fruit quality of lime trees grown under Toshka vs. Nubaria region conditions.

MATERIAL AND METHODS

The present study was carried out during two successive seasons of 2005 and 2006 on 6- years old nucellar lime trees (*Citrus aurantifolia* L.) grown in two different regions: 1) Toshka Region represented by the experimental farm of Abo Sombol Reaserch Station and **2)** the new lands at Nubaria region represented by a private farm at Ali Ben Abi-Talib. Average climatic parameters of the two regions was presented in Fig.(1).In both farms, trees were planted at 5 × 5 m apart in sandy soil under drip irrigation system. The recommended cultural practices were applied. Five uniform and healthy trees were chosen from each farm to serve as 5 replicates. Four branches were selected for each tree representing the four geographic directions to determine the studied parameters.



The Central Lab for Agricultural Climate.

Fig. (1): Average climatic parameters of the two regions.

Flowering, vegetative growth parameters yield and fruit quality were recorded on the replicates of the two locations as follows:

1. Vegetative growth:

- **Leaf number** was recorded on the selected branches at the second week of September for both seasons.
- **Leaf area** was measured on 25- mature leaf sample per each replicate collected at the second week of September using laser leaf area meter CI-203CA from CID. Inc. company.
- **Leaf density** was estimated on the basis of the branch diameter in relation to its leaf area.

- **Total shoot number and height** were recorded on the selected branches.
- **Canopy volume (CV):** tree height **(H)** and average of tree diameter **(D)** were recorded and canopy volume was calculated as follow, $0.523\ HD^2$ according to Turell (1946).

- **Chlorophyll content:**

A representative leaf sample of about 60 leaves (15 leaves per each) was collected from shoot apex for each replicate in the first week of October, washed with tap water several times and then distilled water. All leaves were of spring non fruiting shoots. Chlorophyll content was extracted using DMSO (Dimethyslphoxied) and determined (as $mg.g^{-1}$ of fresh leaf tissue) according to Hiscox and Israelstam, (1979).

2. Flowering:

- **Flowering dates:** beginning and ending dates of spring flowering was recorded and used to calculate the spring flowering duration.
- **Sex ratio** as a percentage of female flowers in relation to the total flowers on the selected branches was recorded and calculated.

3. Yield:

- **Fruit yield** was annually recorded (as number and weight) in August (resulted from spring blooming only). Fruits were collected at maturity after 165 days of anthesis (Morton, 1987)
- **Tree yield efficiency** kg of fruit per cubic meter of canopy volume was calculated. (Castle and Philips, 1980).

4. Fruit quality:

Fruit quality parameters of were determined in September on 15 fruits sample per each replicate as follows: **a)** fruit physical properties i.e., fruit weight, fruit size, peel thickness, juice content and **b)** fruit chemical properties i.e., total soluble solids, acidity, TSS/ acid ratio and Vitamin C (A.O.A.C., 1985).

Statistical analyses:

The analyses of variance for a complete randomized design were used as described by Snedecor and Cochran (1972). Differences among means were compared using Duncan multiple test (Duncan, 1955) at 5% level.

RESULTS AND DISCUSSION

1-Vegetative growth:

Table (1) indicates that tree height, canopy volume and leaf area were significantly influenced by environmental conditions. Regarding to leaf measured values, the obtained data revealed that Toshka limes significantly had the higher number of leaves and area compared to the Nubaria region, El-Behira Governorate lime trees. Moreover, leaf density which reveals the ability of the tree in reproducing leaves as an indicator of the vegetative growth showed superiority for Toshka lime trees compared with the other ones under study.

In addition, number of branches showed also the same trend as it recorded higher values in lime trees under Toshka conditions compared to trees under Nubaria region conditions. On the other hand, branch length scored the reverse in Toshka region compared to the other ones.

All above mentioned growth parameters were reflected in the lime trees outlines growth as they formed the larger canopy volume and the higher trees height in Toshka region comparing with the ones of the Nubaria region.

