GLOBAL JOURNAL OF BIOLOGY, AGRICULTURE & HEALTH SCIENCES
(*Published By*: *Global Institute for Research & Education*)

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Physiological Studies on Improving Fruit Quality of valencia Orange Fruits

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Abstract

Optimum fruit size is one of the most important parameters determining the profitability of citrus production to acquire high marketing value. The study was conducted on valencia orange trees (*Citrus sinensis*, L) budded on sour orange rootstock (*Citrus aurantium*). Trees were planted at 5x5 m spacing (168 trees/ feddan) in clay soil under flood irrigation and growing in a private orchard, located at El kalubia governorate, Egypt. **The study involved two experiments.**

First experiment was done in season, (2012 and 2013) to estimate fruit growth rate from mid May, 2012 (30 day after full bloom) to mid March, 2013**.** Obtained results indicated that, fruit growth rate passes through three stages**.** First stage (cell division) up to in mid-June, second stage (cell division and elongation) up to in mid-August and third one (slightly cell elongation) which continued until harvest time**.**

Second experiment was done in (2013/2014) and (2014/2015) seasons to determine the effects of foliar nutritional sprays on fruit quality, yield and leaf mineral content. Trees were either left untreated or had foliar applications of monopotassium phosphate (MKP) at 1% and 2%, dipotassium phosphate (DKP) at 1% and 2% and active bread yeast at 40 and 80 ppm. Trees were sprayed by all treatments at full bloom stage then were divided into two groups the first was sprayed by the same treatments in mid June and the second was sprayed in mid August. Obtained results indicated that, (DKP) at 1% was the best treatment for increasing fruit quality, yield and leaf mineral content followed in a descending order by (MKP) at 2% and active bread yeast at 40ppm. Foliar sprays trees in mid-June resulted in the best results than mid- August treatment.

Key words. *valencia orange, fruit size, yield, leaf mineral content, potassium phosphate and yeast*

1- INTRODUCTION

In Egypt, valencia orange fruits represent the second rank of Egyptian citrus exportation after Navel orange fruits. valencia orange plantations represent about 27.6% from total citrus area (Ministry of Agriculture and Land Reclamation of Egypt, 2014). Fruits of valencia orange budded on sour orange rootstock are smaller than those budded on Volkamer lemon rootstock. Thus, fruit size is one of the most important parameters determining the profitability of citrus production. Markets have specific demands for fruit size and offer higher rewards for fruit of optimum size (El-Otmani *et al*., 1993; Guardiola & García-Luis, 2000). The production of fruit of unsatisfactory size, however, lead to the reduction in profitability with production costs in some instances higher than rewards offered by consumers (Guardiola and García-Luis, 1997; Guardiola & García-Luis, 2000; Gilfillan, 1987). Factors influencing fruit growth and eventual fruit size can be divided into two groups: those out of the producer's control, such as climate, soil- and rootstock type and those that can be managed by the producer, such as water supply, nutrition, flower number and fruit load (Gilfillan, 1987). Techniques used by producers to ensure optimum fruit size include girdling, pruning, optimum irrigation and fertilization. As fruit size is inversely related to flower number and eventual fruit load (Barry and Bower, 1997; Lenz and Cary, 1969), producers make use of thinning methods to reduce inter-fruit competition and increase fruit size (Guardiola, 1997). Except for hand thinning, this requires large amounts of labor.

A foliar application of potassium is one of the most important macro-elements which is highly mobile in plants at all levels, from individual cell to xylem and phloem transport. This cation plays a major role in: enzyme activation, protein synthesis, stomatal function, stabilization of internal pH, photosynthesis, turgor-related processes and transport of metabolites. Potassium improves fruit quality by enhancing fruit size, juice contents, color, and juice flavor (Tiwari, 2005 and Ashraf *et al*., 2010). Calvert (1969) reported that foliar sprays of potassium nitrate (KNO_3) were more effective in rapidly increasing the K content of leaves than ground applied fertilizers. Foliar K sprays can be an effective method to shorten the time required for its uptake compared to soil applications (Embleton, *et al*., 1969) . Application of potassium increased mineral content and crop yield (El-Safty. *et al*., 1998).

The possibility of using the active bread yeast for improving growth and productivity of fruit crops was mentioned by Suriabananont (1992) and Stino *et al*. (2009). However, the various positive effects of applying active bread yeast as a newly used bio-fertilizer were attributed to its own component from different nutrients, higher percentage of proteins, massive amount of vitamin B and the natural plant growth hormone namely cytokinins which increase cell division (Jackson, 2003; Davis, 2004). In addition, application of active bread yeast was very effective in releasing CO_2, which it's in turn was reflected on improving net photosynthesis (Idso *et al*., 1995 and Hashem *et al*., 2008). Also (Khafagy. *et al*., 2010) on Navel orange and Mohamed, (2008) on Balady mandarin trees indicated that, spraying trees with active dry yeast zinc sulphate resulted in high yield values.

