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Improving growth and fruiting as well as chemical constituents of Washington Navel orange trees grown in new reclaimed soils by using yeast extract; GA_3 and potassium citrate

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ABSTRACT

Two field experiments were conducted at a private farm in Wadei El-Natrowan town El-Behara Governorate during 2013 and 2014 seasons to study the effect of some stimulating compounds (i.e., yeast extract, Gibbrellic acid (GA_3) and potassium citrate as foliar spray each at two assigned rates) on some aspects of growth and fruiting as well as chemical constituents of Washington Navel orange trees seven-years-old and budded on Volkamer lemon rootstock. The obtained results clearly indicated that an obvious activity of the applied treatments for improving growth parameters. However, the highest values of number of shoots/ one meter length limb, shoot length, shoot thickness, number of leaves and the average of leaf area were scored by yeast extract foliar spray at the two rates (100 and 50 ml/L), followed by potassium citrate at 1000 mg/L in the two seasons. Also, all applied treatments increased each of fruit set and the remained fruits percentages as well as minimizing fruit dropping and increasing the weight of yielded fruits with improving quality. Moreover, the best results of the aforementioned parameters were recorded by using yeast extract at the high and low level in both seasons. Furthermore, all tested foliar sprays of growth stimulants improving leaf chemical composition contents i.e. photosynthetic pigments, N, P, K, Fe, Zn and Mn contents with superior for yeast extract at the high level in the two seasons.

Key words: Bio-stimulating compounds, sea weed extract, Gibbrellic acid, yeast extract, growth and fruiting parameters, photosynthetic pigments and mineral contents.

Introduction

Citrus (*Citrus spp*.) is one of the most important fruit crops grown in many tropical and subtropical countries. At the moment there is about 1.5 million hectares of citrus fruits cultivated for commercial scale in the world yielded nearly 40 million metric tons of oranges, lemons, limes, etc (Anonymous, 2008). In Egypt, citrus has great attention due to its importance for local consumption or as a main source for foreign currencies by exportation to the European country. The area of citrus cultivated in Egypt was increased rapidly with the reclamation of new desert lands reaches about 35.59 hectare (Anonymous, 2008). Slow increase in Citrus production for the 2009/2010 season, both orange area and production are expected to increase. This expected increase in production is due to the increased number of bearing trees in the vast expansion of new cultivated area in the newly reclaimed land. The increase can also be attributed to the continued absence of strong winds, which can be a large determining factor for overall yield and production as they usually cause damage to fruit set. In 2012/2013, total planted orange area is forecast at 163,000 hectares compared to 155,000 estimated for 2011/2012 and 150,000 hectares in 2010/11. Production in 2012/2013 is forecast to increase to 3.88 million MT, up from the estimated 3.67 million MT in 2011/12 compared to about 3.55 million MT in 2010/2011. The expected increase in total orange production is mainly due to the increase in the number of bearing trees. The expected increase in total orange production is mainly due to the increase in the number of bearing trees. Nowadays, new biostemulating materials such as

Potassium (K) that one of the most important nutrients commonly applied as fertilizer by citrus growers. Potassium (also called potash) is listed on the fertilizer label as K_2O. Potassium plays a key nutritional role in determining yield, fruit size, and quality. The sandy soils used to produce citrus in

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Florida are naturally low in K. Also, K is not fixed and does not accumulate in those sandy soils, even with repeated fertilizer applications. Thus, K fertilizer application is required every year in Florida citrus groves. Potassium deficiency is not common when a grove is fertilized normally, but deficiency can develop on high pH soils or when high N rates stimulate high fruit production. Zewail *et al*., (2011).

In addition, Gibberellin treatment is a common agricultural practice that is currently used to inhibit flowering in citrus trees. In this respect applications of gibberellic acid during citrus bud development have been widely shown to inhibit flower production leading to a greater ratio of terminal flowers in leafy shoots and consequently a higher fruit Domingo *et al.,* (2007).

With regard to the yeast extract yeast as a natural source for photohormones, growth factors and vitamins providing has been reported its stimulus effect up on flowering set of Washington Navel orange trees (Atawia and El-Desouky, 1997). Washington navel orange with GA_3 at 20 mg/l and Yeast extract at 100 ml/l increased vegetative, flowering, fruit set and fruit yield and quality as well as.

