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Effect of Irradiated Compost and Bio-Fertilizer on Vegetative Growth and Fruit Quality of Valencia Orange

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THIS work was conducted on fruitful Valencia orange trees grown in sandy soil under drip irrigation system planted in a private orchard located at Cairo-Alexandria Desert Road for three seasons (2016 to 2019) to investigate the effect of irradiated compost and/or bio-fertilizer on Valencia orange trees.

Concerning the studied vegetative growth parameters results could be suggested that adding 5 kg irradiated compost at 20 KGy + 30 ml bio-fertilizer /tree was the most enhancing shoot length, diameter, number of leaves/shoot as well as leaf area increment % .

Regarding to yield and fruit quality, all treatments were significantly enhanced fruit yield and fruit quality with the superiority of using combination between organic + bio-fertilizer (5 kg/tree irradiated compost at 20 KGy + 30 ml bio-fertilizer). Furthermore, the thickest fruit peel thickness (5.2 mm) resulted by non-irradiated compost + 30 ml microbine. Juice TSS %, vitamin C, and TSS/acid ratio were impressively enriched by using non/or irradiated compost and/or bio-fertilizer. Moreover, all treatments were enhanced N, P and K uptakes by trees and this was reflected on the vegetative growth and yield as well as the three leaf elements concentration.

The aim of this study was to improve Valencia orange vegetative growth, yield and fruit quality and to reduce the excessive use of mineral fertilizers. Thus, we concluded that the use of 5 kg irradiated compost at 20 KGy + 30 ml bio fertilizer) /tree during January can be suggested under similar conditions.

Keywords: Irradiated Compost, Bio fertilization, Valencia orange.

Introduction

Citrus fruits are the biggest area cultivated or production in addition to fruit exportation also it is considered the most popular fruit crop in Egypt. Valencia orange grown in sandy soils, which usually poor in nutrient content, organic matter and low water holding capacity, with high nutrient leaching losses resulting in negative effects on vegetative growth, yield and fruit quality. Trees grown in such soils, therefore need more attention in cultural practices such as fertilization, foliar spray with minerals and bio fertilizers to enhance growth, yield and fruit quality Salama, 2015.

Organic fertilizers act as safe alternative to chemical fertilizers, it improves physical, chemical and biological properties of almost all soil types, improves soil structure, retention of moisture, adjusting soil pH, increasing soil solubility and production of the plants. Adding organic fertilizers not only increase the organic matter in the soil but also increase the available phosphorus and the exchangeable potassium, calcium, and the other

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micro-elements, through their impact on soil PH, encourages soil micro-organisms to proliferate, increases microbial population and production of microbial enzymes, (Abou-Hussein et al., 2002 and Evanylo et al., 2008). Application of either non-irradiated or gamma-irradiated sludge enhanced wheat and rice yield as application rate increased. Moreover, irradiated sludge induced higher wheat and rice yield as compared to non-irradiated sludge. On the other hand, non-irradiated and irradiated sludge had similar positive effect on chile pepper, higher application rate of both significantly increased the yield (Zhou et al., 2002 and Mitrosuhardjo et al., 2002).

Bio-fertilizers play vital role in maintaining long term soil fertility and sustainability by fixing atmospheric dinitrogen (N=N), mobilizing fixed macro and micro-nutrients or converting insoluble P in the soil into plant-available forms, thereby increases their efficiency and availability. Bio- fertilizers are products containing living cells of different micro-organisms, which have ability to convert nutritionally important elements from unavailable to available form through biological processes. They had been described as an alternative to chemical fertilizers in order to increase soil fertility and crop production in sustainable agriculture and because they contain different types of microorganisms such as bacteria, fungi, and algae, these microorganisms may convert nutrients from unavailable to available forms. Bio-fertilizers are play an important role in increasing vegetative growth, yield and fruit quality of citrus trees and it could be decreased plant nitrogen requirements by 25%. (Vessey 2003, Sheraz et al., 2010, El-Khawaga & Maklad, 2013 and Itelima et al., 2018).

Modern agriculture has to be more productive, sustainable, and environmentally friendly. While macro-nutrients such as N, P, K and sulfur (S) supplied by mineral fertilizers are vital to crop production, agriculturally beneficial microorganisms may also contribute directly or indirectly to crop improvement and fertilizers efficiency. So more efforts have to be made in order to thoroughly understand the multiple functions of beneficial microorganisms within the soil microbial community itself and the interaction with plants and mineral resources to represent a promising sustainable solution to improve agricultural production (Timmusk et al., 2017 and Adnane et al., 2018).

The objectives of this study was to highlight the collaborating and benefits effects that may occur within combined interactions between the two used substances (irradiated compost and/or microbial groups) and positive concerns on plant mineral uptake, growth, yield and quality. Improving use of mineral nutrients is a must to secure higher yield and productivity in a sustainable manner, therefore continuously designing, developing and testing innovative integrated plant nutrient management systems based on relevant biological resources (crops and microorganisms) is highly required. It also aimed to encouraging sustainable or green agriculture to enable our country's agriculture to use bio-fertilizers as a major source of soil fertility and reduce costs as well as pollution resulting from the excessive use of mineral fertilizers.