The aim of this study is to improve the quality of valencia orange fruits in terms of weight and size to reduce the proportion of off type fruits which tend for exportation.

2- MATERIAL AND METHODS

This investigation was conducted during (2013/2014) and (2014/2015) seasons in a private orchard belongs to Mr.

Hussein Saber located at El kalubia governorate on valencia orange trees (*Citrus sinensis, L*) budded on sour orange rootstock (*Citrus aurantium*) to study the effect of foliar application of monopotassium dihydrogen orthophosphate (MKP) "1K: 2 P", dipotassium hydrogen orthophosphate anhydrous (DKP) "2K:1P"and active bread yeast on increasing weight and size of valencia orange fruits.

The trees were 20 years old, and were planted at 5x5 m spacing (168 trees/ feddan) in clay soil under flood irrigation, and irrigation was given at intervals of about ten days in summer and 15-20 days in winter. **The study involved two experiments.**

First experiment was carried out in season, (2012& 2013) to estimate fruit growth rate (%) of the diameter of tagged fruits from random trees (50 fruits on each of 10 trees) was measured by using a digital vernier caliper each two weeks, from mid May, 2012 (30 day after full bloom) to mid March (2013), average diameter of fruits for each time and fruit growth rate were calculated.

Second experiment was done during (2013/2014) and (2014/2015) seasons**,** thirty nine trees were used according to vigor and number of flowers for data collection.

The selected trees were sprayed as follows:

1. Control trees (untreated), were sprayed with water
2. 1% Monopotassium phosphate
3. 2% Monopotassium phosphate
4. 1%Dipotassium phosphate
5. 2% Dipotassium phosphate
6. 40 ppm active bread yeast
7. 80 ppm active bread yeast

Active bread yeast has been brought by Starch and Yeast Company contained cytokinins at 4.2%.

Active bread yeast at 40 ppm was prepared before foliar spraying about 24 hour as 1g of yeast and 20 cm^3 of black strap molasses / liter of tap water, each tree was sprayed by 10 liter and the other concentration (80 ppm) was prepared with the similar method. The trees were sprayed at full bloom stage then divided into two groups the first was sprayed by the same treatments in mid June and the second was sprayed in mid August.

The design was completely randomized block with 3 single tree replicates with one tree for each replicate. Also, balanced flair fertilization off all microelements was adopted three times yearly (February, May and August).

The following parameters were carried out.

Fruit quality. Ten fruits of Valencia orange were randomly taken from the yield in two seasons for each replicate and the following determinations were carried out:

Fruit length, diameter (mm) in each individual fruit was measured by using a digital vernier caliper. Juice weight percentage was calculated and recorded. Total soluble solids (T.S.S %) was determined by using Zeiss hand refractometer. Total acidity (%) was determined in fruit juice as anhydrous citric acid according to A.O.A.C, (1995). Total soluble solids/acid ratio was calculated from the values of total soluble solids divided by values of total acids. Ascorbic acid (Vitamin C) was calculated as mg/100 ml juice according to Horwitz, (1972).

Yield. The number of fruits per tree was counted at the harvesting time .The yield per tree (kg) was determined and the theoretical yield (ton/ fed.) was calculated.

Leaf mineral content. Leaves were collected according to Jones and Embleton, (1960) to determine leaf content of N, P and K on leaf dry weight basis. Total nitrogen (%) was determined by using microkjeldahl method according to (Pregl, 1945). Phosphorus (%) was determined calorimetrically according to Troug and Meyer, (1939). Potassium (%) was determined using the flame photometric method according to Brown and Lilliland, (1966).

Statistical analysis. Randomized complete block design with three replicates per treatment and one tree per replicate was used. The obtained data were statistically analyzed according to Clarke and Kempson (1997) and comparison among means were made using Duncan Multiple Range Test (Duncan, 1955).