This study aimed to determine the effect of biostemulating materials potassium citrate, GA_3 and yeast extract on flowering, fruit set, fruit yield and fruit quality of Washington navel orange grown in new reclaimed soils.

Materials and Methods

Two field experiments were conducted at a private farm in Wadei El-Natrowan town El-Behara Governorate during 2013 and 2014 seasons to study the effect of some bio-stimulating compounds on fruitful Washington navel orange trees seven-year old budded on Volkamer lemon rootstock and grown in new reclaimed soil which were the plant material used in this regard to investigate the influence of bio-stimulating compounds as follows:

1- Control (untreated).
2- Potassium citrate source from 55 % potassium citrate (Biotic Company) using at 500 and 1000 mg/l.
3- Gibberellic acid (GA_3) source from (Made in England) using at 20 and 50 mg/l.
4-Yeast extract at 100 and 150 ml/l.

Yeast Extract preparation:-

Using a technique allowed yeast cells (commercial soft yeast) to be grown and multiplied efficiently during conducive aerobic and nutritional conditions. To produce denovo beneficial bio constituents (i.e., carbohydrates, sugars, proteins, amino acids, fatty acids, hormones and etc), hence allowed such constituents to release out of yeast cells in readily form by using two followed cycles of thawing and freezing.

Such technique for yeast preparation based on:

- Nutritional medium glucose and casein as 2 favorite sources of C, N and other essential elements (P, K, Ca, Mg, Fe. Mn, Zn, Cu, B, Mo as well as Na and Cl) in suitable balance.
- Air pumping and adjusting incubation temperature.
- Freezing for disruption of yeast cells and releasing their content.

Data Table (1) show that procedure modified described by AbdeI-Rahim *et al.*, (1988).

Management through tree growth:

Foliar spray with biostimulants as different concentration periodically applied three times/season at 30 March (full bloom); the second time at 30 April and mid meddle of may. Different agriculture practical i.e. irrigation, fertilizers, pest and weeds control as recommended in new reclaimed soil.

Table 1: Chemical analysis of yeast extract.

Minerals				Amino acids (mg/100g fresh weight)		Total carbohydrate (g/100g dry weight)		Enzymes (mg/100g fresh weight)		Vitamins (mg/100g fresh weight)	
Macro (g/100g dry weight)		Micro (mg/100g dry weight)									
Total N	6.23	Al	200.2	Arginine	1.99	Carboh-ydrates	13.2	Cytochrome oxidase	0.35	Riboflavin (B2)	4.27
P_2O_5	45.68	Ba	105.6	Histidine	1.63	Glucose	11.33	Cytochrome peroxidase	0.29	Nicotinic acid	25.89
K_2O	24.39	Co	47.8	Isoleiucine	1.31			Catalase	0.063	Panthothenic acid	13.56
NaO	0.35	Pb	238.6	Leucine	2.09					Biotin (H)	0.09
MgO	3.76	Mn	61.3	Lysine	1.95					p-amino benzoic acid	6.23
CaO	2.05	Sn	123.9	Methionine	0.72					Folic acid	2.36
SiO_2	1.55	Zn	235.62	Pheylalanine	1.01					Thiamine (B1)	3.94
SO_2	0.49			Threonine	1.09					Pyridoxine (B6)	4.15
CI	0.06			Tryptophan	0.45					Vitamin B12	1.53 (µg/100g)
FeO	0.92			Valine	1.19					Inositol	202.1 (µg/100g)
NaCl	0.30			Glutamic acid	1.00						
				Serine	1.59						
				Aspartic acid	1.33						
				Cystine	0.23						
				Proline	1.53						
				Tyrosine	1.49						

Experiment layout:

The complete randomized block design with four replications was employed for arranging the seven investigated fertilization treatments, where as each replicate was represented by a single tree. Consequently, twenty eight healthy fruitful Washington navel orange trees were carefully selected, as being healthy, disease free and in the on-year state. Chosen trees were divided according to their growth vigours into four categories (blocks) each included seven similar trees for receiving the investigated seven fertilization treatments (a single tree was randomly subjected to one treatment).
Taking into consideration that spray treatments were applied covering the whole foliage of each tree canopy, whereas3 liters found to be sufficient in this concern. Besides, soil drench application of a given nutrient compound particularly concentration of spray solution.
Methodology as has been reported in this study in order to evaluate the response to various biostemulating treatments was carried out through determining changes in different measurements of the following examined characteristics:
On late March 2013 and early April 2014 four main branches (limbs/scaffolds) well distributed around each tree periphery were carefully selected and tagged during 1st and 2nd seasons, respectively. Moreover, 20 newly spring developed shoots were also labeled.

