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Influence of Soil Application with Vermicompost and Effective Microorganisms on The Productivity and Fruit Quality of Picual Olives

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ABSTRACT

Using vermicompost as organic fertilizers and effective microorganisms (EM) as bio-fertilizer is one of the best ways to reach the highest productivity and the best quality of fruits without causing environmental damage while restoring the microbial balance in the soil around the tree roots. Therefore, the purpose of this experiment was to study the effect of vermicompost and effective microorganisms (EM) on the yield and fruit quality of olive trees "Picual cv.". The study was conducted during the seasons (2021-2022) in a private orchard in Sarabium city in Ismailia Governorate - Egypt. Vermicompost was added at a rate of 1, 2 or 3 kg/tree with or without EM. The results cleared that the soil treatment with 3 kg of vermicompost plus effective microorganisms (600 ml EM divided into 3 addition times) gave the highest yield and the largest weight, size, length and diameter of fruits, as well as the highest flesh weight and content of potassium, iron, zinc and manganese in the leaves, while the treatment with 2 kg of vermicompost with effective microorganisms (EM) recorded the lowest seed weight, the highest flesh/seed ratio and the maximum oil percentage in the fruits during the two seasons of the experiment.

Keywords: vermicomposting, effective microorganisms (EM), olive tree, productivity, fruit quality, fruit oil content

1. Introduction

Olives (*Olea europaea* L.) are a highly significant fruit crop for the global economy, especially in the Mediterranean area. More than many other fruit crops, olive trees can withstand salinity, drought, and climate fluctuations. Additionally, because natural resources are scarce, enhancing the yield and quality of the fruit produced by olive trees in arid zones requires appropriate agricultural, technological, and financial management. With a total fruit production of over 1,137,075 tons, the area of olive trees in Egypt quickly expanded to approximately 112,851 hectare (FAO, 2022). Although olives can withstand drought, salinity and malnutrition, they need regular irrigation and fertilization to achieve high and profitable production. Increased interest in olive cultivation and production contributes significantly to the national economy. There are many cultivars of olives in Egypt, some of which are pickled olives, some are olives for oil extraction, and some of which have fruits that are suitable for both purposes, such as the Picual cultivar, which is one of the most widespread cultivars on farms and its fruits are harvested at the ripening stage (Hassan *et al.,* 2019).

One of the most recent forms of organic fertilizers is vermicompost, which is made when earthworms break down organic waste (plant or animal). Furthermore, when mixing vermicompost with traditional organic fertilizer, it increases its nutretion value, also when using earthworms is intended to expedite the breakdown of organic matter and generate materials that are rich in essential nutrients and organic materials that support plant growth, productivity, and the enhancement of soil qualities (Eman *et al.,* 2022). Vermicomposting, which is the process by which worms convert organic wastes into biofertilizers, is a technology that is widely employed in today's solid waste

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management (Manyuchi *et al.,* 2013). Furthermore, vermicompost differs from other kinds of organic fertilizers in that it has proportions of natural growth regulators such gibberellins, cytokinin, and IAA (Bellitürk *et al.,* 2015). Additionally, the use of vermicompost has a positive impact on the microbial activity and the enzyme activities in the production material. (Mishra *et al.,* 2017). A recent study's findings indicate that certain plants cultivated with vermicompost applications have a significant impact on the removal of heavy metals from the soil (Shrestha *et al.,* 2019). Moreover, compared to conventional organic fertilizers, vermicompost has higher concentrations of numerous macro and micronutrients, including nitrogen, potassium, phosphorous, iron, copper, magnesium, and so on. This increases the concentration of these elements in plant leaves, which in turn promotes tree growth and productivity (Bellitürk *et al.,* 2020). As well as, numerous scientists' studies have demonstrated that applying an aqueous extract of vermicompost (vermicompost tea) to the soil suppressed the growth of plant parasitic nematodes in a variety of crops (Fritz *et al.,* 2012 and Arancon *et al.,* 2012). Also, several studies have confirmed that fertilizing with vermicompost with traditional organic fertilizers increases productivity and improves the physical and chemical properties of fruits (Eman *et al.,* 2022 and Amr *et al.,* 2019).