The outstanding performance of lime trees under Toshka environmental conditions may be mainly due to growth promotion figured out though high temperature where Khairi and Hall, (1976), Moss (1976) and Hall, *et al.* (1977) pointed out that high atmospheric temperatures promoted development of vegetative shoots. Furthermore, even the growth habits of the lime trees affected by this extreme environmental condition as the leaf and shoot number were increased

significantly under these circumstances; which may du to producing more of growing points with internodes. This was clarified by Frederick and Albrigo (1994) who mentioned that potentially shoots are produced throughout the season in tropical regions due to high mean temperatures year-round, shoots are generally produced from many growing points with internodes. This may also explain the deficit in shoot length in Toshka lime tree comparing to the Nubaria region ones as they produced much more branches vs. branch length. Moreover, Sayed, (2004) on preliminary studies about some citrus specie and varieties grown Abo Sombol, showed that their superiority attributed to the high rate of vegetative growth.

Table (1): Vegetative growth parameters of lime tree under Toshka and Nubaria region conditions (2005 & 2006 seasons).

Para-Meters / Locations	Leaf No.	Leaf area (cm^2)	Leaf density (cm/mm)	Shoot No.	Branch Length (cm)	Branch thickness (cm)	Canopy volume (m^3)	Chl (A) (mg/100g tissue)	Chl (B) (mg/100g tissue)
	(2005 season)								
Toshka	68.82 a	19.18 a	25.57 a	7.44 a	63.86 b	0.75 a	12.94 a	0.41 b	0.17 b
Nubaria	62.15 b	16.69 b	23.50 b	6.10 b	72.88 a	0.71 a	11.26 b	0.55 a	0.23 a
	(2006 season)								
Toshka	69.11 a	20.22 a	27.70 a	8.69 a	59.87 b	0.73 a	16.06 a	0.42 b	0.16 b
Nubaria	64.11 b	17.59 b	25.49 b	5.98 b	68.69 a	0.69 a	13.98 b	0.57 a	0.24 a

Means followed by the same letter within each column are not significantly different at 5% level.

- **Leaf chlorophyll content:**

It could be concluded from Table (1) that leaf chlorophyll content of lime trees under Toshka conditions gave the lowest chlorophyll content either for **A** or **B** in both seasons compared to lime trees in Nubaria region. This reduction in chlorophyll content may be due to the high temperature in Toshka region in both seasons at the sampling time which may lead to chlorophyll breakdown in leaf. Theses results were confirmed by Pinhass and Elizer, (1996) who stated that in tropics –warm temperatures interfere with the loss of chlorophyll as well as with the build up of carotenoids.

2- Flowering:

The importance of temperature as a major factor of flower induction is well established and has been recognized for a long time (Altman and Goren, 1974; Guardiola *et al.*, 1982; Valiente and Albrigo, 2004; Nebauer *et al.*, 2006). Moreover, (Agusti, 2000) reported that the number of flowers and their ability to set involve climatic conditions. As a result of the high temperature, lime trees grown under Toshka conditions started and ended blooming earlier than those grown under Nubaria region. It could be noticed from data (Table2) that lime trees started flowering earlier by about 2 weeks in Toshka (Feb.5th & Feb.11th) where they flowered in Nubaria region at (Feb 21st & Feb 26th), respectively. In addition, flowering ended at the begging of Marsh under Toshka conditions in both seasons while it extended nearly about the end of March at Nubaria region (Marsh 26th & April 2nd), respectively. While, the period of flowering in Toshka limes trees was less than that in Nubaria region. This could be clarified as Lovatt, *et al.* (1984), Bellows & Lovatt, (1989) and Davenport, (1990) observed that high temperatures accelerate anthesis and shorten the blooming period while low temperatures lead to an extended flowering period.

Table (2): Spring flowering begging, ending and period for lime tree under Toshka and Nubaria region conditions.