Actually, few reports are available on the effect of irradiated compost on fruit crops. However, substantial work was done in this study to understand the role of irradiated compost and /or bio-fertilizer on Valencia orange trees. Thus, future studies need to be conducted to find ideal formulations combined usage of organic and bio-fertilizers such as nitrogen-fixing microorganisms, solubilizing and mobilizing phosphorus microorganisms to increase soil fertility, productivity and decrease the use of mineral fertilizers and environmental pollution. So we are therefore trying to achieve these objectives by using irradiated compost and/ or bio-fertilizers.

Materials and Methods

This experiment was conducted during three successive 2016-17, 2017-2018 and 2018-19 experimental seasons on mature fruitful Valencia orange trees (*Citrus sinensis* L. Osbeck) grafted on volcamer lemon (*Citrus volkameriana*) rootstock, planted at 3.5×7 m in distance and grown in sandy soil under drip irrigation system in Centech Egypt Green, Al Shrooq orchard at Cairo-Alexandria Desert Road, Egypt. The data for the last two seasons 2017-2018 and 2018-19 in addition of first season estimated yield are only considered. Randomized complete block layout was designed with three replications, whereas seventy two healthy trees of uniform vigor as possible were selected (8 treatments × 3 replicates x 3 trees). The applied treatments were combination of irradiated or non-irradiated compost as an organic fertilizer and microbine as a bio-fertilizer as follow:

T1- Control: orchard treatment.
T2- 30 ml bio-fertilizer.
T3- Non irradiated compost at 5 kg/tree.

T4- Non irradiated compost at 5 kg/tree + 30 ml bio-fertilizer.
T5- 10 KGy irradiated compost (5 kg/tree).
T6- 10 KGy irradiated compost (5 kg/tree) + 30 ml bio-fertilizer.
T7- 20 KGy irradiated compost (5 kg/tree).
T8- 20 KGy irradiated compost (5 kg/tree) + 30 ml bio-fertilizer.

Microbine is a commercial bio-fertilizer compound produced by the General Organization for Agricultural Equalization Fund (GOAEF), Ministry of Agriculture, Egypt which consists of large group of micro-organisms such as *Bacillus megaterium*, *Azospirillum* and *Azotobacter*. Compost was irradiated at 10 and 20 KGy absorbed dose at National Center for Radiation Research and Technology. The composition of the used compost was presented in Table 1.

At first week of January (2016, 2017 and 2018), a trench of 20 centimeters in depth and 80 centimeters in length was made on both sides of all experimental trees. The irradiated and non-irradiated compost 2.5 (kg on each side of the tree) was added after mixing with a soil groove output under the drip irrigation lines then irrigated the orchard immediately. After two weeks, microbine was added to the compost at a rate of 30 ml in the same trench to avoid killing of its microorganisms by the resulted over heat from the irradiated compost.

Soil texture and chemical characteristics:

Soil samples were collected from (0-30 cm) in depth layer with the aid of a 3.5 cm diameter hand soil auger just prior to starting the experiment for determining the soil physical and chemical characteristics according to Page et al. (1984) and Klute (1986). The soil was sandy textured with 82.3% sand, 4.7% Clay, 14% Silt as physical characteristics and the chemical characteristics were presented in Table 2.

The following parameters were measured

Vegetative growth parameters

Eight new spring flushed shoots around tree canopy were labeled and vegetative growth data were recorded for same shoots twice a year in March and September then the rate of change in growth was calculated. Average of shoot length (cm), diameter (mm), number of leaves/shoot and average leaf area (cm^2) were measured according to the method described by Ahmed and Morsy (1999).

Leaf Chemical Composition

At early September in both seasons full extended leaves numbers 3, 4 and 5 from top of non-bearing previously labeled shoots around the tree were picked, washed, oven dried, grounded and digested then leaves N, P and K percentages were determined according to Wilde et al., (1985).

Yield

Number of fruits and kg per tree were estimated then yield ton/feddan was calculated.

Fruit Physical and Chemical Properties

Average fruit weight (g), fruit size (cm^3), fruit height and diameter (cm) were measured and fruit shape index (height/diameter) was calculated, average fruit peel thickness (cm), fruit firmness (lb. / $inches^2$) were measured. TSS %, acidity % (as mg citric acid/100 cm juice), TSS/acid ratio and vitamin C (ascorbic acid as mg/100ml juice) were determined according to AOAC (2000).

TABLE 1. Analysis of used organic compost.

Moisture content (%)	pH value (1:10)	EC value (1:10) (mmohs/cm)	Organic carbon (%)	Organic matter (%)	Total nitrogen (%)	Soluble ammonium (KCl) (%)	Soluble nitrate (%)	C/N ratio	P (%)	K (%)
19.3	8.45	8.3	39.5	67.9	2.92	0.22	0.05	16.3	1.57	1.55

TABLE 2. Chemical characteristics of the (0-30 cm) in depth experiment soil.