Effective Microorganisms (EM) mixture has been established for a long time and has gained increasing interest in recent years due to its important roles in helping the soil restore its biological diversity. As a result of the excessive use of chemical fertilizers, the soil content of beneficial microbes has been negatively affected, and therefore it is necessary to add microorganisms to the soil. According to (Mohan, 2008), EM is a mixture of live cultures of microorganisms that have been isolated from naturally fertile soils and are useful for fruit and crop production. These microorganisms may include photosynthetic bacteria (*Rhodobacter sphaeroides,* Rhodopseudomonas palustris), lactobacilli (*Lactobacillus plantarum, L.casei,* and *Streptococcus lactis*), actinomycetes (*Streptomyces spp.*), and yeasts (*Saccharomyces spp.*) and other beneficial microbes (Javaid, 2010). Increasing the biodiversity of soil micropora will boost crop yield, which is the main goal of EM. According to reports, photosynthetic bacteria collaborate with other microbes to meet a plant's nutritional needs and prevent sickness (Condor *et al.,* 2007). In this respect, many studies have confirmed that bio-fertilization and the addition of effective microorganisms to the soil have led to an increase in the efficiency of absorption of nutrients and their availability in the soil, which has led to an increase in the yield and quality of the fruits and an improvement in the nutritional status of the trees (Ayan *et al.,* 2022; Amro *et al.,* 2014; Shokouhian *et al.,* 2013 and El-Shafei *et al.,* 2008).

The study aims to increase the benefit from traditional organic fertilizer by adding vermicompost to it, as well as increasing the soil content of beneficial microbes by adding effective microorganisms (EM) to the soil at different times during the growing season, in order to improve the nutritional status of trees and the leaf content of minerals, all with the aim of achieving the highest yield, the best quality of fruits, the best oil percentage, and achieving the greatest economic return.

Materials and Methods

This study was conducted at a private orchard in Sarabium city, Ismailia Governorate-Egypt, over the course of two seasons (2021 and 2022). The "Picual" cultivar of olive trees that were ten years old were used for the investigation. The trees are cultivated in sandy soil and are spaced 4 by 6 meters under a drip irrigation system. The selected trees had uniform forms. Table (1) provided the soil analysis, and Table (2) displayed the water irrigation analysis.

Table 1: Physical and chemical properties of orchard soil.

Particle size distribution (%)			
Sand	**Silt**	**Clay**	**Texture**
81.9	8.8	9.3	Loamy sand

Properties	pH (1:2.5)	EC dSm^{-1} (1:5)	Soluble cations (me/l)				Soluble anions (me/l)			
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	$CO3^{-2}$	HCO^{-3}	Cl^{-}	$SO4^{-2}$
Value	8.22	1.31	2.7	1.8	8.2	0.6	-	1.5	9.9	1.9

Table 2: Orchard irrigation water analysis.

Properties	pH	EC dSm^{-1}	Soluble cations (me/l)				Soluble anions (me/l)			
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	$CO3^{-2}$	HCO^{-3}	Cl^{-}	$SO4^{-2}$
Value	7.65	6.57	19	7.5	45.6	0.3	-	3.2	46.9	22.3

Experimental design and Treatments

The study included one experiment designed in the form of randomized complete block design (RCBD), the experiment contains six treatments and control, each treatment includes three replicates, and each replicate is one tree. The experiment was designed to study the effect of soil application Picual olive trees with vermicompost and effective microorganisms (EM) at different rates. Vermicompost (VC) was added by rate 1, 2 or 3 kg per tree/year during the last week of December with the date of adding traditional organic fertilizer. Effective microorganisms (EM) were added by rate 600 ml per tree divided into three addition times, which were mid-February, mid-April, and mid-June.

The experiment included six treatments and control, which were:

1- Untreated trees (control).
2- 1 kg vermicompost without EM.
3- 1 kg vermicompost + EM.
4- 2 kg vermicompost without EM.
5- 2 kg vermicompost + EM.
6- 3 kg vermicompost without EM.
7- 3 kg vermicompost + EM.

The vermicompost used was obtained from the central lab aquaculture research, agricultural research center, Egypt (prepared by Pro. Dr. Yasser Thabet A. Mostafa). The table (3) shows the physiochemical parameters analysis of vermicompost.

All trees were treated with the horticultural program of the farm, except for the trees treated with vermicompost, where the amount of traditional organic fertilizer was reduced by 25%, which is approximately equal to (15 kg organic fertilizer per tree).

Table 3: Physiochemical parameters analysis of vermicompost.

Parameters	O.M	Humidity	ash	C/N ratio	N	P	K	Amino acids	ABA	GA3	IAA
Unit	**%**	**%**	**%**		**%**	**%**	**%**	**Mg/g DW**	**g/100g**	**g/100g**	**g/100g**
Sample	21.05	27.34	54.93	11.58	1.07	0.4	1.86	0.43	0.01	0.16	0.03

The effective microorganisms (EM) used were obtained from the Agricultural Research Center of the Egyptian Ministry of Agriculture, which is a commercial product under the name (EM1), which is a microbial mixture containing a variety of beneficial soil bacteria that are useful for the growth and development of plants. The microbial mixture was earlier described by (Javaid, 2010).

Measurements

The following measurements were made on the trees that were chosen for the experiment in December, just before the start of the new growing season:

Fruit Yield

In mid-October of every season, the total weight of the fruits on the tree (kg) was measured to determine the yield of the tree.

