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Effects of Different Organic Manures and Chemical Fertilizers on Yield and Yield Component of Olive (*Olea europaea* L.,) cv Zard In Kermanshah Province

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ABSTRACT

Olive is one of the most important fruit trees for oil and table purpose. Olive tree nutrition is inadequate in calcareous soils because of problem in nutrient availability. To solve this problem, combining chemical fertilizer with organic manure and placing in a suitable area of the root may be appropriate. This research was carried out to evaluate the effect of some organic manure with or without of chemical fertilizers placement in root zone on growth and fruit characteristics of ten years old Zard olive cultivar during two consecutive years. Treatments were vermicompost (V), chicken (Ch), cow (C) and sheep (Sh) manures with or without of chemical fertilizers (F) in compare to controls (Co) (with or without of chemical fertilizer). Different vegetative and reproductive traits were measured. The highest growth rate was recorded from chicken manure and chicken manure + chemical fertilizers treatments. Applying animal manures with chemical fertilizers improved trunk growth rate in compare to the animal manure alone. Number of inflorescences per twig and flower number per inflorescence were significant under different treatments in the second year. The maximum fruit and flesh weight were obtained by applying Ch, Ch+F, V and V+F treatments in compare to the control in the first year. Fruit yield was higher through the application of Sh+F, Sh, C+F and Ch+F treatments in the second year respectively. Fruit dry matter was higher in the second season in comparison with the first year under combination of manures and chemical fertilizers. Oil content (based on dry matter) was mainly affected by Sh+F and V treatments. In general, the results revealed that a combination of chemical fertilizers with vermicompost, sheep and cow manures were more effective for two years in calcareous soil, but chicken manure must be used every year.

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1. Introduction

Olive (*Olea europaea* L.,) grows as one of the fruit trees in Rijab region of Dallaho in Kermanshah province recently. Olive cultivation area is 1001 hectares with a production of 3740 tons in Kermanshah province (Anon, 2019). High quality and quantity production need to be properly managed in olive orchards. Fertilization is one of the factors, which has great influence on the growth and fruit quality of olive trees (Tekaya *et al.*, 2016). Fertilizer management improvement is essential to grow crops successfully on calcareous soils. Organic matter application can enhance the availability of mineral nutrients in calcareous soils (Manirakiza and Şeker, 2020). Locally placement of chemical fertilizers in combination with organic manure minimizes soil contact thus nutrient availability will be increase (Iqbal *et al*., 2019).

Scotti et al. (2015) stated that organic matter (OM) is used as foundation of soil fertility. It can regulate water, nutrients and air supply to plants and soil organisms. Franzluebbers et al. (2010) explored that organic matter strongly influence fertilizer requirements of plants so that it can deliver over half of the nitrogen and a quarter of the phosphorous to crops requirement. The use of organic materials is interesting because of their positive impact on soil structure,

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stability, nitrogen and carbon content. The biological component of the soil is very important because of its responsibility for soil humus formation, cycling of nutrients and building soil structure along with many other functions (Esmaeilzadeh and Gholamalizadeh Ahangar, 2014). Farmers historically have applied animal manures and human wastes to the land to increase their productivity (Scotti *et al.*, 2015).

Today, growers tend to shift the production system to organic production by replacing organic matter instead of chemical fertilizers (Brenes-Munoz *et al.*, 2016). Experimental findings revealed that organic matters are slow in break down and supply nutrients to the plant root for longer time (Goss *et al.*, 2013). Sheep and chicken manures have been recommended for olive cultivation under arid and semi-arid regions with limited in water resources, especially sandy soil. Soil physical and chemical characteristics improved by sheep and chicken manures and consequently growth of olive trees was enhanced (Abdel-Nasser and Harash, 2001). The number of inflorescences per shoot and the number of flowers per inflorescence increased in olive trees by applied organic manures (Maksoud, 2000; Hegazi *et al.*, 2007). Hegazi et al. (2007) stated that organic fertilization increased economical yield, fruit set percentage and improved the oil properties of olive trees.

AL-Kahtani and Ahmed (2012) found that the agricultural waste + 10% sheep manure increased leaf area, shoot length, pigments content and leaf mineral contents (N, K and Fe) of Picual olive trees. Moreover, flowering, fruit set, yield and fruit physical characteristics and oil yield were increased in treated olive trees by the agricultural waste + 10% sheep manure. Fernandez-Escobar et al. (2006) reported that mineral fertilization influenced olive yield and oil quality.