Vegetative growth measurements:

On mid October 2013 and 2014 years the following vegetative growth parameters were determined during 1st and 2nd experimental seasons, respectively.
In this regard, average number of newly developed shoots per one meter of every tagged limb, average (length & thickness) and number of leaves, per each labeled shoot were estimated. Besides, average leaf area (cm) on the weight basis was also determined. Hence, twenty mature leaves from the previously labeled shoots per each limb were randomly collected. Then 20disks each of one cm. area

were taken and oven dried together with the rest leaves at 80°C till constant weight. Based on the known other, then average leaf area in cm. was calculated dry weight of a known surface area of leaves i.e., 20 leaf discs from one hand and the total weight of 20 leaves from the other, then average leaf area in cm. was calculated.

B. Fruiting measurements:

B.1. Fruit set percentage:

At full bloom during each experimental season number of perfect flowers per each tagged limb was counted. After 75% of petal fall fruit set as percentage of perfect flowers were estimated according the following equation used by Westwood (1978).

$$\text{Fruit set \%} = \frac{\text{Number of set fruitlets}}{\text{Number of perfect flowers}} \times 100$$

B.2. Fruits retention and drop %:

Percentage of both retained and dropped fruits, were periodically determined on June 20th, August 1st, October 3rd and mid December according to the following equations:

$$\text{Fruits retention \%} = \frac{\text{Number of presented (remained) fruits at a given date}}{\text{Number of set fruitlets}} \times 100$$

$$\text{Fruits drop \% (*)} = \frac{\text{Number of dropped fruits at a given date}}{\text{Number of set fruitlets}} \times 100$$

B.3. Yield:

On mid December 2013 and 2014 fruits of each individual tree were separately harvested, then counted and weighted. Tree productivity (yield) was estimated either as number or weight (kg) of harvested fruits per each tree.

B.4. Fruit quality:

Fruit physical characteristics:

In this regard average fruit weight (g.); size (cm^3); dimensions (polar & equatorial diameters i.e., length &width in cm. & mm.); fruit shape index (length: width); juice volume (cm^3) and peel/rind thickness (mm) were the fruit physical characteristics investigated in this regard.

Fruit chemical properties:

Total soluble solids (T.S.S. %): Handy refractometer was used to determine the TSS % in fruit juice according to A.O.A.C. (1985).

Fruit titratable acidity (%): Fruit juice acidity % as citric acid (g/100 g fruit juice) according to Vogel (1968).

TSS/acid ratio: TSS/acid ratio was estimated by dividing the total soluble % over total acidity % also estimated. Vitamin C content was determined and measured by A.O.A.C. (1985). Moreover, total sugars% were determined after the method described by Smith *et al*., (1956).

C. Leaf chemical analysis:

C.1. Photosynthetic pigments (chlorophyll, A, B and carotenes):

Leaf chlorophylls A, B and carotenoides contents in response to different treatments during both seasons were determined according to Saric *et al*. (1967).
Total chlorophyll determined by using chlorophyll mater model

C.2- Leaf mineral content:

Leaf contents of some macro elements (N, P & K) and some micro nutrients (Fe, Zn & Mn) were determined. The following procedures were used:

Total N was determined by modified micro-Kjeldahl method as described by Pregl (1945). While P determination was carried out colormeterically according to Murphy and Reily (1962). Moreover, K, Ca, Mg, Fe, Zn, Mn and Cu were determined using Atomic absorption spectrophotometer (3300) according to Jackson and Ulrish (1959) and Chapman and Pratt (1961).

Statistical analysis:

All data obtained during both seasons for two experiments included in this investigation were subjected to analysis of variance was according to Sendecor and Cochran (1980) statistically analyzed by using the least significant differences test (L.S.D)**.**

Results and Discussion

Vegetative and fruiting characteristics:

a- Vegetative behaviour.