Fruit physical properties

In order to measure the fruit weight (g), volume (cm3), length (cm), diameter (cm), shape index (length/diameter ratio), weight of the seed and flesh (Calculated by subtracting the seed weight from the fruit weight) (g), and flesh/seed ratio, a random sample of 20 fruits were chosen during harvest (mid- October) from each replication tree.

Fruit moisture content

Fruit moisture percentage was assessed for the previous fruit samples. The samples were dried at 70 degrees Celsius in an electrical air oven until weight stability. After that, the fruit moisture % was calculated by A.O.A.C. (1995).

Fruit oil content

According to Banat *et al. (*2013), a soxhlet oil extraction apparatus with a petroleum ether boiling point between 60 and 80 degrees Celsius was used to calculate the oil percentage in the fruit on a dry weight basis.

Leaf mineral content

In July, samples of leaves were taken from trees in all directions. Additionally, mature leaves (from middle of the branch) were taken from branches that did not bear fruit.Then all the leaves of each treatment were mixed. After the leaves were dried in a drying oven set at 70 degrees Celsius, Then the leaves were digested using concentrated sulfuric acid and perchloric acid, and the sample volume was increased to 100 ml with distilled water. The following mineral elements were measured in the solution:

The Kjeldahl method was used to determine nitrogen in accordance with Pregl, (1945). Using spectrophotometric methods, the phosphorous element was estimated (Chapman and Pratt, 1961). In addition, potassium is measured using the Flamephotometric instrument in accordance with procedures described by Brown and Lilleland (1946). According to Jackson's (1973) methodology, an atomic device (atomic absorption) was used to measure the elements iron, zinc, and manganese in leaves.

Experimental Design and Statistical Analysis

Using the statistical software CoStat, the data collected over the course of the two experiment seasons were analyzed using the ANOVA (analysis of variances) method as described by (Snedecor and Cochran, 1980). Moreover, the computation method LSR (least significant ranges) with a probability of 5% was used to compare the averages within the data (Duncan, 1955).

3. Results and Discussion

3.1. Yield, fruit weight and volume

The results presented in figure (1) demonstrated that, the ultimate yield (kg/tree), fruit weight and volume were significantly affected with all treatments of vermicompost and effective microorganisms as opposed to untreated trees. The results showed that, the highest values of yield and fruit weight recorded with addition 3 kg Vermicompost plus EM, since it was (19.67 and 30.00 kg/tree for yield) and (6.89 and 7.02 g for fruit weight) in the first and second seasons, respectively. On the other hand, untreated trees (control) were determined to have the lowest yield and fruit weight, since it was (19.67 and 30.00 kg/tree for yield) and (5.82 and 5.96 g for fruit weight) in both studied seasons, consecutively. During the two experimental seasons, all other experimental treatments produced higher yields than the control.

Based on results shown in figure (1), the trees treated with 2 kg Vermicompost plus EM had the maximum fruit volume (6.83 cm^3) in the first season. Nevertheless, during the second season, soil application with 3 kg Vermicompost plus EM recorded the highest value (7.16 cm^3). On the other hand, untreated trees (control) exhibited the least amount of fruit volume during the first and second season, since it was 5.66 and 5.50 cm^3, respectively. While the other treatments were in the middle.