Abdel-Nasser and Harash (2001) stated that sheep and chicken manure improve olive fruit yield. Hegazi et al. (2007) explored that olive yield and yield components were increased by appling organic manure. Olive flowering was enhanced by organic manure application (Maksoud, 2000; Hegazi *et al.*, 2007). Bakheit and Elsadig (2015) obtained increased yield of banana with combined of organic and chemical fertilizers. Less research has been conducted on the use of organic manure and chemical fertilizers in combination for olive fruit trees. This research was conducted to evaluate the combination effect of chemical fertilizers and organic manures in a new olive trees cultivation area in calcareous soils.

Rijab region is the main cultivation area of olive trees with about 600 hectares of olive orchard in Kermanshah province. Soil in this region categorized in class II so it requires careful soil management, including conservation practices, to prevent deterioration or to improve air and water relations when the soils are cultivated. Some farmers apply animal manures with or without chemical fertilizers as broadcasting in the olive orchards. Application of fertilizer is not suitable for fruit trees because of much lime in the soil. So, application of fertilizer in the right place with the right manner is very important. The main aim of this study was evaluating the effects of different organic manures coincided with chemical fertilizer in the root zone of Zard olive cultivar in Rijab region of Kermanshah province.

2. Materials and methods

2.1. Experimental location, design and treatments

This experiment was carried out during two successive seasons (2011 and 2012) on ten years old Zard olive orchard in Rijab region (longitude: 45º 56´ E, latitude: 34º 31´ N, altitude: 935 m) of Kermanshah province. Trees were planted in a sandy soil (Table 1) with 6*6 meters apart (277 trees/hectare). Total numbers of 90 trees were used. The average annual rainfall was about 472.5 and 335 mm in the first and the second years, respectively which concentrated in the autumn and winter periods.

Treatment were used as a complex of organic manure with or without of chemical fertilizers in three holes with 40×40×40 cm around the trees. Treatments were used in this experiment consist of 1- cow manure (C), 2- Cow manure + chemical fertilizer (C+F), 3- sheep manure (Sh), 4- sheep manure + chemical fertilizer (Sh+F), 5- chicken manure (Ch), 6- chicken manure + chemical fertilizer (Ch+F), 7- control (Co) (without any fertilizing), 8- control (F) (chemical fertilizer) 9- vermicompost (V) and 10- vermicompost + chemical fertilizer (V+F). Treatments were applied in the 5 the March of the first year. Organic manures treatments were cow (15 kg/tree), sheep (12 kg/tree), chicken (10 kg/tree), and vermicompost manures (12 kg/tree). Chemical fertilizer recommendation was 1200g ammonium sulfate, 200g triple superphosphate,

200g Potassium sulfate, 40g EDDHA, 30g manganese sulfate, 120g zinc sulfate, 50g copper sulfate and 20g boric acid based on soil analysis for each tree.

Some physical and chemical characteristics of the soil and chemical characteristics of water are shown in table 1 and 2 respectively. The chemical compositions of the organic manures are shown in Table 3.

Table1. Some physical and chemical characteristics of soil

Soil depth (cm)	Horizon	Particle- size distribution (%)				Texture	EC dS/m	pHs	OC %	
		Sand	Silt	Clay	Gravell					
0-15	AP	32.00	34.00	34.00	-	C-L	1.10	7.50	1.10	
15-55	BW	40.00	30.00	30.00	-	C-L	1.30	7.55	0.80	
55-100	BK1	26.00	36.00	38.00	5.00	C-L	0.90	7.55	0.20	
100-130	BK2	26.00	40.00	34.00	-	C-L	0.90	7.60	0.10	
Soil depth (cm)	Soluble cations, (meq/l00g soil)			Soluble anions (meq/100g soil)			nutrients			
	Co_3^-	Ca+Mg	Na^+	$HCO3^-$	Cl^-	$SO4^{-2}$	Total N%	Ava. P mg/kg	Ava. K mg/kg	TNV %
0-15	0.00	5.60	1.00	4.60	2.00	0.00	0.11	10.00	310.00	46.00
15-55	0.00	4.00	3.16	3.00	2.40	0.16	0.08	6.00	240.00	54.00
55-100	0.00	3.60	1.68	240	2.80	0.08	0.02	2.00	8200	36.50
100-130	0.00	4.00	2.00	3.00	3.90	0.00	0.01	1.00	63.00	32.50

Table 2. Chemical characteristics of water river used

CO_3^-	SAR	Na^+	Ca+Mg	Fe	$SO4^{-2}$	Cl^-	HCO_3^-	pH	TDS	EC	Water Source
meq/l	%			meq/l					mg/l	dS/m	
0	2.40	0.28	2.3	0	0.38	0.32	0.8	7.2	385	0.78	River