E.C dS/ cm	PH	Cations (Positive ions) meq/ liter			Anions (Negative ions) meq/ liter				Exchangeable cations meq/100g soil CEC				SAR	O.M (organic matter)
		Mg ++	Na +	K +	CO_3 --	HCO_3 -	CL -	SO_4 --	Ca ++	Mg ++	Na +	K +		
1.9	8.2	1.9	9	1.6	-	2.9	8.6	9.7	8.1	1.9	9	1.6	2.85	0.8%

Statistical analysis

Data obtained during each experimental season were subjected to analysis of variance and significant differences among means were determined according to Snedecor and Cochran, (1990). Letters were used for distinguishing between means of all treatments, according to Duncan's Multiple Range Test (1955) by using MSTAT-C software (Freed & Scott, 1986).

Results and Discussion

Vegetative Growth parameters

Data in Table 3 and Fig 1&2 declared that all compost treatments significantly increased shoot length and diameter except shoot diameter at spring measurements in both seasons. The increment rate percentage for both shoot length and diameter was higher in the 2nd season than 1st one. Moreover, the highest increment percentage for shoot length and diameter was recorded with T8 treatment in both seasons of average 82.6% and 166.4%, respectively. The number of leaves/ shoot was significantly increased by all treatments (T2-T8) with the highest value obtained with T3- Non irradiated compost at 5 kg/tree in the 1st season and T8- Irradiated compost at 20 KGy (5 kg/tree) + 30 ml bio-fertilizer in the 2nd season. Most of the compost treatments (T3-T8) significantly increased the leaf area in both seasons with the highest area obtained with T8 in both seasons, except spring measurement in the 2nd season, where T5 gave the highest leaf area. The highest rate of increment for leaves number/ shoot and leaf area was recorded by T8 in both seasons (87%, 66.9%, 31% and 60.9%, respectively) except leaf area in 1st season where T1- Control showed higher increment than other treatments (32.4%). The positive effect of irradiated compost over non-irradiated one on some vegetative growth parameters was obvious in the 2nd season. The subsequent enhancement of the combined use of compost and bio-fertilizers could be due to fixing the atmospheric nitrogen, improving soil physical and chemical properties so, increased availability and absorption of nutrients resulted in increased vegetative growth.

Our results are in accordance with those reported by El-Aidy et al. (2018), where combined application of NPK, organic, and bio fertilization significantly increased shoot number and length of Valencia orange trees, as well as, leaf number and area

TABLE 3. Effect of different treatments on some vegetative growth parameters of Valencia orange trees.

Parameter	Shoot length (cm)		Shoot diameter (cm)		No. of leaves/shoot		Leaf area (cm2)	
2017-2018 season								
Treatment	**Spring**	**Autumn**	**Spring**	**Autumn**	**Spring**	**Autumn**	**Spring**	**Autumn**
T1	9.92 C	13.42 D	0.20 A	0.31 C	5.75 E	8.92 F	15.17 D	20.08 C
T2	10.17 C	14.58 D	0.23 A	0.33 C	6.17 D	10.33 E	16.72 C	22.08 BC
T3	13.33 A	19.67 A	0.25 A	0.43 B	7.25 A	12.92 A	18.78 B	23.42 AB
T4	11.00 BC	16.75 C	0.23 A	0.48 B	6.25 D	11.08 D	18.79 B	24.47 AB
T5	11.83 B	18.58 AB	0.21 A	0.46 B	7.00 AB	11.50 C	19.35 B	25.11 A
T6	11.83 B	18.25 B	0.20 A	0.47 B	6.58 C	11.67 C	19.62 A	24.97 A
T7	10.58 BC	17.75 BC	0.22 A	0.53 A	6.75 BC	11.50 C	18.97 B	23.94 AB
T8	11.96 AB	19.83 A	0.21 A	0.55 A	6.92 AB	12.94 A	19.63 A	25.72 A
2018-2019 season								
T1	9.00 C	16.08 E	0.21 A	0.35 D	6.33 F	10.17 F	16.64 D	21.64 E
T2	9.67 BC	18.42 D	0.23 A	0.38 D	8.25 E	13.25 E	16.56 D	22.73 D
T3	10.08 BC	18.58 D	0.22 A	0.48 C	8.92 D	14.67 D	18.54 B	24.33 C
T4	11.08 AB	20.17 BC	0.24 A	0.49 C	9.42 C	14.75 D	17.70 C	23.03 D
T5	10.83 AB	18.92 CD	0.24 A	0.51 C	9.33 C	15.25 C	19.16 A	24.29 C
T6	11.75 A	20.50 B	0.25 A	0.56 B	11.42 B	16.42 B	18.99 AB	25.72 B
T7	12.17 A	21.25 B	0.25 A	0.63 A	11.50 B	16.42 B	17.32 C	24.24 C
T8	11.83 A	23.58 A	0.24 A	0.65 A	13.33 A	22.25 A	17.31 C	27.86 A

Means followed by different letter/s in the same column are significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$).

compared to the control which recorded the lowest value. Also, Ahmed et al. (2013) on Balady mandarin found that the combined utilization of organic, bio- and chemical fertilizers led to significant increment of shoots diameter and number of leaves/shoot. Also, the clear enhancing effect of organic fertilizers on the vegetative growth in our study was supported by the results of El-Kobbia (1999) on Washington navel orange, while the effect of bio-fertilizers was augmented by the findings of Singh *et al.* (2000) on Mosambi sweet orange and El-Khawaga and Maklad (2013) on Valencia orange.