As shown in Table (2) different applied treatments i.e., Gibberellic acid (GA_3) at 20 or 50 mg/l, yeast extract at 50 or 100 ml/l and potassium citrate at 500 or 1000 ppm all of them significantly increased each of tested growth parameters (number of shoots /one meter length limb, shoot length (cm), shoot thickness (mm), number of leaves per shoot and the average leaf area (cm^2)). The obtained results were nearly behaved the same in the two seasons (2013 & 2014). Also, it is obvious that yeast extract with the two applied concentrations was the most active treatment for increasing different assigned growth aspects. In this respect, e.g. the average leaf area (cm^2) was reached to (18.00 & 18.73 cm) with 50 ml and (19.52 & 20.75 cm) with 100 ml/l of yeast extract during 2013 and 2014 seasons, respectively. These results could be of great interest because thereafter are being reversed upon following, fruit setting and their remaining on the trees as well. Thereby, such yeast extract treatment is being of economic value for increasing the fruitful yield.

b- Fruiting properties.

Data in Tables (3, 4 and 5) show that different applied treatments of Gibberellic acid, yeast extract and potassium citrate each in the two tested concentrations significantly increased the percentage of fruit set in the two assigned seasons. Also, yeast extract was proceeding in this respect meanwhile Gibberellic acid and potassium citrate ranked the second in this respect. Yet, the high concentration of each treatment gave the highest percentage of fruit set when compared with the lower one. Also, the percentages of remained fruits (i.e., fruits completed their development) during June reached their maximum with yeast extract treatments (21.14 & 21.50 %) with the low concentration of yeast extract (50 ml/l) during 2013 and 2014 seasons, respectively. These values were raised to 21.85 & 22.00 with 100 ml/l i.e., the high concentration during June month in 2013 and 2014 seasons, respectively. Meanwhile, GA_3 treatment was the second in this respect, yet, potassium citrate treatment ranked the last. This trend of increasing the remained fruits was also obtained in the other three months (i.e., August, October and December) in the two assigned seasons.

In this respect these results are of great interest, since the final number and weight fruits/tree or per feddan as shown in Tables (3 and 4) will greatly affected with them.

Data in Table (4) clearly indicate that during the months of June, August, October and December for 2013 and 2014 seasons; fruits drop % nearly behaved as the same as fruit setting. In this respect, it is obvious had the yeast extract treatment was the prevailing one to minimize the percentage of fruit dropping followed by the other two treatments i.e., gibberellic acid and potassium citrate treatments.

Table 2: Effect of some bio-stimulating treatments on vegetative growth parameters of Washington navel orange during 2013 and 2014 seasons.

Characteristics / Treatments	No. of shoots /one meter length limb	Shoot length (cm)	Shoot thickness (mm)	No. of leaves per shoot	Average leaf area (cm^2)
	First season: 2013				
Control	14.33	26.32	2.25	19.00	14.23
Gibberellic acid (GA_3) at 20 mg/l	19.33	27.62	3.10	20.66	15.00
Gibberellic acid (GA_3) at 50 mg/l	19.00	27.95	3.20	21.00	16.25
Yeast extract 50 ml/l	20.33	30.21	4.75	25.66	18.00
Yeast extract 100 ml/l	21.33	33.42	5.00	27.33	19.52
Potassium citrate at 500 mg/l	19.33	29.52	3.25	21.33	16.31
Potassium citrate at 1000 mg/l	19.66	28.75	3.40	23.00	16.81
L.S.D. at 5 %	1.25	1.10	0.53	0.72	0.80
	Second season: 2014				
Control	13.66	27.41	2.85	20.66	14.55
Gibberellic acid (GA_3) at 20 mg/l	19.66	31.89	3.20	21.33	15.21
Gibberellic acid (GA_3) at 50 mg/l	19.33	32.96	3.35	22.66	16.45
Yeast extract 50 ml/l	20.66	35.75	4.92	26.33	18.73
Yeast extract 100 ml/l	21.66	37.80	5.10	29.66	20.75
Potassium citrate at 500 mg/l	18.00	32.67	3.30	23.00	16.74
Potassium citrate at 1000 mg/l	20.00	33.42	3.45	23.33	16.90
L.S.D. at 5 %	1.30	1.15	0.65	0.85	0.92

Table 3: Effect of some bio-stimulating treatments on fruit set (%) and changes of fruit retention (%) of frutiful Washington navel orange trees during 2013 and 2014 seasons.