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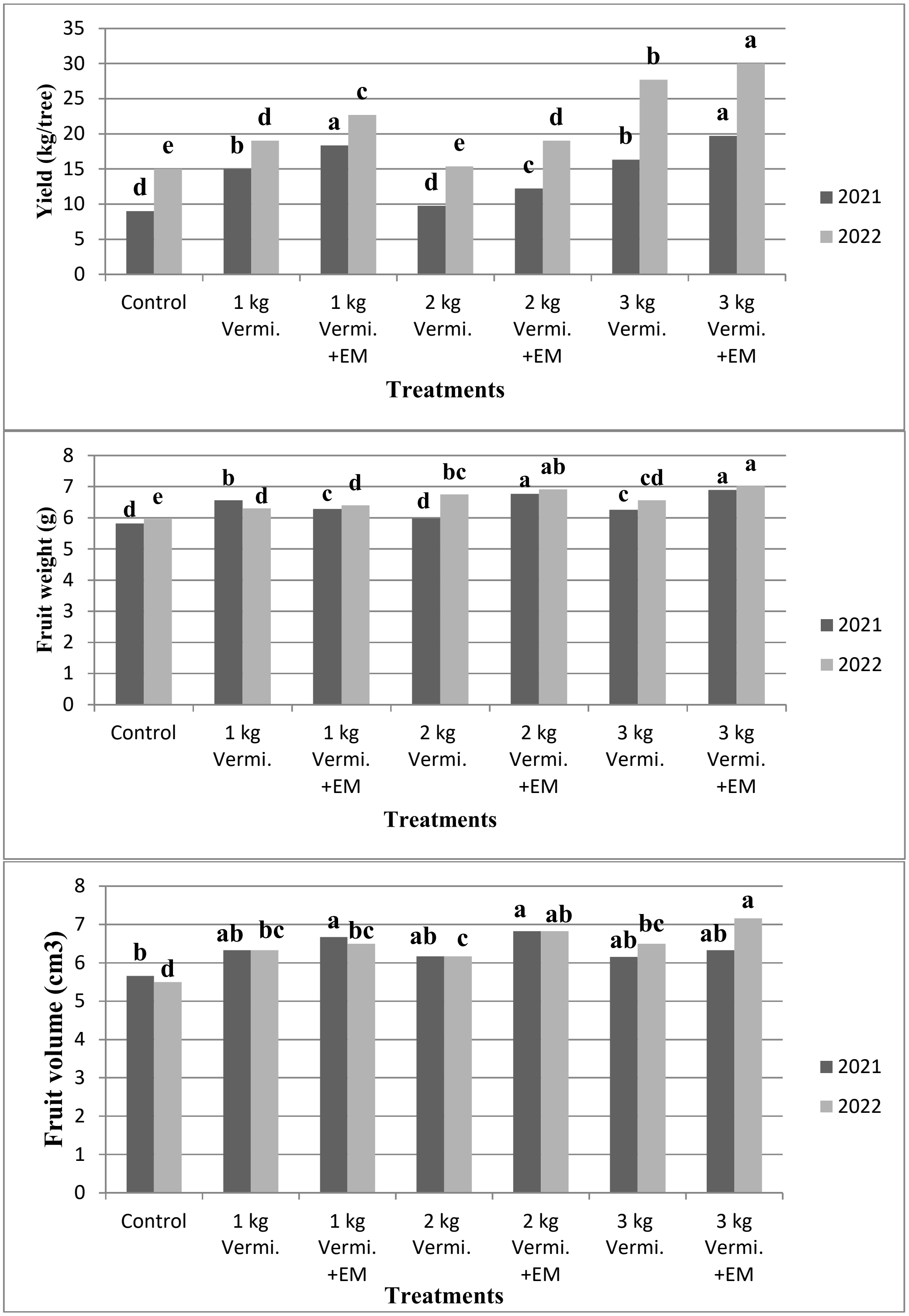

Fig. 1: Influence of soil application with vermicompost and effective microorganisms (EM) on yield, fruit weight and volume of Picual olives in 2021 and 2022 seasons.

3.2. Flesh and seed weight, and Flesh/Seed ratio

It is clear from the data in figure (2) in both seasons, the flesh weight increased significantly with each soil application treatment when compared to the control treatment. The trees treated with 3 kg

Vermicompost plus EM and 2 kg Vermicompost plus EM showed the greatest flesh weight values in the first season, weighing 5.71 and 5.72 g, respectively