3- RESULTS AND DISSCUTION

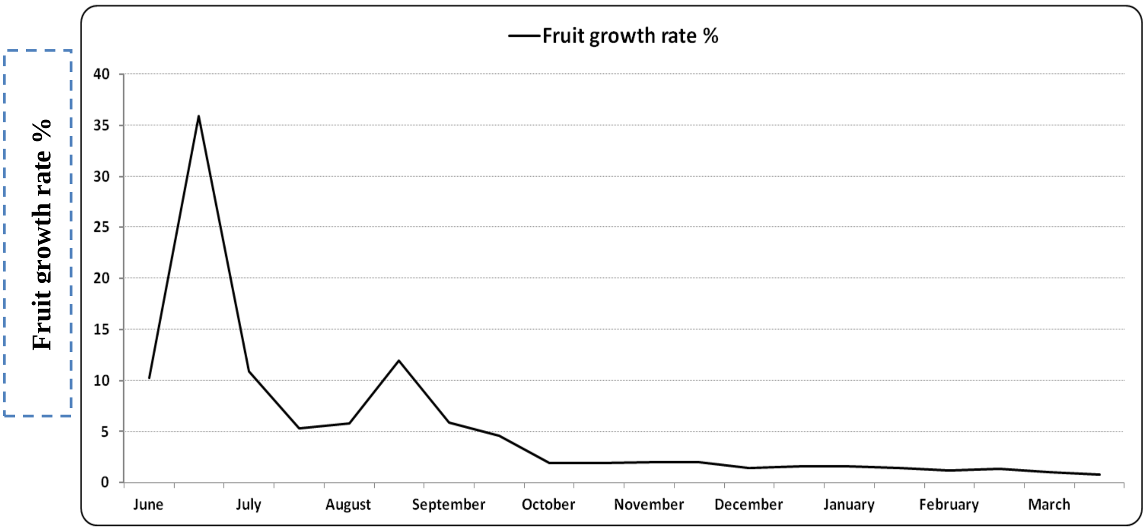

Fig. 1. Fruit growth rate of valencia orange from mid May, 2012 to mid March, 2013

Fruit growth rate (%).

Figure (1) showed the fruit growth rate (%) of valencia orange from mid May, 2012 (30 day after full bloom) to mid March (2013), and the results indicated that, increasing the size of fruits passes through three stages, first stage was in mid-June, which showed the highest rate of increasing in fruit size, and the second stage was in mid-August that gave a smaller increasing in fruit size, then the third stage which gave a slight increasing in fruit size which continued until harvest time. These results are in line with these mentioned by (Bain, 1958) who reported that, the growth and development stages of 'valencia' orange fruit are divided into three distinct stages and follow a sigmoid pattern, which holds true for most citrus cultivars.

In this respect Cooper,*et al*., (1963) and Richardson, *et al*., (1997) stated that during the first stage of fruit development, cell division and as a result the formation of the cellular structures of the fruit occur, also they proved that both day and night temperatures during this period affect fruit growth and eventual fruit size of 'valencia' orange and 'Satsuma' mandarin. Also (Bain, 1958) mentioned that during the second stage of fruit development, cell growth and expansion of the pulp occur and are responsible for most of the increase in fruit diameter and weight also during this stage fruit growth are more limited by too high temperatures (exceeding 38°C) rather than low temperatures (Hilgeman, *et al*., 1959). Moreover, very little growth takes place during the third stage of fruit development (Bain, 1958) and final fruit size are less influenced by climatic conditions during this period, compared to the first and second stages. Thus, to increase fruit size of valencia oranges, special treatments showed be applied in June (cell division stage) and again in August (cell division and elongation stage).

Fruit quality

According to fruit growth rate, the application of treatments of our study was done at mid-June and mid-August. Fruit dimensions (diameter and length) and Juice weight (%) were taken at the harvest stage. Juice weight (%) which is related to fruit size is an extremely important parameter in industrial processing of fruits size. Results in (Tables1&2) indicated that all treatments increased fruit dimensions and Juice weight (%) especially fruits on trees that had dipotassium phosphate at 1% followed by monopotassium phosphate at 2% and yeast at 40ppm whereas, these treatments that treated fruits tended to grow at a faster rate and were larger and had maximum Juice weight (%) than the control fruit, while little difference was noted between other treatments. Also it could be noticed that, foliar applications of all treatments at mid- June were effective in increasing fruit dimensions and Juice weight (%) than mid-August at the first and second seasons (2014 and 2015).

In general, these results disclose a positive relationship may be established between fruit size and foliar spray of potassium. The physiology of potassium function and its conspicuous role in plant water relations has long been known (Hsiao and Lanchli, 1986). The present results are in a general harmony with Erner, *et al*., (1993) on citrus, Okada, *et al*., (1994) on Satsuma mandarin and Zaied *et al*., (2006) on Navel orange, who mentioned that, fruit size increase with increasing the level of applied potassium. Also these results may be attributed to the role of active bread yeast which contains higher percentage of proteins, massive amount of vitamin B and the natural plant growth hormone namely cytokinins which increase cell division (Jackson, 2003; Davis, 2004). In this respect Elham, *et al*., (2010) stated that spraying keitte mango trees with algae at 2% combined with yeast at 0.2% increased fruit length, fruit width and fruit weight. The same result was found by (Ayman, 2011) on Le Conte Pear cultivar.

As for fruit weight (gm) and average fruit weight (%) during two seasons (2014 & 2015), results in (Table 3) and (Figures 2&3) showed that fruit weight was significantly increased by all treatments either with potassium spraying at any form and any concentration or with active bread yeast . However, fruit weight was gradually increased by potassium spraying than the control then the range of increasing was higher when trees treated with active bread yeast at 80ppm and reached the maximum with potassium treatments especially dipotassium phosphate at 1% which gave the highest fruit weight (gm). Also it could be noticed that, fruits sprayed in mid- June were bigger than fruits sprayed in mid- August at the first and second seasons. Also (Fig.2&3) showed average fruit weight (%) than the control of two seasons (2014 & 2015) and indicated that foliar spraying trees with dipotassium phosphate at 1% increased fruit weight (%) by 19.44% over control in mid- June and 3.45% over control in mid- August followed by monopotassium phosphate at2% which increased fruit weight by (18.37 and 2.11%) then active bread yeast at 40ppm which increased fruit weight by (17.24 and 2.73%) over control in mid- June and mid- July respectively.