Locations	Beginning of bloom		End of bloom		Blooming duration (days)	
	2005	2006	2005	2006	2005	2006
Toshka	Feb, 5th	Feb, 11th	Mar, 1st	Mar, 3rd	24	20
Nubaria	Feb, 21st	Feb, 26th	Mar, 26th	Apr, 2nd	33	35

Moreover, the light intensity and warm weather seemed to promote flower fertility as sex ratio for lime flowers under Toshka environmental contestations was significantly higher than that of lime flowers of Nubaria region even though the trees grown in the later one had the highest number of the total flowers. Correspondingly, Mesejo, *et al.* (2007) stated that temperature conditions may have important consequences for the chances of pollination and fruit set, as it also affects the growth rate of pollen tubes.

The obtained results are in agreement with that obtained by Monselise, (1986) who found that the citrus species floral load depends on the cultivar, tree age and environmental conditions. In the same line Albrigo, (2003) indicated that high temperature enhanced flowering. In addition Valiente and Albrigo, (2000) found that high temperature in February was associated with early flowering of citrus trees and warm temperature within the physiologically moderate range would be expected to hasten the time to bloom. They also reported that, accumulated hours of temperature in January did relate to earlier blooming dates and temperature above 30°C seems reasonable to decrease blooming duration.

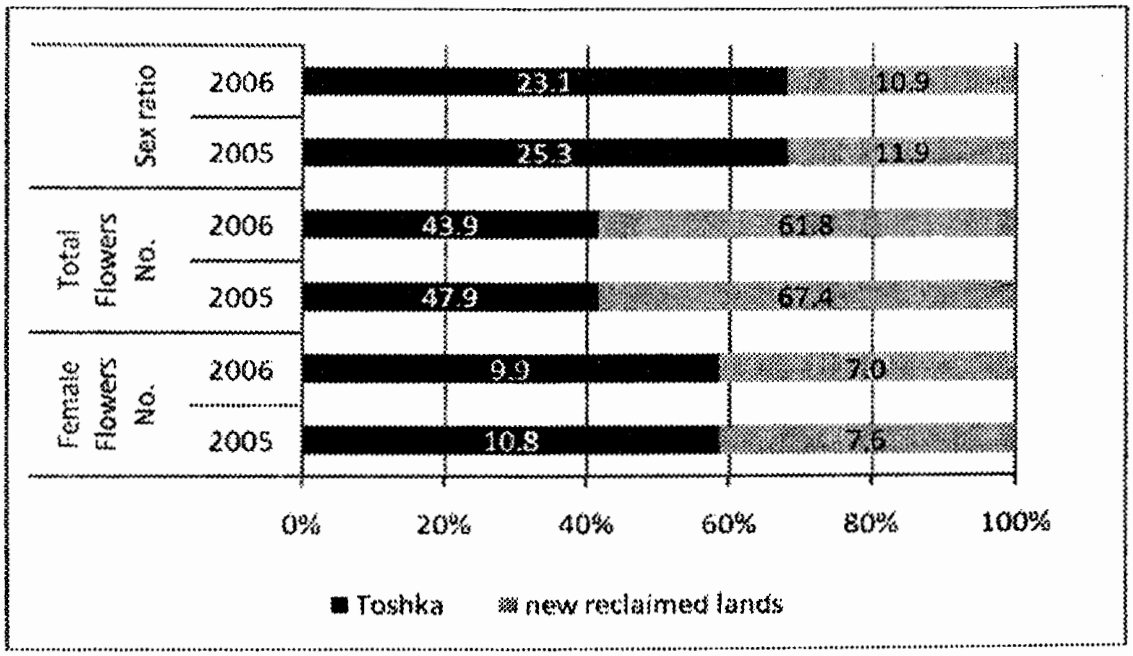


Fig. (2): Number of female flower, total number of flowers and sex ratio of lime trees grown under Toshka and Nubaria region conditions.