However, irradiation of organic fertilizers did not affect the total amount of organic C, N, and P but it significantly increased dissolved organic matter and availability of N and P (Zhou, et al., 2002). Moreover, higher nitrogen levels was accompanied by increased leaf area (Abdo, 2008).

Yield Parameters

Yield was estimated as number of fruits per tree and its weight in Kg then Tons per feddan was calculated during the three experimental seasons and shown in Table 4.

Table 4 reveals that highest fruits number/ tree was recorded by treatment 7 and 8 during the two main experimental seasons 2017-18 and 2018-19, while as for yield in kg fruits /tree, it has noticed that treatment 7 and 8 replaced there cites in the superiority. Data in Table 4 indicate

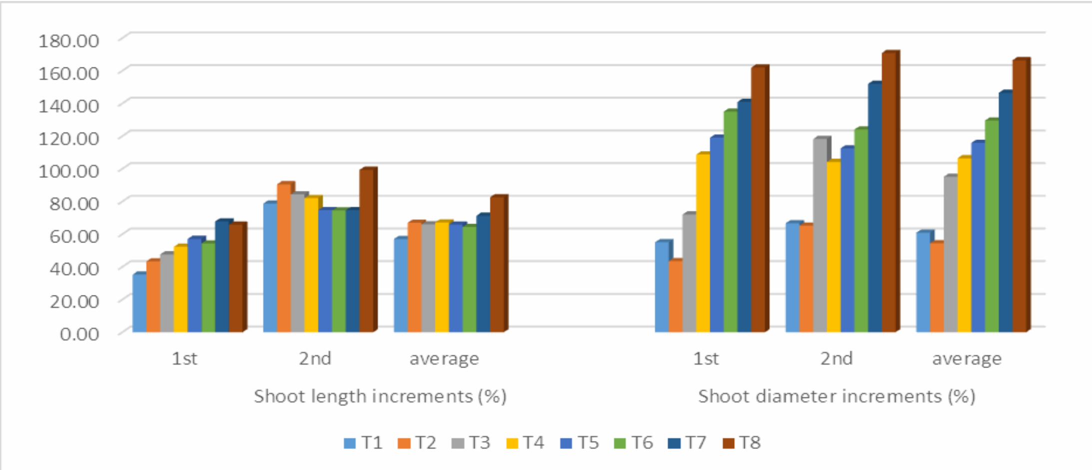

Fig. 1. Shoot length and diameter increments (%) affected by the tested treatments on Valencia orange trees in both 2017-18 and 2018-19 experimental seasons.

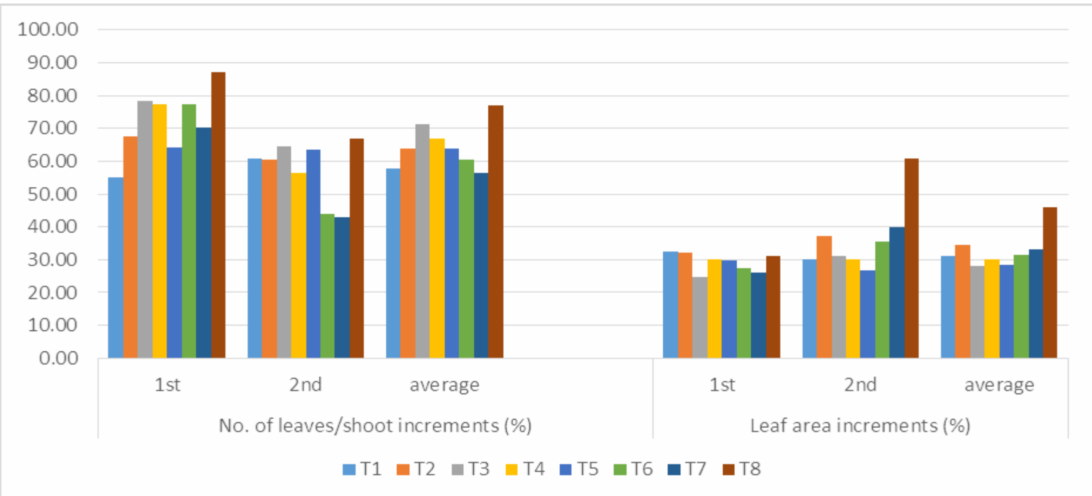

Fig. 2. leaves number/ shoot and leaf area increments (%) affected by the tested treatments on Valencia orange trees in both 2017-18 and 2018-19 experimental seasons.

that all treatments were significantly enhanced yield Ton/Feddan and the highest yield was 15.30, 17.05 tons per feddan in 2017-18 and 2018-19, respectively were recorded for T8 (5 kg irradiated compost at 20 KGy + 30 ml bio fertilizer)/tree . Meanwhile, the control treatment resulted in the lowest values among all treatments in the three yield parameters used at all seasons. It is obvious from data in Table 4 that the using irradiated compost plus microbine as bio-fertilizer increased the average weight and number of fruit per tree resulting in a significant increase in yield as ton per feddan as a final outcome of the interaction of these treatments together.