Characteristics / Treatments	Fruit set (%)	Remained fruits % (June 20^{th})	Remained fruits % (August 1st)	Remained fruits % (October 3^{rd})	Remained fruits % (December 15^{th})
	First season: 2013				
Control	12.64	16.55	14.00	10.25	9.75
Gibberellic acid (GA_3) at 20 mg/l	14.18	17.22	15.25	12.75	11.50
Gibberellic acid (GA_3) at 50 mg/l	14.87	18.00	15.42	13.45	12.62
Yeast extract 50 ml/l	16.71	21.14	16.55	16.42	12.72
Yeast extract 100 ml/l	17.35	21.85	17.23	17.55	13.75
Potassium citrate at 500 mg/l	15.40	19.63	15.22	14.62	12.11
Potassium citrate at 1000 mg/l	14.97	18.66	15.32	13.50	12.40
L.S.D. at 5 %	0.32	1.45	0.745	0.72	0.67
	Second season: 2014				
Control	13.07	16.75	14.22	11.30	10.00
Gibberellic acid (GA_3) at 20 mg/l	14.58	18.53	15.60	12.80	11.40
Gibberellic acid (GA_3) at 50 mg/l	15.14	19.40	15.72	13.75	11.68
Yeast extract 50 ml/l	17.20	21.50	16.85	17.60	12.86
Yeast extract 100 ml/l	17.48	22.00	17.50	17.90	13.50
Potassium citrate at 500 mg/l	15.58	19.84	15.42	14.75	12.32
Potassium citrate at 1000 mg/l	15.39	18.72	15.48	14.85	12.52
L.S.D. at 5 %	0.55	1.50	0.835	0.80	0.70

Table 4: Effect of some bio-stimulating treatments on fruit drop (%) of Washington navel orange trees during 2013 and 2014 seasons.

Characteristics / Treatments	Fruits drop % (June 20th)	Fruits drop % (August 1st)	Fruits drop % (October 3rd)	Fruits drop % (December 15th)
	First season: 2013			
Control	83.45	86.00	89.75	90.25
Gibberellic acid (GA_3) at 20 mg/l	80.78	84.75	85.25	87.50
Gibberellic acid (GA_3) at 50 mg/l	81.00	83.58	84.35	87.38
Yeast extract 50 ml/l	78.86	83.45	83.58	87.28
Yeast extract 100 ml/l	79.15	82.77	82.45	86.25
Potassium citrate at 500 mg/l	80.37	84.78	85.38	87.89
Potassium citrate at 1000 mg/l	81.34	84.68	86.50	87.60
L.S.D. at 5 %	1.31	1.10	0.875	1.13
	Second season: 2014			
Control	83.25	85.78	88.70	90.00
Gibberellic acid (GA_3) at 20 mg/l	80.47	84.40	84.20	87.60
Gibberellic acid (GA_3) at 50 mg/l	80.60	83.28	83.25	87.32
Yeast extract 50 ml/l	78.50	83.15	82.40	87.14
Yeast extract 100 ml/l	79.00	82.50	82.10	86.50
Potassium citrate at 500 mg/l	80.16	84.58	85.25	87.68
Potassium citrate at 1000 mg/l	81.28	84.52	85.15	87.48
L.S.D. at 5 %	1.42	1.13	0.921	1.15

Also, Table (5) exhibits that the total number of the remaining fruits showed its maximize (465 & 472 and 475.00 & 480 fruits) in 2013 and 2014 seasons, respectively with 50 & 100 mg/l of yeast extract treatment. Also, it could be noticed that potassium citrate was ranked the second meanwhile gibberellic acid was the last treatment in this respect.

In addition, fruits weight either per tree or per feddan were behaved as the same as the number of fruits. Since yeast extract gave the highest weight followed by potassium citrate and gibberellic acid in decending order. The above mentioned results are being great interest because they represent the economic yield of this plant. Therefore, the effectiveness of the applied treatment especially yeast extract could recommended for using by citrus growers to minimize the at scission of flowers and new sited fruits, to maximize fruits yield due to increasing each of numbers and weights of yielded fruits.

In this respect other studies exhibited also, positive effects of up on citrus fruit yield of these studies are Catrso *et al*., (1998) on (*Citrus sinensis* L. Osbeck) orange tree, Spann and Little (2010) on Sweet orange, Ahmed *et al.,* (2013) and El-Shamma *et al*., (2013) on Valencia orange trees.

Table 5: Effect of some bio-stimulating treatments on fruit yield of Washington navel orange trees during 2013 and 2014 seasons.