Concerning juice T.S.S, acidity and T.S.S./acid ratio results in (Table 4) indicated that all treatments tended to increase juice T.S.S. and T.S.S./acid ratio contents and decreased fruit acidity as compared with control treatment. In more details and regarding fruit TSS percentage, the highest values were obtained by the use of dipotassium phosphate at 1% followed by monopotassium phosphate at 2% and yeast at 40ppm. While, the minimum values were obtained by control treatment. Meanwhile, the differences between the other treatments were in between during two seasons. As for acidity % data in (Table 4) revealed that, all treatments reduced acidity, whereas, control treatment recorded the highest values, while differences between other treatments didn't show any obvious trend during two seasons. TSS/Acid ratio is an important characteristic for fruits exportation. The results indicated that, dipotassium phosphate at 1% was the best treatment for achieving the maximum values as compared to control treatment. On the other hand foliar applications of all treatments at mid-August gave the best values than mid- June during two seasons (2014 &2015).

These results are attributed to the role of potassium in plant water relations and also the present results are in general harmony with Sdoodee and Chiarawipa (2005) on Shogun mandarin, who found that, trees sprayed with $CaCl_2$ 1% and boric acid 0.8% enhanced T.S.S. and total acidity. In this concern, Qinxuannaw and Shaoguo (1996**)** mentioned that, trees sprayed 4 times with KCL (1%) increased T.S.S. and total acidity contents on Eureka lemon. Meanwhile, Dass and Srivastava, (1997) found that the interaction with other nutrients and crop demand for K increases in juice high T.S.S./acid ratio of citrus trees. Moreover, Zaied, *et al*., (2006) reported that, Juice T.S.S, T.S.S./acid ratio content increased significantly with increasing applied potassium on Washington navel orange trees. In view of the preceding results, they may be attributed to the role of active bread yeast which contained many sources of cytokinins like, Sitofix

"CPPU" and thus plays an important role for improving fruit weight. The increase in fruit size could be attributed directly to the CPPU effects whereas; exogenous application of CPPU acts as early and rapid on cell division in the fruitlet and also on subsequent growth. Thus, the fruit becomes bigger in size due to the increased cells, which are able attract so much water, minerals and carbohydrates that enable the fruit to expand to large size (Kano, 2003). Our results go along with those found by (Abd El Raheem *et al.*, 2013) who revealed that application of 3, 4 ppm CPPU either singly or in combination with 30 ppm GA3was superior for increasing fruit weight of Navel orange. Moreover,(Elham, *et al.*, 2010) revealed that spraying Keitte mango trees with algae combined with yeast improved fruit physical and chemical properties. The same trend was obtained by (Gobara, *et al.*, 2002) on Red Romy grapevines and (Ayman, 2011) on "Le Conte" Pear.

Table (1) Fruit dimensions (mm) at the end of the first and second seasons.

Treatments	Fruit diameter (mm) Mid June	Mid August	Mean (Treat.)	Fruit length (mm) Mid June	Mid August	Mean (Treat.)
The first season (2014)						
Control	67.10f	67.10f	67.10f`	68.67cd	68.67cd	68.67 b
1% MKP	69.71ab	67.66de	68.68ab	69.14bc	69.14bc	69.14ab
2% MKP	**70.36 ab**	68.12cd	69.24ab	**70.79ab**	67.29d	69.04 b
1% DKP	**71.63 a**	68.10cd	69.86 a	**71.96 a**	68.81cd	70.38 a
2% DKP	69.27bc	67.43ef	68.35bc	68.84cd	68.52cd	68.68 b
40 ppm Yeast	**69.47bc**	68.88bc	69.18ab	**70.07bc**	69.24bc	69.65 ab
80 ppm Yeast	68.76bc	67.71de	68.23bc	68.49cd	69.02bc	68.75 b
Mean (Time)	69.47 a	67.86 b		69.71 a	68.67b	
The second season (2015)						
Control	66.27cd	66.27cd	66.27c	68.21bc	68.21bc	68.21 a
1% MKP	67.75cd	65.53 e	66.64bc	69.43ab	67.50bc	68.46 a
2% MKP	**69.95ab**	65.98de	67.96 b	**69.69ab**	67.17de	68.43 a
1% DKP	**72.01 a**	67.68cd	69.85 a	**71.14 a**	68.83ab	69.98 a
2% DKP	67.87bc	64.86 e	66.36 c	69.59ab	66.87 e	68.23 a
40 ppm Yeast	**68.13bc**	65.40 e	66.77bc	**69.86ab**	66.79 e	68.32 a
80 ppm Yeast	66.45cd	66.45cd	66.45bc	69.86ab	67.23cd	68.54 a
Mean (Time)	68.35	65.02 b		69.68 a	67.51 b	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Table (2). Juice weight (%) of valencia orange fruits during 2014 and 2015.