3- Yield and tree yield efficiency:

In the face of fruit weight and yield as number or weight of fruit per one tree of lime grown under Toshka region were significantly utmost those grown under Nubaria region (Tables 3 & 4), there was no significant difference in the tree yield efficiency (kg of fruits/m^3 of canopy) between the trees in the

two locations. Whereby, yield is the culmination of the interplay of several factors like biochemical, physiological characters and yield parameters (Thirugnanavel, *et al.*, 2007). Therefore, it could be pointed out that the growth promotion achieved in the lime trees accordingly to the environmental conditions of Toshka region led vegetative growth to prevail over the yield efficiency. Analogous Pinhass and Elizer, (1996) stated that vegetative growth is a continuing process; fruit production is a result of the reproductive process, followed by phases of fruit set and development.

It is worth to mention that, the relative shortage of the tree yield attributed mainly – besides it represents only the spring fruiting yield - to the delay in fruiting which characterizing the nucellar trees behavior. Where, (Saunt, 1990) stated that the nucellar budlines seedlings have a long period of juvenility and slowness in coming into fruit production.

Table (3): Lime tree yield parameters under Toshka and Nubaria conditions (2005 & 2006 seasons).

Parameters / Locations	Fruit No./ tree	Fruit weight/tree (Kg)	Yield efficiency (kg/m^3)
	(2005 season)		
Toshka	202 a	6.14 a	0.47 a
Nubaria	198 b	5.10 b	0.45 a
	(2006 season)		
Toshka	268 a	7.62 a	0.47 a
Nubaria	254 b	6.10 b	0.44 a

Means followed by the same letter within each column are not significantly different at 5% level.

4- Fruit quality:

In citrus, yield together with fruit quality determines crop value and farmer profits (Agusti, 2000). So, studying the lime fruits properties tabulated in (Table 4) reveled that these fruits were influenced in distinct performance in the two locations of the study responding to the different environmental conditions. Where, concurrently with the influence of temperature factors on fruit quality there is a strong influence of the vigor of vegetative growth on fruit development and quality (Walter, 1960). Moreover, Khurshid and Hutton, (2005) indicated that temperature is the climatic factor that most affects fruit quality characteristics in citrus.

4-a. Fruit physical properties:

The measurements of fruit physical properties represented in Table (4) reveled that Toshka lime fruits had the highest values of fruit weight, peel thickness and juice percentage compared to the fruits of the lime trees grown in Nubaria region.

The variance in lime fruit physical properties between the two regions could be attributed to growth processes enhancement through the high rate of temperature in Toshka. These results are agreed with those obtained by Pinhass and Elizer, (1996) who found that under the high temperature prevailing in the tropics fruit development is fast, and fruit get very large, Also Richardson *et al.* (2000) noted that fruit size increased significantly when temperature rising during anthesis and fruit development stages.

4-b. Fruit chemical properties:

Concerning lime fruit chemical properties under study, it could be noticed from data shown in Table (4) that there was a variation in the trend of these properties. Whereas, TSS was of a higher value for Toshka lime fruit under Toshka region climate than those of Nubaria region lime fruits.

Table (4): Lime fruit properties under Toshka and Nubaria conditions (2005 & 2006 seasons).

Para-meters / Locations	Fruit Weight (gm)	Fruit Volume (cm^3)	Peel Thickness (cm)	Juice %	TSS %	Acidity %	TSS Acid ratio	V.C mg/100cm^3
	(2005 season)							
Toshka	30.40 a	35.30 a	0.21 a	45.15 a	8.25 a	7.03 b	1.17 a	40.23 b
Nubaria	25.69 b	29.73 b	0.15 b	37.47 b	7.75 b	7.66 a	1.01 b	53.91 a
	(2006 season)							
Toshka	28.47 a	31.10 a	0.22 a	41.40	8.30	6.45 b	1.29 a	41.15 b
Nubaria	24.00 b	27.50 b	0.16 b	36.85	7.60	7.03 a	1.08 b	52.78 a

Means followed by the same letter within each column are not significantly different at 5% level.

Conversely, the total acidity % and vitamin C content of Toshka lime fruits was the lower if compared to that of lime tree fruits grown under Nubaria region conditions. These results were in accordance with the findings of Nagy, (1980) who stated that climate, especially temperature - total available heat - affect vitamin C levels. Areas with cool nights produce citrus fruits with higher vitamin C levels. Hot tropical areas produce fruit with lower levels of vitamin C. In addition, Hutton and Landsberg, (2000) stated that, a linear reduction in acid ratio with increasing effective heat units (EHUs) was evident in both Valencia and Navel oranges varieties.