Table 3. Some chemical characteristics of the used organic manures

Parameters	Cow	Sheep	Chicken	Vermicompost
pH	7.42	7.31	7.12	7.5
EC (dS/m)	7.8	5.32	4.12	6.21
Total N (%)	1.25	1.57	3.45	1.40
Total P (%)	0.49	0.81	1.12	0.71
Total K (%)	0.65	1.21	1.28	1.41

2.2. The following parameters were recorded

2.2.1. Vegetative characteristics

The growth rate of trunk diameter (GRTD) of trees (20 cm above soil surface), was measured according to the following equation: GRTD = final trunk diameter in September (cm) – initial trunk diameter in March (cm). Shoot growth of 15 new shoots were measured in the end of shoot growth season.

2.2.2. Flowering characteristics

Average number of inflorescences per twig, flowers per inflorescence and perfect flowers per inflorescence were measured at full bloom stage.

2.2.3. Fruit characteristics

Fruit Weight (g), Flesh weight (g), Pit weight (g), Fruit Length (mm), fruit diameter, moisture content and fruit dry matter (Fruit were weighted before and after drying in oven at 70°C) of 40 fruit for each tree were measured.

2.2.4. Yield and oil content

Yield of each tree was measured at maturity stages. Oil content was measured by extraction the oil from the dried fruit with Soxhelt using petroleum ether 60-80°C of boiling point (A.O.A.C., 1995).

2.2.5. Statistical analysis

The obtained data were tabulated and statistically analyzed as randomized complete block design with three replications and the means of results were compared using LSD method at 5 % level.

3. Results and discusion

3.1. Vegetative growth

Data presented in table 4 reveals that all treatments had a significant effect on trunk diameter growth rate in the first and second years ($P \leq 0.05$). The highest growth rate (>37 cm) was recorded from chicken

manure and chicken manure + chemical fertilizers treatments. Applying animal manures with chemical fertilizers improved trunk growth rate in compare to the animal manure alone. Season shoot growth was significantly higher by applying chicken manure and chicken manure + chemical fertilizers in compare to the other treatments in the first year (P≤0.05) (Table 4). The higher vegetative growth occurred under chicken manure + chemical fertilizers. This result suggests that increase in vegetative growth could be attributed to the enhanced mineral nutrient availability to the tree roots.

Table 4. Effects of different organic and chemical fertilizer on the growth parameters of olive cv Zard during two seasons

Treatments	Shoot growth (cm)	Shoot growth (cm)	Trunk diameter growth (cm/year)	Trunk diameter growth (cm/year)
	First year	Second year	First year	Second year
C	29.36^{b}	28.89^{a}	1.023^{d}	1.097^{def}
C+F	28.74^{b}	32.63^{a}	1.167^{cd}	1.247^{cd}
Sh	31.64^{b}	31.81^{a}	1.177^{cd}	1.193^{cde}
Sh+F	30.53^{b}	30.10^{a}	1.313^{bc}	1.267c
Ch	37.75^{a}	33.03^{a}	1.627^{a}	1.667^{b}
Ch+F	37.61^{a}	33.53^{a}	1.753^{a}	1.853^{a}
Co	28.86^{b}	30.00^{a}	1.063^{d}	1.023^{f}
Co+F	28.64^{b}	31.49^{a}	1.037^{d}	1.057ef
V	29.67^{b}	29.36^{a}	1.177^{cd}	1.210^{cde}
V+F	30.48^{b}	32.75^{a}	1.437^{b}	1.520^{b}
LSD at 5%	3.155	5.803	0.1627	0.1534

Different letters in each column indicate a significant difference (p<0.5)
C = cow manure, C+F = Cow manure + chemical fertilizer, Sh = sheep manure, Sh+F = sheep manure + chemical fertilizer, Ch = chicken manure, Ch+F = chicken manure + chemical fertilizer, Co = control (without any fertilizing), F = control (chemical fertilizer), V = vermicompost, V+F = vermicompost + chemical fertilizer.

Organic manure serves as a reservoir of soil water and nutrients. Mineral nutrients will be more available when a mixture of organic manure and chemical fertilizers used in the holes near the root system (Zang *et al.*, 2016). This phenomenon has been observed in chicken manure + chemical fertilizers, vermicompost + chemical fertilizer and sheep manure + chemical fertilizer treatments in compare to the other treatments. Data presented in table 1 reveals that soil is calcareous with pH>7.5. Localized fertilizer placement could be more efficient to enhance vegetative growth in such conditions. Research shows that organic manures stabilize nutrient elements and chelate those (Zang *et al.*, 2016). In such condition, mineral elements quickly could convert to available form for the plant roots (Zaccardelli *et al.*, 2013).