Treatments	Juice weight (%) Season, 2014 Mid June	Mid August	Mean (Treat.)	Season, 2015 Mid June	Mid August	Mean (Treat.)
Control	53.98 f	53.98 f	53.98 d	55.26 i	55.26 i	55.26 d
1% MKP	60.50 c	56.11de	58.30 c	61.01cd	58.26ef	59.63bc
2% MKP	**62.38ab**	56.61de	59.49ab	**63.35ab**	58.09ef	60.72 b
1% DKP	**63.11 a**	57.10 d	60.10 a	**64.62 a**	59.66de	62.14 a
2% DKP	61.16bc	56.53de	58.84bc	60.93cd	56.33gh	58.63 c
40 ppm Yeast	**61.95ab**	55.45ef	58.70bc	**61.62bc**	57.30fg	59.46bc
80 ppm Yeast	61.05bc	56.61de	58.83bc	61.36cd	56.03hi	58.69 c
Mean (Time)	60.59 a	56.05 b		61.16 a	57.28 b	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Table (3) Fruit weight of valencia orange during two times foliar applications

Treatments	Fruit weight (gm) Season, 2014 Mid June	Mid August	Mean (Treat.)	Season, 2015 Mid June	Mid August	Mean (Treat.)
Control	159 e	159 e	159 e	160 d	160 d	160 d
1% MKP	176 cd	159.7e	167.8cd	183 b	161 d	172 bc
2% MKP	188.3a	162.7e	175.5a	189.3ab	163 d	176.2ab
1% DKP	189.3a	163 e	176.2a	191.7a	167cd	179.3 a
2% DKP	180 bc	160.7	170.3bc	188 ab	162 d	175 ab
40 ppm Yeast	186 ab	161.7e	173.8ab	188ab	166 cd	177ab
80 ppm Yeast	170 d	160 e	165d	172 c	162 d	167.2c
Mean (Time)	178.4 a	161 b		181.7a	163 b	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

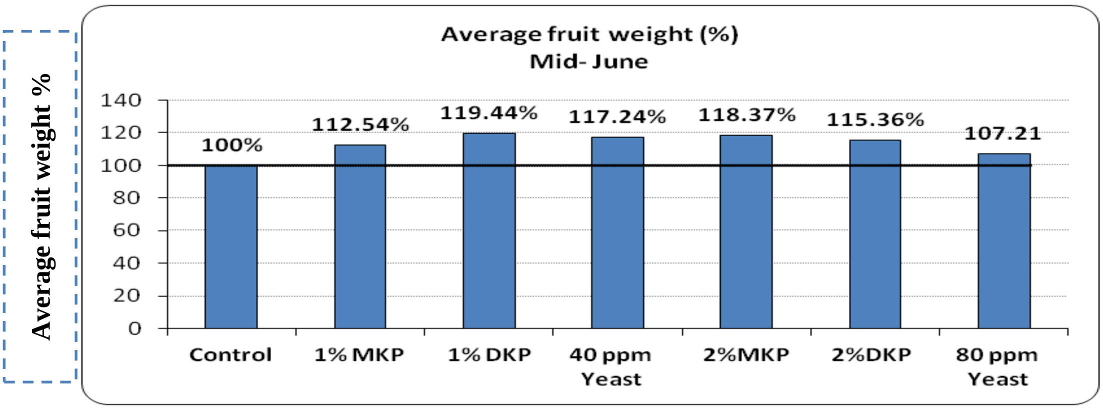

Fig. 2. Average fruit weight (%) than the control at mid- June of two seasons.

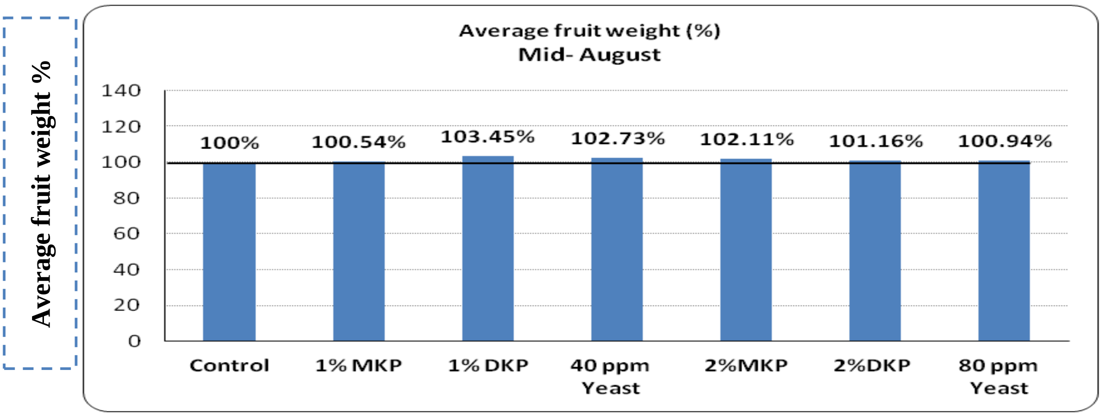

Fig. 3. Average fruit weight (%) than the control at mid- August of two seasons.