We can also explain the obtained results that when compost was irradiated (exposed to various doses of gamma rays), the elements were degradations so, it becomes more available and in easy absorption form by plants furthermore the addition of microbine as bio-fertilizer also helped to provide nitrogen and phosphorus which are necessary for different biological processes in the trees, which led to encouraging the trees to maximize the benefit of the availability of these elements so its reflected of good vegetative and fruit growth resulted in high final total yield in tons per feddan.

Our results regarding the increment of Valencia orange fruit number, fruit weight/tree and total yield are in accordance to El-Aidy et al. (2018), where combined fertilization of Valencia orange trees using compost, mineral and bio-fertilizers significantly increased fruit number and yield per tree when compared to the control. Many researchers go on line with our results of compost impact on yield such as Nelson et al. (2008) on “Rio Grande” grapefruit, Dhewar and Waghmare (2009) on sweet orange and Islam et al. (2017) on “Bari Malta 1” sweet orange.

Ahmed et al. (2002) found that higher rates of sewage sludge gave wheat yields similar to mineral fertilization. They added that irradiated sewage sludge produced higher wheat yields than non-irradiated one probably due to higher plant dry-matter production. In addition, Zhou et al. (2002) found that sludge irradiation gave highest wheat and rice yields as compared to non-irradiated sludge, they added that irradiated organic fertilizers exerted a favorable effect on the yield probably due to increased mineralized N and improved mineralization of organic N due to alternation of organic N forms, and due to destruction of complex stable organic-N compounds that leads to increased availability. The positive role of bio-fertilizer was supported by Abdel-Hak et al. (2012) and El-Khawaga & Maklad (2013) on Valencia orange, whereas they found that addition of bio-fertilizer to mineral fertilizers significantly increased fruit number and yield/ tree as compared to mineral fertilization only.

TABLE 4. Yield of Valencia orange estimated as number of fruits/tree, Kg/tree and Ton/Feddan during the three experimental 2016-17, 2017-18 and 2018-19 seasons as affected by different treatments.

Parameter	Yield estimated as:								
	Number of fruits/tree			Fruits weight (Kg)/tree			Fruits weight (Ton)/Feddan		
	Seasons			Seasons			Seasons		
	2016-17	2017-18	2018-19	2016-17	2017-18	2018-19	2016-17	2017-18	2018-19
T1	282.33 E	280.00 F	273.00 D	53.83 F	54.41 G	59.15 G	9.15 F	9.25 G	10.06 G
T2	300.33 D	290.00 F	280.00 D	58.06 E	60.32 F	63.93 F	9.87 E	10.25 F	10.87 F
T3	316.67 C	340.00 C	300.00 C	62.07 D	70.49 D	70.25 E	10.55 D	11.98 D	11.94 E
T4	336.67 A	322.00 D	300.00 C	68.01 B	72.99 C	74.50 D	11.56 B	12.41 C	12.66 D
T5	260.00 F	302.00 E	280.00 D	54.60 F	66.64 E	66.73 F	9.28 F	11.33 E	11.34 F
T6	282.67 E	360.00 B	320.00 B	54.93 F	78.72 B	78.40 C	9.34 F	13.38 B	13.33 C
T7	327.33 B	384.00 A	349.00 A	70.70 A	89.35 A	89.00 B	12.02 A	15.19 A	15.13 B
T8	301.33 D	383.00 A	340.00 A	65.59 C	90.01 A	100.30 A	11.15 C	15.30 A	17.05 A

Means followed by different letter/s in the same column are significantly different according to Duncan’s Multiple Range Test ($P \leq 0.05$).

Fruit Physical Properties

The data in Table 5&6 show that fruit weight and volume was significantly increased in response to all treatments as compared to the control (T1) with superiority of T8 (5 kg irradiated compost at 20 KGy + 30 ml bio fertilizer) /tree followed by T7 (20 KGy irradiated compost 5 kg/tree), it worth noting that addition of microbine to any of the treatments added a positive stimulating effect on the volume of the fruits as shown in both seasons except with irradiated compost in the 1st season where insignificant effect could be detected. On the other hand, all treatments increase fruit height, diameter and shape index however, the differences could not reach a significant level.

Data in Table 6 show that different compost and microbine treatments significantly increased juice weight/ fruit as compared to the control. Whereas, T8 showed the highest fruit juice extracted weight (128.33 g and 156.67 g for both seasons, respectively), while the lowest values for abovementioned parameter were obtained by T1 (92.22 g and 117.92 g for both season, respectively). Again, addition of microbine to any of the studied treatments had an additional promoting effect on fruit juice weight as shown in both seasons except few exceptions. As for Juice % w/w (fruit juice weight: fruit weight percent), it has been observed the superiority of T5 and T2 in 1st and 2nd experimental seasons, respectively while T1 and T6 in the 1st season and T4 and T8 in the 2nd season came last in this concern.

Fruit rind firmness (hardness of the fruit rind) measurements indicated that the highest fruit rind resistant to punctured obtained by fruits of T2 (30 ml bio fertilizer) followed by T7 in the 1st season and vice versa in the 2nd season. The reverse was true with fruits from T4 in the 1st season and T5, T6 and T8 in the 2nd season where the lowest resistance was recorded. Moreover, it was found that addition of microbine to compost treatments significantly decreased fruit firmness except with 10 KGy irradiated compost in both seasons.