Characteristics / Treatments	Number of fruits /tree	Fruits weight (kg) /tree	Fruit weight (ton) feedan.
	Second season: 2013		
Control	400.0	95.52	13.16
Gibberellic acid (GA_3) at 20 mg/l	412.7	100.30	13.82
Gibberellic acid (GA_3) at 50 mg/l	420.3	102.60	14.14
Yeast extract 50 ml/l	465.0	135.22	18.63
Yeast extract 100 ml/l	472.3	142.30	19.61
Potassium citrate at 500 mg/l	425.3	105.13	14.48
Potassium citrate at 1000 mg/l	433.0	110.47	15.22
L.S.D. at 5 %	7.55	5.03	1.50
	Second season: 2014		
Control	406.3	100.32	13.82
Gibberellic acid (GA_3) at 20 mg/l	415.7	106.45	14.66
Gibberellic acid (GA_3) at 50 mg/l	425.3	108.26	14.92
Yeast extract 50 ml/l	475.3	140.33	19.34
Yeast extract 100 ml/l	480.7	152.65	21.03
Potassium citrate at 500 mg/l	430.0	110.12	15.17
Potassium citrate at 1000 mg/l	440.3	112.85	15.55
L.S.D. at 5 %	7.23	5.50	1.75

Some aspects of fruit quality:

Data in Tables (6) clearly indicate that the weight of fruit was significantly increased with different treatments, yet, its maximize existed with yeast extract (290.2 & 295.9 g/fruit and 306.5 & 310.4 g/fruit with 50 and 100 mg/l in 2013 and 2014 seasons, respectively. Meanwhile, each of potassium citrate and gibberellic acid significantly increased this weight but to less extent.

Also, it could be noticed that fruit size was behaved nearly the same as fruit weight except only that insignificant increase in 2014 season existed with GA_3 at 20 mg/l. as for the juice volume (cm^3) it is more evident that the highest significant increase of this volume was reached with yeast extract treatment (the two applied concentrations). With regard to the peel thickness, also yeast extract treatment was more active as compared with other two treatments i.e., gibberellic acid and potassium citrate as wet). Moreover, as shown in (Table, 7) each of fruit dimensions and the fruit shape index were less affected with the applied treatments but also with superiority for yeast extract upon the two aspects of fruit quality.

Table 6: Effect of some bio-stimulating treatments on fruit quality of Washington navel orange trees during 2013 and 2014 seasons.

Characteristics / Treatments	Fruits weight (g)	Fruit size (cm^3)	Juice volume (cm^3)	Peel thickness (mm)
	Second season: 2013			
Control	200.40	190.20	68.33	2.75
Gibberellic acid (GA_3) at 20 mg/l	208.20	200.20	79.37	2.80
Gibberellic acid (GA_3) at 50 mg/l	210.80	202.40	80.38	2.95
Yeast extract 50 ml/l	290.20	285.00	95.50	3.25
Yeast extract 100 ml/l	306.50	300.25	102.51	3.50
Potassium citrate at 500 mg/l	210.40	205.50	80.46	2.85
Potassium citrate at 1000 mg/l	223.30	207.00	83.44	2.95
L.S.D. at 5 %	4.50	6.50	2.071	0.32
	Second season: 2014			
Control	195.30	189.00	70.34	2.50
Gibberellic acid (GA_3) at 20 mg/l	210.10	195.25	80.37	1.50
Gibberellic acid (GA_3) at 50 mg/l	212.30	198.75	81.38	2.75
Yeast extract 50 ml/l	295.90	280.00	100.52	3.50
Yeast extract 100 ml/l	310.40	290.75	105.53	3.75
Potassium citrate at 500 mg/l	208.40	200.25	81.46	3.00
Potassium citrate at 1000 mg/l	225.30	203.00	84.45	3.00
L.S.D. at 5 %	5.62	7.20	1.965	0.37

Table 7: Effect of some bio-stimulating treatments on fruit quality of Washington navel orange cv. during 2013 and 2014 seasons.