Table (4) Chemical fruit quality of valencia orange at the first and second seasons.

	The first season (2014)								
	T.S.S%			Acidity %			T.S.S / Acid		
Treatments	Mid June	Mid August	Mean (Treat.)	Mid June	Mid August	Mean (Treat.)	Mid June	Mid August	Mean (Treat.)
Control	10.17 f	10.17 f	10.17 e	1.09 d	1.09 d	1.09 d	9.36 g	9.36 g	9.36 g
1% MKP	10.67 e	11.00de	10.83 d	1.12cd	1.08 d	1.10cd	9.53fg	10.16de	9.85 c
1% DKP	12.17 b	13.17 a	12.67 a	1.15bc	1.20ab	1.17ab	10.61ab	11.00 a	10.81 a
40 ppm Yeast	11.00de	12. 33b	11.67 c	1.10cd	1.18ab	1.14bc	10.00e	10.48bc	10.24 b
2% MKP	11.67 c	13.00 a	12.33 b	1.15bc	1.22 a	1.19 a	10.18cd	10.63ab	10.40 b
2% DKP	10.67 e	11.50 c	11.08 d	1.12cd	1.17ab	1.15 b	9.56fg	9.80ef	9.68cd
80 ppm Yeast	10.83 e	11.33cd	11.08 d	1.15bc	1.27 a	1.18 a	9.46fg	9.29 g	9.38de
Mean (Time)	11.02 b	11.79 a		1.12 b	1.17 a		9.81 b	10.10 a	
	The second season (2015)								
Control	11.17 d	11.17 d	11.17 d	1.15 c	1.15 c	1.15 c	9.74bc	9.74bc	9.74 c
1% MKP	11.67cd	13.33 b	12.50 c	1.14 c	1.23bc	1.19bc	10.20 b	10.84 a	10.52b
1% DKP	12.33 c	14.00a b	13.17ab	1.15 c	1.25 b	1.20bc	10.75 a	11.20 a	10.98 a
40 ppm Yeast	12.17 c	13.33 b	12.75ab	1.19bc	1.24 b	1.22 b	10.22 b	10.74 a	10.48 b
2% MKP	12.33 c	14.17 a	13.25 a	1.21bc	1.27ab	1.24ab	10.20 b	11.12 a	10.66ab
2% DKP	12.00 c	13.33 b	12.67bc	1.25 b	1.36 a	1.30 a	9.64 c	9.86bc	9.75 c
80 ppm Yeast	11.83cd	13.50a b	12.67bc	1.21bc	1.36 a	1.28 a	9.76bc	9.97bc	9.87 c
Mean (Time)	11.93 b	13.26 a		1.19 b	1.26 a		10.07 b	10.50 a	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Yield

Data tabulated in (Table 5 and Figure 4&5) showed the number of fruits/tree and production (ton) / feddan. The average yield comparing with the control (%) of two seasons in mid- June and mid- August and the results indicated that foliar spraying with all treatments at the first time gave maximum yield than the second time application whereas, spraying trees with dipotassium phosphate at 1% was recommended to achieve maximum yield over control (35.98%) in mid June and (10.38%) in mid- August followed in ascending order by monopotassium phosphate at 2% (28.32& 2.87%) and active yeast bread at 40ppm (20.13% & 2.73%) as compared with control treatment in mid- June and mid-August, respectively. From the above mentioned results, it is interesting to notice that, spraying potassium and yeast at different rates increased the yield of valencia orange trees. These results are in the same line with those obtained by **(El-**Fangary, 1998 and Mostafa, *et al*., 2005) who found that, KNO3 enhanced fruit set and increased yield of orange and mandarin trees. The same results were obtained by (Abd El-Rahman *et al*., 2012) on Washington Navel orange. The foregoing results agree with those obtained by (Fornes, *et al*.,2002) and (Abada, 2002) who reported that yield of orange, mandarin and Red Roomy grapevines were increased by algae and yeast extracts.