TABLE 5. Effect of treatments on fruit quality characteristics in the two experimental 2017-18 and 2018-19 seasons.

Parameter	Fruit wt. (g)	Fruit volume (cc)	Fruit height (cm)	Fruit diameter (cm)	Shape index
2017-18 season					
T1	194.33 E	207.67 D	7.24 A	7.10 A	1.02 A
T2	208.00 D	223.00 C	7.39 A	7.22 A	1.02 A
T3	207.33 D	223.00 C	7.31 A	7.19 A	1.02 A
T4	226.67 B	243.33 A	7.77 A	7.41 A	1.05 A
T5	220.67 C	234.00 B	7.84 A	7.36 A	1.07 A
T6	218.67 C	232.00 B	7.57 A	7.36 A	1.03 A
T7	232.67 A	245.67 A	7.67 A	7.59 A	1.01 A
T8	235.00 A	248.00 A	7.95 A	7.43 A	1.07 A
2018-19 season					
T1	216.67 G	232.33 G	7.54 A	7.33 A	1.03 A
T2	228.33 F	244.00 F	7.80 A	7.49 A	1.04 A
T3	234.17 E	250.00 E	7.85 A	7.65 A	1.03 A
T4	248.33 C	264.00 C	7.78 A	7.48 A	1.04 A
T5	238.33 D	255.00 D	7.93 A	7.68 A	1.03 A
T6	245.00 C	262.33 C	8.01 A	7.71 A	1.04 A
T7	255.00 B	273.33 B	8.11 A	7.86 A	1.03 A
T8	295.00 A	310.67 A	8.55 A	8.13 A	1.05 A

Means followed by different letter/s in the same column are significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$).

Regards to the fruit peel thickness, data in Table 6 show that all treatments significantly increased peel thickness except fruits of T6 in the 1st season that showed a significant lower peel thickness. The thickest fruit peel was obtained by T2 and T4 in the 1st and 2nd seasons, while the lowest value was recorded in T6 and T1 for both seasons, respectively. Our findings were in line with those obtained by Sharaf et al. (2011) on Washington navel orange, who reported that combined organic and bio-fertilizers increased fruit weight, dimensions, while peel thickness and fruit shape index were not affected as compared to mineral fertilization only. Ebrahiem & Mohamed (2000) who's found significant increment in fruit weight and juice percentage of Balady mandarin in response to application of filter mud or farmyard manure. El-Aidy et al. (2018) on Valencia orange who suggested that application of mineral NPK, compost with bio-fertilizer significantly increased fruit weight, juice volume and fruit peel thickness as compared to the control. They added that the stimulating effect of bio-fertilizer increased as its rate increased. The positive role of bio-fertilizer was supported by El-Khawaga and Maklad (2013), where addition of bio-fertilizer to mineral fertilizers significantly increased fruit weight and fruit juice volume of Valencia orange as compared to mineral fertilization only.

Fruit Chemical Properties

Concerning the fruit chemical characteristics, data presented in Table 7 declare that data of TSS%, Acidity %, TSS/A ratio and VC mg/100g juice didn't follow the same trend. Herein, all treatments significantly increased TSS over T1 (control) in both seasons and the highest juice TSS% resulted by T7 (11.08 and 10.67% for both seasons, respectively) and T2 in the 2nd season (10.67%), while the minimum juice TSS% was recorded in (T1) control treatment in both seasons (9.92 and 9.67%, respectively). irradiated compost significantly improved TSS% over non-irradiated one when utilized alone, where T5 and T7 gave higher TSS% than T3 in both seasons, however, when combined it with microbine, irradiated compost exerted little enhancing effect or no effect on TSS%.

TABLE 6. effect of treatments on fruit quality characteristics in the two experimental 2017-18 and 2018-19 seasons.

Parameter	Juice/Fruit (g)	Juice % w/w	Firmness	Peel thickness (cm)
		2017-18 season		
T1	92.22 H	47.50 F	16.14 C	0.41 BC
T2	103.33 G	49.71 E	18.06 A	0.45 A
T3	110.67 E	53.37 B	15.44 E	0.44 A
T4	116.11 D	51.64 C	14.88 F	0.44 A
T5	122.33 B	55.45 A	16.35 C	0.42 B
T6	104.44 F	47.77 F	16.07 CD	0.36 D
T7	118.89 C	51.35 CD	16.98 B	0.41 BC
T8	128.33 A	51.19 D	15.80 D	0.40 C
		2018-19 season		
T1	117.92 H	54.24 CD	16.60 C	0.39 E
T2	136.67 D	59.92 A	17.60 B	0.46 C
T3	132.08 E	56.41 B	17.69 B	0.45 C
T4	129.17 G	52.03 E	16.02 D	0.52 A
T5	130.00 F	54.44 C	14.87 E	0.46 C
T6	137.50 C	56.12 B	14.90 E	0.43 D
T7	143.33 B	56.35 B	18.29 A	0.49 B
T8	156.67 A	53.71 D	15.06 E	0.49 B

Means followed by different letter/s in the same column are significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$).