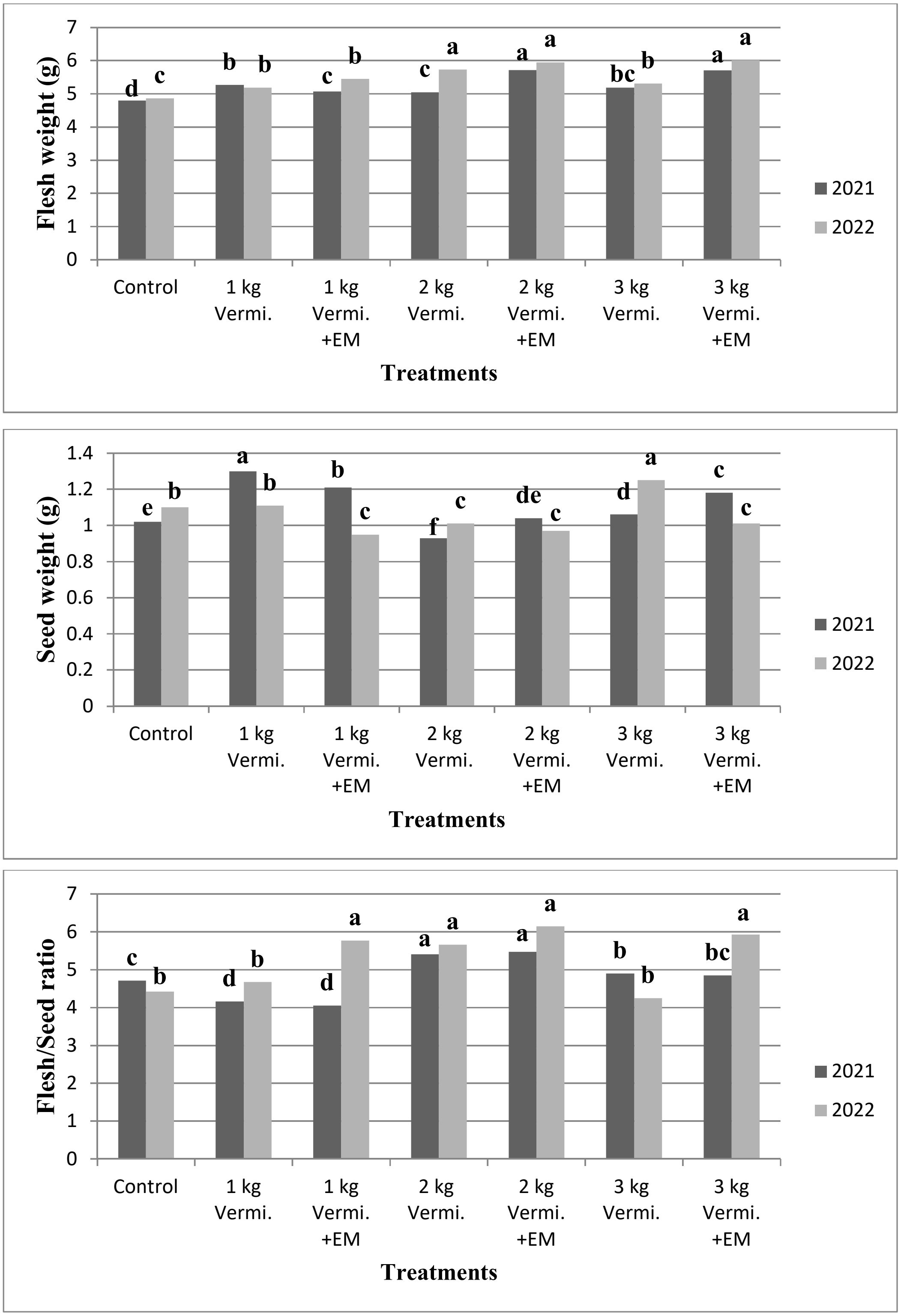

Fig. 2: Influence of soil application with vermicompost and effective microorganisms (EM) on flesh weight, seed weight and flesh/seed ratio of Picual olives in 2021 and 2022 seasons.

Additionally, in the second season, the trees treated with 3 kg Vermicompost plus EM, 2 kg Vermicompost plus EM and 2 kg Vermicompost produced the highest values of flesh weight (6.01, 5.95 and 5.73g). Conversely, the control trees produced the lowest flesh weight in the first and second seasons, since it were 4.80 and 4.86 g in both of seasons, consecutively.

The results shown in figure (2) demonstrated that different treatments considerably affected the amount of seed weight in both seasons. The lowest seed weight value (0.93 g) was achieved in the first season with 2 kg Vermicompost plus EM. Similarly, the second season saw the lowest amounts with soil applications by1 kg Vermicompost plus EM, 2 kg Vermicompost plus EM and 2 kg Vermicompost, where the values were 0.95, 0.97 and 1.01 g, respectively. whereas the treated trees by 1 kg Vermicompost in the first season and 3 kg Vermicompost in the second one showed the maximum seed weight, since it were 1.30 and 1.25 g, respectivelyFigure (2) showed that soil application by 2 kg Vermicompost and 2 kg Vermicompost plus EM recorded the highest flesh/seed ratio (5.41 and 5.47) were achieved in the first season. Meanwhile, in the second season, the treatments increased the flesh/seed ratios, however, no significant differences were amongst the treatments. Conversely, the treated trees by 1 kg Vermicompost plus EM in the first season and 3 kg Vermicompost in the second one showed the minimum ratios, since it were 4.05 and 4.25, consecutively.

3.3. Fruit length, diameter and shape index

It is clear from the data in table (4) that the most treatments significantly increased the fruits length in comparison to the control treatment in both of seasons. The trees treated with 3 kg Vermicompost plus EM showed the highest fruit length value (2.68 cm) in the first season. Additionally, soil application with 3 kg Vermicompost plus EM and 1 kg Vermicompost plus EM produced the highest values in the second season, since it was 2.70 and 2.71 cm. However, the control trees and the treated by 2 kg Vermicompost produced the lowest values (2.54 and 2.54 cm) in the first season. Meanwhile, in the second one, untreated trees (control) gave the minimum fruit length (2.48 cm) compare with the other treatments.

Table 4: Influence of soil application with vermicompost and effective microorganisms (EM) on length, diameter, shape index, and moisture content of Picual olive fruit in 2021 and 2022 seasons.