Characteristics / Treatments	Fruit dimensions (cm)				Fruit shape index	
	Polar diameter		Equatorial diameter			
	2013	2014	2013	2014	2013	2014
Control	7.20	7.40	7.20	7.23	1.00	1.02
Gibberellic acid (GA_3) at 20 mg/l	7.30	7.35	7.30	7.33	1.01	1.07
Gibberellic acid (GA_3) at 50 mg/l	7.35	7.40	7.33	7.43	1.03	1.08
Yeast extract 50 ml/l	8.40	8.48	8.38	8.23	1.12	1.22
Yeast extract 100 ml/l	8.78	9.00	8.55	8.55	1.25	1.32
Potassium citrate at 500 mg/l	7.50	7.78	7.80	7.50	1.02	1.09
Potassium citrate at 1000 mg/l	7.80	7.85	7.60	7.55	1.03	1.09
L.S.D. at 5 %	0.48	0.52	0.62	0.53	N.S.	N.S.

Effect on some bio-constituents:

As shown in Table (8) different applied treatments i.e., gibberellic acid, yeast extract and potassium citrate increased each of total soluble solids (TSS), total acidity and total sugars percentages as well as the content of vitamin C content in the fruits of the applied trees.

Also, it could be noticed that yeast extract was more pronounced in this respect. The only exception

was that reduction in the total acidity % existed with each of yeast extract and potassium citrate with the two applied rates in the two seasons of this study.

Table 8: Effect of some bio-stimulating on fruit quality of Washington navel orange trees during 2013 and 2014 seasons.

Characteristics / Treatments	TSS %	Total acidity %	TSS/Acid. ratio	Total sugars %	V.C (mg/100ml)
	First season: 2013				
Control	8.00	1.15	6.96	5.40	50.00
Gibberellic acid (GA_3) at 20 mg/l	9.00	1.20	7.50	6.30	52.00
Gibberellic acid (GA_3) at 50 mg/l	9.00	1.35	6.67	6.60	54.75
Yeast extract 50 ml/l	11.00	1.60	6.88	8.00	65.00
Yeast extract 100 ml/l	12.00	2.30	5.22	9.20	66.75
Potassium citrate at 500 mg/l	9.00	1.30	6.92	6.80	52.75
Potassium citrate at 1000 mg/l	10.00	1.25	8.00	6.90	53.50
L.S.D. at 5 %	0.50	0.12	0.63	0.55	2.08
	Second season: 2014				
Control	9.40	1.20	7.83	6.30	51.25
Gibberellic acid (GA_3) at 20 mg/l	9.30	1.20	7.75	6.42	51.25
Gibberellic acid (GA_3) at 50 mg/l	9.40	1.40	6.71	6.72	52.75
Yeast extract 50 ml/l	11.50	1.70	6.76	8.12	66.25
Yeast extract 100 ml/l	12.75	2.40	5.31	10.32	67.00
Potassium citrate at 500 mg/l	9.60	1.40	6.86	6.90	53.00
Potassium citrate at 1000 mg/l	10.33	1.30	7.95	6.95	55.00
L.S.D. at 5 %	0.65	0.15	0.72	0.61	1.99

Effect on photosynthetic pigments:

Data in Table (9) clearly indicated that different applied treatments gibberellic acid at 20 and 50 mg/l, yeast extract at 50 and 100 mg/l and potassium citrate at 500 and 1000 mg/l increased each of chlorophyll A, B and carotenoids, as well. This increment of chlorophylls and carotenoids, content was obtained In the two seasons but the highest rate of each substance or stimulator was more active when compared with the lowest rate in case of comparison. Also, it could be noticed that the treatment of yeast extract exhibited the highest increase of chlorophylls (chloro. A and B) and carotenoids as well. Furthermore, this increments of photosynthetic pigments would be the direct reason for maximizing fruits yield and improving their quality as well.

Obtained results with respect to the response of investigated fruit chemical properties to studied treatments one supported by the findings of many researchers Catrso *et al*., (1998) on (*Citrus sinensis* L. Osbeck) orange tree, Wajahatullah et al., (2009) on Washington navel orangeand Ahmed *et al.,* (2013) on Valencia orange trees.

Effect on mineral content in leaves:

As indicated in Table (10) the applied treatments obviously affected the content of different estimated nutrients in leaves of treated trees. As for nitrogen, the yeast extract at the two applied rates (i.e., 50 & 100 mg/l) was the most pronounced in this respect that it showed (3.62 & 3.72 and 3.93 & 3.95) of N % with the first and second rates of yeast extract in 2013 and 2014 seasons, respectively. Also, it could be noticed that regarding the activity of treatments upon increment of leaves minerals content; potassium citrate was ranked the second in this respect followed by GA_3 that gave the lowest increment of nitrogen in the two seasons. With regard to phosphorus and potassium contents in leaves of treated trees, they behaved as the same as nitrogen. Since yeast extract followed by potassium citrate and GA_3 exhibited their activity in descending order.