As for the juice acid %, differences between the different treatments were small, and the lower acidity percent was 0.90% for T 3, T4 in the 1st season and 0.87 % for T3 in the 2nd season, while the highest percentage of fruit juice acidity was 1.01 % for T1 and T6 in the 1st season and 1.08 % for T2 in the 2nd season. Fruit juice acidity was increased in response to application of irradiated compost more than non-irradiated one when utilized alone or in combination with microbine.

Regarding to the TSS/ acidity ratio, data in Table 7 demonstrate that T3 was the superior during both seasons (11.57 & 11.87 %, respectively), meanwhile, the lowest TSS/A ratio, 9.82 and 9.88% for both seasons, respectively was correlated to control in the 1st season and T2 in the 2nd one. However, the combined increment in TSS% and acidity % was with irradiated compost application, it was correlated with a significant reduction in TSS/A ratio when compared to non-irradiated compost.

Our results are in parallel with El-Aidy et al. (2018) as he found that application of NPK, compost with bio-fertilizer has significantly affected the fruit TSS %, acidity and vitamin C content in comparison to the control that showed the lowest value.

Due to the severe shortage of references dealing with the effect of Gama irradiation in agriculture in general and irradiated compost specifically on the growth and production of fruit trees, thereby, we found that our results are consistent in parallel line with each other's results such as finding's by El-Motaium & Badawy (2002), who suggested that Fruit total soluble solids and acidity of Tomato seedlings fertilized with sewage sludge was higher as compared to mineral fertilization, Such increment increased as the rate of sludge increased with insignificant difference between irradiated and non-irradiated sludge and previously mentioned (Ahmed et al., 2002 , Mitrosuhardjo et al., 2002 and Zhou et al., 2002), when they used irradiated sludge on wheat, rice and chile pepper plants.

Leaf chemical composition

Data in Table 8 clearly show that leaf N, P and k percentages responded in different manners to different compost and bio-fertilizer treatments. Regarding to leaf N%, all applied treatments significantly increased leaves nitrogen contents as compared to the control with clear superiority of T6-(Irradiated compost at 10 KGy (5 kg/tree) + 30 ml bio-fertilizer) which gave the highest leaves nitrogen % (2.26 and 2.37% for both two seasons, respectively). It is evident that adding irradiated compost significantly increased leaves nitrogen content than non-irradiated one even applied it alone or with microbine (bio-fertilizer) with a tiny few exceptions. Also, addition of microbine had a similar promoting effect on leaf N%.

Leaf P content was significantly enhanced by all employed treatments and the highest value was recorded with T6-(Irradiated compost at 10 KGy (5 kg/tree) + 30 ml bio-fertilizer). Herein, non-irradiated compost was less effective when

TABLE 7. Effect of different treatments on chemical fruit quality characteristics in the two experimental 2017-18 and 2018-19 seasons.

Parameter	TSS %		Acidity %		TSS/Acid Ratio		VC mg/ 100g juice	
Treatment	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**
T1	9.92 E	9.67 D	1.01 A	0.94 C	9.82 E	10.29 D	54.80 G	54.80 G
T2	10.17 D	10.67 A	0.91 B	1.08 A	11.17 B	9.88 E	58.40 F	59.47 F
T3	10.42 C	10.33 C	0.90 B	0.87 E	11.57 A	11.87 A	60.13 E	60.93 D
T4	10.17 D	10.50 B	0.90 B	0.91 D	11.30 AB	11.54 B	63.07 B	63.47 B
T5	10.67 B	10.50 B	1.01 A	0.95 C	10.78 C	11.05 C	62.80 BC	60.40 E
T6	10.50 C	10.42 BC	1.00 A	0.90 D	10.40 D	11.58 B	62.53 C	63.47 B
T7	11.08 A	10.67 A	0.99 A	0.94 C	11.08 B	11.35 B	61.73 D	61.60 C
T8	10.08 D	10.58 AB	0.97 A	1.03 B	10.39 D	10.27 D	65.73 A	65.07 A

Means followed by different letter/s in the same column are significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$).

used solely than combined it with microbine which showed more positive effect. Microbine was significantly enhanced leaf P content in both seasons with all treatments and it's due to the role of microorganisms in phytohormone production and phosphorus solubilization in the soil.

Treatments were significantly raised potassium leaf content than control in both experimental seasons but the differences was few especially during the second season. We can attribute the little differences of potassium level between different treatments to the bio-fertilizer used, which didn't contain potassium solubilize bacteria, so we can say that increment leaves potassium content of treated trees than control is due to the potassium contained in the used (irradiated or non) compost.

The obtained results were paralleled to those obtained by El-Aidy et al. (2018) on Valencia' orange leaves that fertilization trees with NPK and compost in combination with bio-fertilizer induced a significant elevation of leaf N, P and K% compared to mineral fertilization.

The use of compost beside mineral fertilization or reduction of mineral fertilization with combined application of organic fertilizer alone or with bio-fertilizer significantly increased N, P, and K% of different Thompson seedless grapevines parts. Irradiation of such compost resulted in higher minerals content as compared to non-irradiated compost (Eman et al., 2008 and Khamis et al., 2013).