Treat.	Fruit length L (cm)		Fruit diameter D (cm^3)		Fruit shape index (L/D)		Fruit moisture content (%)	
	2021	2022	2021	2022	2021	2022	2021	2022
Control	2.54 d	2.48 e	2.10 bc	2.03 e	1.20 d	1.21 b	60.02 a	59.05 a
1 kg Vermi.	2.60 c	2.55 d	2.15 a	2.08 d	1.22 cd	1.23 b	59.03 bc	58.51 ab
1 kg Vermi. + EM	2.63 b	2.71 a	2.09 c	2.10 d	1.26 ab	1.29 a	58.35 c	59.34 a
2 kg Vermi.	2.54 d	2.63 bc	2.08 c	2.12 c	1.21 cd	1.24 b	60.16 a	59.32 a
2 kg Vermi. + EM	2.62 bc	2.67 ab	2.13 ab	2.15 b	1.23 c	1.24 b	59.87 ab	57.11 b
3 kg Vermi.	2.54 d	2.61 c	2.03 d	2.12 c	1.25 b	1.23 b	58.84 c	60.31 a
3 kg Vermi. + EM	2.68 a	2.70 a	2.10 bc	2.19 a	1.28 a	1.23 b	56.59 d	54.46 c

The means in every column that have a similar letter or letters do not differ significantly at the 5% level.

Table (4) findings demonstrated that, with regard to fruit diameter, the trees treated with 1 kg Vermicompost in the first season displayed the highest fruit diameter (2.15 cm). When compared to other treatments, the trees treated with 3 kg Vermicompost plus EM in the second season had the highest values in this regard (2.19 cm). Conversely, the trees treated with 3 kg Vermicompost in the first season yielded the lowest fruit diameter (2.03 cm). Moreover, untreated trees (control) gave the minimum fruit diameter (2.48 cm) in the second one.

In the same table, data clearly revealed the trees treated with 3 kg Vermicompost plus EM in the first season had the largest value (1.28) in relation to the fruit shape index. Comparing the trees treated with 1 kg Vermicompost plus EM to those treated with other treatments in the second season exhibited the largest value in this regard. Whereas, the control trees produced the lowest values for fruit shape index in the first and second seasons, since it were 1.20 and 1.21, respectively.

Fruit moisture and oil content

Data in table (4) displays the largest percentage of fruit moisture recorded with 2 kg Vermicompost plus EM (60.16 %) and control treatment (60.16 %) during the first season. The second season saw the highest value for soil application with 2 kg Vermicompost (60.31 %) with no significant differences between the treatments. However, the trees treated by 3 kg Vermicompost plus EM produced the lowest fruit moisture percentage in both studied seasons, since it were 56.59 and 54.46 %, respectively. Compare with the other treatments.

The results displayed in figure (3), the fruit oil content significantly affected with all treatments of vermicompost and effective microorganisms compared to untreated trees. The results showed that, the highest values of oil percentage recorded with 2 kg Vermicompost plus EM, where it reached 34.00 and 33.66 % within the first and second seasons, respectively. Otherwise, untreated trees (control) and 1 kg Vermicompost were determined to have the lowest percentages, since it were (28.02 and 28.66 % in the first season) and (30.83 and 30.85 % in the second season), respectively. All other experimental treatments produced higher fruit oil content than the control.

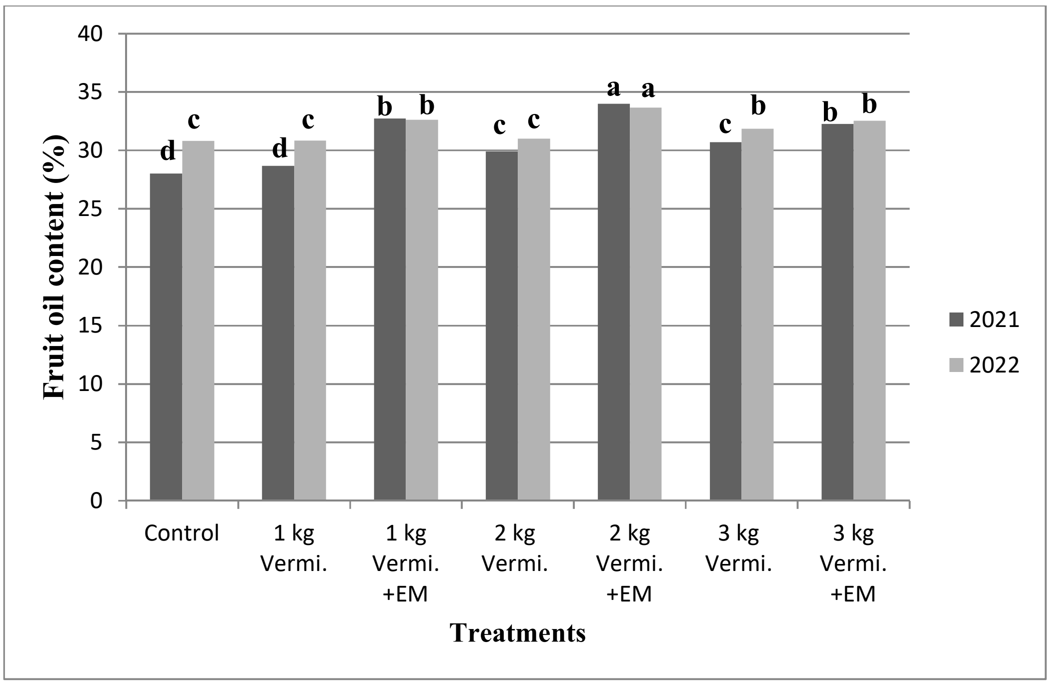

Fig. 3: Influence of soil application with vermicompost and effective microorganisms (EM) on fruit oil content of Picual olives in 2021 and 2022 seasons.