These results were also in accordance with those obtained by Pinhas and Eliezer (1996), who stated that under high temperature, internal fruit quality is also affected by climate and tends to have high total soluble solids content. While, these fruits are often very low in acid.

At the main time, there was no significant difference between the fruits in the two regions pertaining to TSS/acid ratio.

Consequently, it could be concluded from above mentioned discussion that lime tree shows potential under Toshka distinguishing climate makes it capable to be one of the promising citrus varieties may be introduced to expanding citrus plantation in such prospective region. Where, further studies need to be done to overcome the partial negative impact of these environmental conditions on some internal fruit components and to increase tree yield efficiency.

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تقييم أداء أشجار الليمون البلدى المالح تحت ظروف منطقة توشكا

مجدى عبد الفتاح إبراهيم ، سعاد عبد الرحيم محمد، محمد عبد الرحمن الفنجرى ، سلامة عيد سالم

معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة – مصر

أجرى هذا البحث خلال موسمين متتاليين (٢٠٠٥ – ٢٠٠٦) لدراسة سلوك أشجار ليمون بلدى مالح بذرية(*Citrus aurantifolia* L.) مزروعة فى اراضى رملية فى منطقتين متباينتين: ١) منطقة توشكا والممثلة بالمزرعة التجريبية بمحطة ابو سمبل البحثية، ٢) منطقة النوبارية والممثلة بمزرعة أبو طالب الخاصة . كانت مسافات الزراعة ٥×٥ م فى كلا المزرعتين وتم ريهما بنظام الرى بالتنقيط . تلقت الاشجار المعاملات الزراعية الموصى بها فى كلا المنطقتين. تم اختيار خمس اشجار متماثلة تقريبا وفى حالة جيدة فى كل مزرعة لتمثل ٥ مكررات وتم تعليم أربعة افرع موزعة بانتظام حول محيط كل شجرة (مكررة) لحساب وتسجيل القياسات المدروسة والتى تتمثل فى مؤشرات النمو الخضرى ، محتوى الأوراق من الكلوروفيل ،قياسات التزهير ، محصول الشجرة وصفات الجودة للثمار .

اشارت النتائج المتحصل عليها إلى أن اشجار الليمون بمنطقة توشكا كانت أقوى بكثير من حيث كثرة عدد الأوراق ، كبر حجم الأوراق ، زيادة الكثافة الورقية والأكثر انتاجا للأوراق لنفس وحدة المساحة من طول الفرع . بالإضافة إلى ذلك فإن حجم أشجار اليمون بتوشكا كان الأكبر والأكثر ارتفاعا مقارنة باشجار منطقة النوبارية .

لوحظ بدء التزهير مبكرا ، زيادة عدد الأزهار، قصر فترة التزهير وإرتفاع النسبة الجنسية للأزهار فى أشجا الليمون فى منطقة توشكا عنها فى منطقة النوبارية.

لوحظ زيادة المحصول لأشجار الليمون تحت ظروف توشكا عنه فى منطقة النوبارية مع عدم وجود فرق معنوى بينهما فى كفاءة الإثمار (كجم ثمار/ متر مكعب من حجم الشجرة)

ومن ناحية أخرى فإن تأثير الظروف المناخية على اشجار الليمون تحت ظروف توشكا كانت سلبية فيما يتعلق بمحتوى الأوراق من الكلوروفيل (A, B) وكذلك الحموضة وفيتامين ج.

وبناءاً على هذا فإنه فأنه يمكن التوصية بأشجار الليمون البلدى المالح كنوع واعد للتوسع فى زراعة الموالح فى منطقة توشكا البكر مع إجراء المزيد من الدراسات للتغلب على التأثير المعاكس لهذه الظروف المناخية على بعض صفات الليمون ولزيادة الكفاءة الإنتاجية للأشجار.