In addition, each Fe, Zn and Mn were behaved as the same as the macro nutrients but also they highly affected. Here also, it is clear that the yeast extract was the most efficient stimulator followed by potassium citrate meanwhile GA_3 was the last in this respect.

The previous results are in accordance with those revealed by Catrso *et al*., (1998) on (*Citrus sinensis* L. Osbeck) orange tree, Ahmed *et al.,* (2013) and El-Shamma *et al*., (2013) on Valencia orange trees.

Table 9: Effect of some bio stimulating treatments on photosynthetic pigments of Washington navel orange trees during 2013 and 2014 seasons.

Characteristics / Treatments	Chlorophyll A (mg/g F.Wt.)	Chlorophyll B (mg/g F.Wt.)	Chlorophyll A+B (mg/g F.Wt.)	Carotenoids (mg/g F.Wt.)	Chl./cart.
	First season: 2013				
Control	4.23	2.10	6.33	2.12	2.99
Gibberellic acid (GA_3) at 20 mg/l	4.43	2.20	6.63	2.32	2.87
Gibberellic acid (GA_3) at 50 mg/l	4.58	2.32	6.90	2.36	2.93
Yeast extract 50 ml/l	6.62	3.43	10.05	3.41	2.92
Yeast extract 100 ml/l	7.23	3.89	11.12	3.49	3.24
Potassium citrate at 500 mg/l	4.62	2.11	6.73	2.14	3.28
Potassium citrate at 1000 mg/l	4.65	2.32	6.97	2.43	2.79
L.S.D. at 5 %	0.55	0.60	0.82	0.47	0.27
	Second season: 2014				
Control	4.41	2.21	6.62	2.11	3.15
Gibberellic acid (GA_3) at 20 mg/l	4.47	2.24	6.71	2.34	2.87
Gibberellic acid (GA_3) at 50 mg/l	4.65	2.33	6.98	2.38	2.93
Yeast extract 50 ml/l	6.78	3.36	10.14	3.48	2.92
Yeast extract 100 ml/l	7.43	3.91	11.34	3.50	3.24
Potassium citrate at 500 mg/l	4.85	2.42	7.27	2.22	3.28
Potassium citrate at 1000 mg/l	4.72	2.36	7.08	2.54	2.79
L.S.D. at 5 %	0.62	0.48	1.02	0.53	0.29

Table 10: Effect of some bio-stimulating treatments on (N, P,K, Fe, Zn and Mn) contents of fruitful Washington navel orange trees during 2013 and 2014 seasons.

Characteristics / Treatments	N (%)	P (%)	K (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)
	First season: 2013					
Control	1.83	0.221	1.220	70.20	20.12	0.30
Gibberellic acid (GA_3) at 20 mg/l	3.08	0.306	1.430	71.70	25.14	0.50
Gibberellic acid (GA_3) at 50 mg/l	3.22	0.354	1.650	73.10	26.23	0.48
Yeast extract 50 ml/l	3.62	0.520	1.750	85.60	43.29	0.71
Yeast extract 100 ml/l	3.93	0.552	1.850	90.20	52.62	0.73
Potassium citrate at 500 mg/l	3.28	0.355	1.350	72.30	26.15	0.55
Potassium citrate at 1000 mg/l	3.36	0.423	1.450	75.60	27.29	0.56
L.S.D. at 5 %	0.420	0.120	0.150	0.100	0.110	0.140
	Second season: 2014					
Control	1.92	0.253	1.320	71.30	22.26	0.32
Gibberellic acid (GA_3) at 20 mg/l	3.15	0.369	1.420	72.60	26.37	0.45
Gibberellic acid (GA_3) at 50 mg/l	3.25	0.345	1.520	74.90	27.28	0.42
Yeast extract 50 ml/l	3.72	0.553	1.820	86.30	45.24	0.65
Yeast extract 100 ml/l	3.95	0.572	1.910	91.30	43.70	0.70
Potassium citrate at 500 mg/l	3.32	0.345	1.420	73.60	27.25	0.45
Potassium citrate at 1000 mg/l	3.41	0.425	1.520	74.30	29.18	0.50
L.S.D. at 5 %	0.520	0.160	0.210	0.120	0.130	0.160

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