Macro elements content of leaves

The results shown in table (5) demonstrated that different treatments considerably affected the amount of nitrogen content of leaf in both seasons. The trees treated with 2 kg Vermicompost had the maximum values (2.08 and 2.28 %) within the first and second seasons, consecutively. On the other side, untreated trees (control) exhibited the least amount of nitrogen content of leaf during the first and second season, since it was 1.74 and 1.96 %, respectively. While the other treatments were in the middle.

According to the data provided in table (5), the trees treated with 1 kg Vermicompost plus EM and 3 kg Vermicompost plus EM showed the maximum values of phosphorus content of leaf in the first season, where it reached 0.16 and 0.16 %. Additionally, in the second season, the trees treated with 1 kg Vermicompost plus EM produced the highest value (0.16 %). Conversely, the trees treated with 1 kg Vermicompost and 2 kg Vermicompost yielded the lowest phosphorus percentages (0.10 and 0.10

%) in the first season. Moreover, in the second one, the trees treated with 2 kg of vermicompost yielded the lowest percentage (0.11%).

Table 5: Influence of soil application with vermicompost and effective microorganisms (EM) on macro elements content of Picual olive leaves in 2021 and 2022 seasons.

Treat.	N (%)		P (%)		K (%)	
	2021	2022	2021	2022	2021	2022
Control	1.74 d	1.96 d	0.12 c	0.14 b	0.93 f	0.89 f
1 kg vermin.	1.76 d	2.17 b	0.10 e	0.14 b	0.94 e	0.98 c
1 kg vermin. + EM	1.88 c	2.07 c	0.16 a	0.16 a	1.01 b	1.08 a
2 kg vermin.	2.08 a	2.28 a	0.10 e	0.11 e	0.98 c	0.94 d
2 kg vermin. + EM	1.76 d	2.07 c	0.11 d	0.12 d	1.01 b	1.03 b
3 kg vermin.	1.97 b	2.18 b	0.13 b	0.13 c	0.96 d	0.91 e
3 kg vermin. + EM	1.88 c	2.07 c	0.16 a	0.15 b	1.07 a	1.08 a

The means in every column that have a similar letter or letters do not differ significantly at the 5% level.

In the same table, data showed that all treatments significantly increased the potassium content of leaf in comparison to the control treatment in both seasons. Soil application by 3 kg Vermicompost plus EM recorded the highest value (1.07 %) were achieved in the first season. Meanwhile, in the second one, soil application by 3 kg Vermicompost plus EM and 1 kg Vermicompost plus EM gave the highest potassium content of leaf, since it was 1.08 and 1.08 %. However, the untreated trees (control) produced the lowest percentage of potassium in both studied seasons, where values were recorded 0.93 and 0.89 %, consecutively.

Micro elements content of leaves

The findings presented in Table (6) showed that, in comparison to untreated trees, all treatments involving vermicompost and effective microorganisms had a substantial impact on the Fe, Zn and Mn content of leaves. The findings demonstrated that the addition of 3 kg vermicompost plus EM produced the highest iron and manganese content of leaf, which were (206.30 and 181.00 ppm for iron content of leaf) and (40.32 and 42.79 ppm for manganese content of leaf) in both of seasons, respectively. While, untreated trees (control) were determined to have the lowest iron and manganese content of leaf, since it were (130.17 and 128.10 ppm for iron content of leaf) and (23.08 and 22.74 ppm for manganese content of leaf) in both studied seasons, consecutively.

Table 6: Influence of soil application with vermicompost and effective microorganisms (EM) on micro elements content of Picual olive leaves in 2021 and 2022 seasons.

Treat.	Fe (ppm)		Zn (ppm)		Mn (ppm)	
	2021	2022	2021	2022	2021	2022
Control	130.17 f	128.10 f	26.41 e	29.35 d	23.08 e	22.74 e
1 kg vermin.	131.97 f	135.00 e	30.16 de	32.32 c	24.79 d	24.83 d
1 kg vermin. + EM	148.50 c	172.90 b	37.00 c	34.80 b	25.94 d	29.65 c
2 kg vermin.	136.30 e	141.30 d	43.22 b	29.30 d	26.24 d	25.73 d
2 kg vermin. + EM	140.17 d	160.00 c	33.06 cd	28.42 d	28.93 c	29.14 c
3 kg vermin.	162.67 b	133.60 e	29.89 de	33.83 b	33.92 b	36.35 b
3 kg vermin. + EM	206.30 a	181.00 a	47.91 a	37.78 a	40.32 a	42.79 a

The means in every column that have a similar letter or letters do not differ significantly at the 5% level.