On the same line, Awad and Salama, (2012) found that irradiated poultry manure combined with bio-fertilizer significantly enhanced Leaf N, P and K% of sour orange seedlings over mineral fertilization. The promoting effect of bio-fertilizer on leaf N, P, and K% are in line with those reported by Abdel-Hak et al. (2012) and El-Khawaga and Maklad (2013) on Valencia orange, who reported a significant increment of abovementioned nutrients in response to different bio fertilizers.

Conclusion

The use of innovative technologies, such as the use of gamma rays in organic fertilizers irradiation is a recent trend to be studied, so in this research, therefore we tried to shed some light on the effect of irradiated compost and bio-fertilizer on vegetative growth and fruit quality of Valencia orange. Finally results could interpreted and concluded as exposing compost to irradiation treatments achieves sterilization for this compost in some way as well as facilitating the compost elements content and converting it into an easy form and enabling to absorption by roots resulted in raising their rates in leaves, which reflects on the nutritional status of trees, increasing building rates , supplying the fruits by sufficient nutrients needs, and the final result obtained was high yield with excellent quality characteristics. So we can recommend adding (5 kg irradiated compost at 20 KGy + 30 ml bio fertilizer) /tree during January to increase Valencia orange yield and quality.

TABLE 8. Effect of different treatments on leaf N, P and K percentages of Valencia orange during the two experimental 2017-18 and 2018-19 seasons.

Parameter	N%		P%		K%	
Treatment	**1st season**	**2nd season**	**1st season**	**2nd season**	**1st season**	**2nd season**
T1	1.78 E	1.80 E	0.200 G	0.248 F	1.00 D	1.16 C
T2	1.84 DE	1.93 D	0.233 F	0.362 E	1.01 D	1.24 B
T3	1.91 D	1.98 CD	0.290 D	0.442 B	1.21 C	1.35 A
T4	2.00 C	2.03 C	0.353 C	0.452 B	1.39 B	1.33 A
T5	2.04 C	2.03 C	0.304 D	0.414 C	1.39 B	1.33 A
T6	2.26 A	2.37 A	0.411 A	0.501 A	1.57 A	1.37 A
T7	2.07 BC	2.03 C	0.268 E	0.385 D	1.41 B	1.36 A
T8	2.13 B	2.23 B	0.375 B	0.445 B	1.38 B	1.36 A

Means followed by different letter/s in the same column are significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$).

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تأثير الكمبوست المشعع و التسميد الحيوى على النمو الخضرى و جودة ثمار البرتقال الفالنشيا

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أُجريت هذه التجربة على أشجار برتقال فالنشيا مثمرة منزرعه في تربة رملية تحت نظام الري بالتنقيط في بستان خاص يقع على طريق القاهرة - الإسكندرية الصحراوي لمدة ثلاثة مواسم من ٢٠١٦ إلى ٢٠١٩ لدراسة تأثير الكمبوست المعرض للتشعيع و / أو الأسمده الحيوية على أشجار البرتقال الفالنشيا .

فيما يتعلق بقياسات النمو الخضري التي تمت دراستها ، فقد أشارت نتائج الدراسة إلى أن إضافة ٥ كجم من الكمبوست المشعع بجرعة ٢٠ كيلو جراى+ ٣٠ مل سماد حيوى / شجرة أعطت أكبر طول وقطر وعدد أوراق / للفرع بالإضافة إلى زيادة مساحة الورقة.

فيما يتعلق بالمحصول وجودة الثمار ، جميع المعاملات أدت الى زيادة المحصول وجودة الثمار بشكل واضح مع تفوق معاملة الجمع بين الكمبوست + السماد الحيوي (٥ كجم من الكمبوست المشعع بجرعة ٢٠ كيلوجراى + ٣٠ مل سماد حيوي). و نتج أكبر سمك قشرة للثمرة (٥,٢ مم) عن المعاملة بالكمبوست غير المشعع + ٣٠ مل ميكروبين . و بالنسبة لمحتوى عصير الثمار من المواد الصلبة الذائبه الكلية و فيتامين ج ، و النسبة بين الحموضه إلى المواد الصلبه الذائبه الكليه فقد زادت هذه الصفات بشكل واضح عن معاملة المقارنه و خاصة بإستخدام الكمبوست المشعع و/ أوغير المشعع بالإضافة إلى أو بدون ٣٠ مللى ميكروبين. كما أشار تحليل الأوراق إلى أن جميع المعاملات أدت إلى تعزيز امتصاص الأشجار لكل من النيتروجين و الفسفور و البوتاسيوم وقد انعكس ذلك إيجابيا على النمو الخضري والمحصول وكذلك على تركيز العناصر الثلاثة فى الأوراق.

الهدف من هذه الدراسة هو تحسين النمو الخضرى و المحصول و جودة ثمار البرتقال الفالنشيا وكذا تقليل الإستخدام المفرط للاسمدة المعدنية ، و يوصى تحت الظروف المماثلة بإضافة (٥ كجم من الكمبوست المشعع بمعدل ٢٠كيلو جراى + ٣٠ مللى من السماد الحيوى)/ للشجرة خلال شهر يناير.