Table (5) Fruit No. / Tree and productivity (ton / feddan) of valencia orange tree

	The first season (2014)					
	Fruit number/ tree			productivity ton / feddan		
Treatments	Mid June	Mid August	Mean (Treat.)	Mid June	Mid August	Mean (Treat.)
Control	403.3 bc	403.3bc	403.3 b	10.77 e	10.77 e	10.77 e
1% MKP	413.3 bc	403.3bc	408.3 b	12.22 c	10.82 e	11.52 c
1% DKP	446.7 a	420.0bc	433.3 a	14.20 a	11.50 d	12.85 a
40 ppm Yeast	400.0 cd	393.3 d	396.7 b	12.49 c	10.68 e	11.58 c
2% MKP	423.3 b	393.3 d	408.3 b	13.39 b	10.74 e	12.07 b
2% DKP	410.0 bc	400.0cd	405.0 b	12.39 c	10.80 e	11.59 c
80 ppm Yeast	410.0bc	393.3 d	401.7 b	11.70 d	10.57 e	11.14 d
Mean (Time)	415.2 a	401.0 b		12.45 a	10.84 b	
			The second season (2015)			
Control	390 e	390 e	390 d	10.48 f	10.48 f	10.48 e
1% MKP	413.3cd	403de	408.3 c	12.71 c	10.91ef	11.81cd
1% DKP	456.7 a	427bc	441.7 a	14.71 a	11.96 d	13.34 a
40 ppm Yeast	413.3cd	400 de	406.7 c	13.05 c	11.16 e	12.10bc
2% MKP	436.7 b	407de	421.7 b	13.89 b	11.13ef	12.51 b
2% DKP	406.7de	407de	406.7 c	12.84 c	11.07ef	11.95cd
80 ppm Yeast	410.0cd	410cd	410 bc	11.85 d	11.18 e	11.52 d
Mean (Time)	418.1 a	406.2 b		12.79 a	11.13 b	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

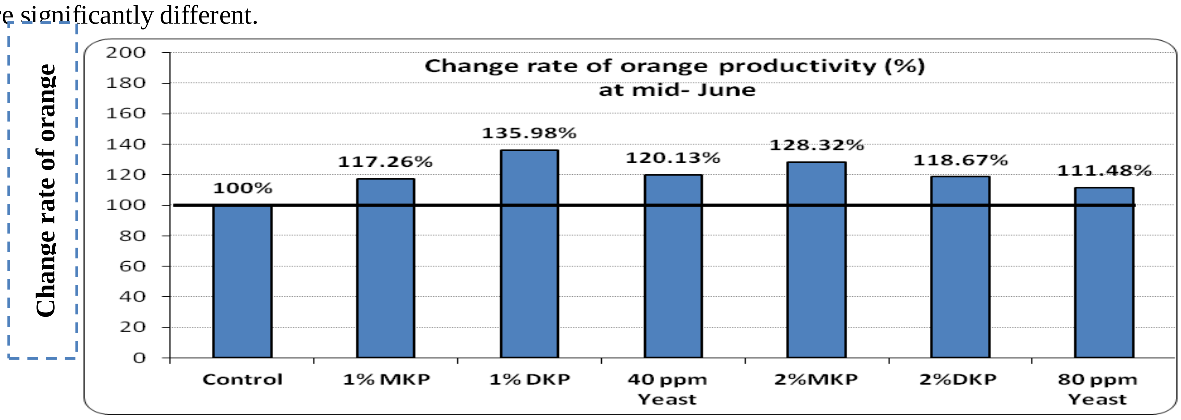

Fig. 4. Average change rate of orange productivity (%) at mid- June of two seasons.

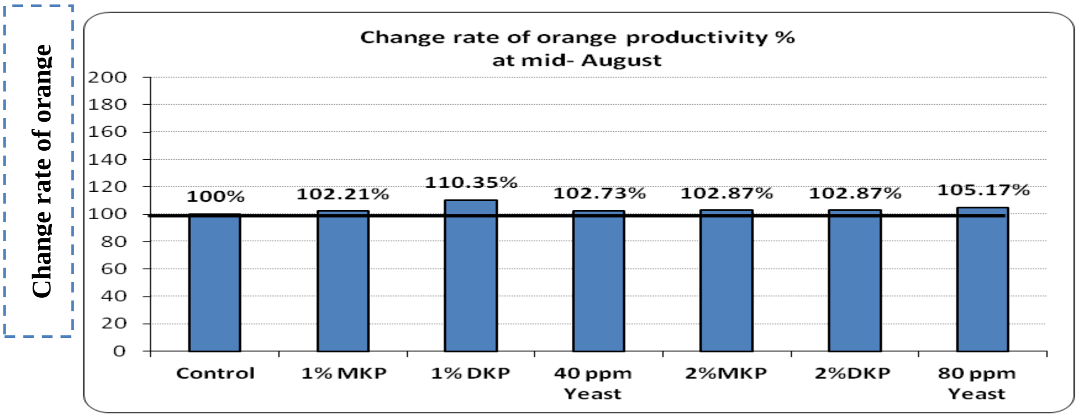

Fig. 5. Average change rate of orange productivity (%) at mid- August of two seasons.