In the same table, the results showed that, the maximum zinc content of leaf recorded with addition 3 kg Vermicompost plus EM, since it was 47.91 and 37.78 ppm in both of seasons, respectively. Otherwise, untreated trees (control) gave the minimum zinc content of leaf (26.41 ppm) in the first season. Meanwhile, trees treated by 2 kg Vermicompost, 2 kg Vermicompost plus EM and control trees produced the least values in the second season, which were 29.30, 28.42 and 29.35 ppm, consecutively.

The previous results showed that adding vermicompost with active microbes to the soil gave clear positive results on most of the studied measurements. This is due to the vermicompost containing many nutrients and elements as shown in Table (3), which improve the nutritional status of the trees, which has a positive effect on the amount of the crop, the quality of the fruits, and the oil content of the fruits. In this respect, Bellitürk *et al.* (2015) explained that vermicompost has proportions of natural growth regulators such gibberellins, cytokinin, and IAA. Also, Bellitürk *et al.* (2020) found that, vermicompost has high concentrations of numerous macro and micronutrients, including nitrogen, potassium, phosphorous, iron, copper, magnesium, and so on. The findings were consistent with those of Gupta and Sangma (2017) for guava and Laishram and Ghosh (2018) for jackfruit. They demonstrated that adding more vermicompost enhanced the fruits' chemical and physical characteristics and increased the amount of sugars and carbohydrates in the plant tissues. In this way, Zhao *et al.* (2010) demonstrated that the use of vermicompost resulted in a significant increase in yield. The results also agreed with Eman *et al.* (2022), they found that the pomegranate yield and the physical and chemical characteristics of the fruits enhanced significantly when mixing vermicompost with traditional organic fertilizer compared to trees not to which vermicompost was added. Vermicompost was a viable supply of nutrients and had a favorable impact on the majority of the parameters examined, according to Alidadi *et al.* (2014), who reported a similar outcome for their study on tomato plants.

As for the effect of adding effective microorganisms (EM) as a bio-fertilizer, the results showed that adding EM to vermicompost increased the positive effects on most of the studied measurements, due to the microbial mixture containing many beneficial and useful microorganisms. These effective microorganisms may include photosynthetic bacteria (*Rhodobacter sphaeroides, Rhodopseudomonas palustris*), lactobacilli (*Lactobacillus plantarum*, *L.casei,* and *Streptococcus lactis*), actinomycetes (*Streptomyces* spp.), and yeasts (Saccharomyces spp.) and other beneficial microbes (Javaid, 2010). Moreover, the use of bio-fertilizers increases microbial diversity in the soil, which increases the speed of decomposition of organic matter and increases soil acidity, which increases the availability of mineral elements and the ability of roots to absorb nutrients from the soil, which ultimately benefits the amount of tree yield and fruit quality (Hassan *et al.,* 2015 and Laila *et al.,* 2016). In addition, effective microorganisms have significant positive effects on the leaf photosynthesis rate and leaf chlorophyll content, i.e. it helped to increase the physiological activity of plants in general (Ayan *et al.,* 2022). Also, the use of effective microbes reduces the degree of soil salinity and pH when added with fermented organic fertilizers (El-Shafei *et al.,* 2008).The results of the experiment were consistent with the results of Shokouhian *et al.* (2013) who found that, fertilization using effective microorganisms (EM) increased the content of mineral elements (nitrogen, phosphorus and potassium) in almond tree leaves, improved vegetative growth and the percentage of chlorophyll in the leaves, and increased the trees' ability to tolerate drought and lack of irrigation water compared to untreated trees. In this respect, Amro *et al.* (2014) conducted a study on Hayani date palms, where effective microorganisms (EM) were used at different rates. It was found that adding EM at a rate of 90 ml per palm with potassium sulfate gave the highest yield per palm, and improved the fruit quality and the mineral content in leaves. The favorable effects of EM application on the physical and chemical qualities of fruit have been observed, and these results concur with the research conducted by Osman *et al.,* (2011) and El-Khawaga (2013).

4. Conclusion

From the previous results, it can be concluded that 3 kg of vermicompost plus effective microorganisms (600 ml EM divided into 3 addition times) can be added to the soil to obtain the highest yield, largest weight, size, length and diameter of olive fruits and highest flesh weight. Also, can be added 2 kg of vermicompost plus EM to achieve the maximum oil percentage in olive fruit for olive oil producers. This can be recommended for olive farms exposed to the same environmental conditions as this experimental farm.

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