Leaf mineral contents

Data in (Table 6) show the effect of potassium foliar sprays and active bread yeast on leaf mineral content. As for nitrogen, it is clear that all treatments significantly increased N% in the leaves comparing with the control. In this respect, presence of dipotassium phosphate at 1% recorded the highest nitrogen content in the leaf, followed by monopotassium phosphate at 2%, while the untreated trees gave the lowest values in both studied seasons. Regarding potassium content in the leaves, it is observed that the results took the same trend of nitrogen percentage in the leaves, since the higher values were obtained with dipotassium phosphate at 1% followed in decreasing order by monopotassium phosphate at 2% then active bread yeast at 40ppm, while the untreated trees were recorded the lowest K%. this trend held true during both studied seasons. Phosphorus percentage in the leaves was not affected by any treatments in the two studied seasons. On the other hand, leaf mineral content of trees sprayed at mid- June was higher than those sprayed at mid- August. The obtained results are in agreement with those reported by (Mostafa and Saleh 2006) and (Mostafa *et al.* 2005) on Balady mandarin, since spraying potassium from several forms i.e. KH2PO4 or K2HPO4or KNO3 raised N, P and K levels in the leaves. Also in this respect (Sarrwy, *et al*., 2012) indicated that foliar spraying with different potassium forms such as potassium nitrate (KNO3), monopotassium phosphate (MKP) and potassium thiosulfate (KTS) at different concentration supported with chelated zinc at 0.5% induced a remarkable promotion in leaf mineral status on Balady mandarin trees. On the other hand, the positive effect of active bread yeast on improving leaf mineral content was reported by Abdelaal, *et al*., (2013) on "valencia" orange trees; Ahmed and Ragab (2002) on "Picual" olive trees ; and El-Sayed (2013) on "Aggizy" olive trees. They mentioned that yeast application enhanced leaf mineral content of the aforementioned fruit species.

Table (6) Leaf mineral content of valencia orange trees in the first and second seasons.

Treatments	N %			P %			K %		
	Mid June	Mid August	Mean (Treat.)	Mid June	Mid August	Mean (Treat.)	Mid June	Mid August	Mean (Treat.)
The first season (2014)									
Control	2.39 c	2.39 c	2.39 d	0.12 a	0.12a	0.12a	0.77e	0.77e	0.77c
1% MKP	2.42bc	2.42bc	2.42cd	0.14a	0.13a	0.13a	1.05a	0.88bc	0.97a
1% DKP	2.44bc	2.45 b	2.44ab	0.14 a	0.14a	0.14a	1.04a	0.91b	0.97a
40 ppm Yeast	2.54 a	2.43bc	2.48 a	0.14 a	0.13a	0.13a	0.89bc	0.85cd	0.87b
2% MKP	2.43bc	2.44bc	2.44 c	0.14a	0.13a	0.14a	1.06a	0.91b	0.98a
2% DKP	2.44bc	2.44bc	2.44bc	0.14a	0.13a	0.14a	1.06a	0.89bc	0.98a
80 ppm Yeast	2.52 a	2.44bc	2.45ab	0.13a	0.12a	0.13a	0.86bc	0.83d	0.85b
Mean (Time)	2.45 a	2.43 b		0.14a	0.13a		0.96 a	0.86 b	
The second season (2015)									
Control	2.41b	2.41b	2.41b	0.12a	0.12a	0.12a	0.81d	0.81d	0.81 c
1% MKP	2.44b	2.42b	2.43b	0.14a	0.13a	0.14a	1.05a	0.94bc	0.99a
1% DKP	2.44b	2.44b	2.44b	0.16a	0.14a	0.15a	1.06a	0.95b	1.01a
40 ppm Yeast	2.56a	2.43b	2.49a	0.13a	0.13a	0.13a	0.93bc	0.90c	0.92b
2% MKP	2.44b	2.43b	2.44b	0.16a	0.13a	0.15a	1.05a	0.95b	1.00a
2% DKP	2.45b	2.44b	2.44b	0.14a	0.13a	0.14a	1.06a	0.97b	1.01a
80 ppm Yeast	2.56a	2.43b	2.49a	0.15a	0.14a	0.15a	0.96b	0.92bc	0.94b
Mean (Time)	2.47 a	2.43 b		0.14a	0.13a		0.99 a	0.92 b	

Mean separation within columns by Duncan's multiple range test, 5% level. Values that don't share the same letter are significantly different.

Conclusion

The importance of fruit size as a parameter of quality has increased markedly in recent times. This is reflected in the changes in the legal regulations which have risen recently in minimum diameter to accept a fruit as marketable in markets.

valencia oranges are considered as the second product for exportation after Navel orange, thus increasing fruit size led to increase national income in addition to increase the economic returns to citrus growers. As presented above fruit growth rate passes through three stages. Thus, time and rate of foliar application of treatments which enhance fruit size of valencia orange trees are very important factors.

According to data in hand , it could be concluded that, foliar spray of dipotassium phosphate(DKP) at 1% was the best treatment for increasing fruit dimensions, fruit (weight, size), fruit weight over control, fruit quality, yield and leaf mineral content. Moreover, foliar spraying trees at mid-June gave the best results than mid- August.

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