Our results were in accordance with those obtained by Fikry et al. (2020) who report that, chicken manure increased all vegetative growth of Murcott tangerine trees. Also, Helail et al. (2003) obtained the same result on shoot length of Washington navel orange by applying poultry manure. Fayed (2010) found that vegetative growth parameters (growth rate of trunk diameter and new shoots length) were significantly increased by different organic manure sources in the four olive cultivars. The results clearly indicate that growth parameters were increased when chemical and organic manure used together.

3.2. Flowering parameters

Flowering quantity and quality were significantly affected by different treatments (Table 5) (P≤0.05). Number of inflorescences per twig and flower number per inflorescence were significant under different treatments in the second year (Table 5). The highest number of inflorescences per twig was recorded for chicken manure + chemical treatment, followed by vermicompost + chemical fertilizer, sheep manure + chemical fertilizer and cow manure + chemical fertilizer respectively. Also, the higher number of flowers per inflorescence was obtained in treated trees with the cow manure + chemical fertilizer and vermicompost + chemical fertilizer.

Perfect flower percentage was significantly (P≤0.05) influenced by different treatments (Table 6). Sheep manure with or without chemical fertilizer gave the

highest effect on perfect flower in compare to the others (Table 6). Fruit set was increased significantly by application of sheep manure + chemical fertilizer, chicken manure + chemical fertilizer, vermicompost + chemical fertilizer and chicken manure in the first year of treatments application, while it was higher in treated trees with sheep manure + chemical fertilizer, sheep manure and cow manure + chemical fertilizer in the second year (P≤0.05). Flowering parameters were improved combination of manures and chemical fertilizer than individual ones (Tables 5, 6).

Table 5. Effects of different organic and chemical fertilizer on flower parameters of olive cv Zard during two seasons

Treatments	No. of inflorescence / twig	No. of inflorescence / twig	No. of flowers / inflorescence	No. of flowers / inflorescence	perfect flowers / inflorescence %	perfect flowers / inflorescence %
	First year	Second year	First year	Second year	First year	Second year
C	11.96^{a}	13.00^{bcd}	10.56^{a}	11.68^{ab}	20.45^{a}	23.49^{abc}
C+F	11.63^{a}	14.30^{abcd}	10.03^{a}	13.04^{a}	22.55^{a}	26.24^{ab}
Sh	10.33^{a}	12.00^{cd}	10.27^{a}	11.37^{abc}	21.51^{a}	26.5^{ab}
Sh+F	11.77^{a}	15.33^{abc}	9.513^{a}	12.75^{ab}	20.04^{a}	27.71^{a}
Ch	13.16^{a}	15.33^{abc}	9.267^{a}	10.85^{bc}	24.40^{a}	24.77^{abc}
Ch+F	10.85^{a}	18.00^{a}	9.883^{a}	11.82^{ab}	22.58^{a}	24.81^{abc}
Co	11.33^{a}	10.73^{d}	9.400^{a}	9.520^{c}	22.19^{a}	20.67^{c}
Co+F	11.95a	12.67^{bcd}	10.02^{a}	11.55^{ab}	19.97^{a}	22.95^{bc}
V	10.47^{a}	13.17^{bcd}	9.407^{a}	11.14^{abc}	21.69^{a}	23.29^{abc}
V+F	13.33^{a}	16.74^{ab}	9.110^{a}	12.39^{ab}	21.37^{a}	24.05^{abc}
LSD at 5%	2.974	3.781	2.589	1.718	4.357	4.056

Different letters in each column indicate a significant difference (p<0.5)
C = cow manure, C+F = Cow manure + chemical fertilizer, Sh = sheep manure, Sh+F = sheep manure + chemical fertilizer, Ch = chicken manure, Ch+F = chicken manure + chemical fertilizer, Co = control (without any fertilizing), F = control (chemical fertilizer), V = vermicompost, V+F = vermicompost + chemical fertilizer.

Table 6. Effects of different organic and chemical fertilizer on fruit parameters of olive cv Zard during two seasons

Treatments	Fruit Weight (g)	Fruit Weight (g)	Flesh Weight (g)	Flesh Weight (g)	Pit Weight (g)	Pit Weight (g)
	First year	Second year	First year	Second year	First year	Second year
C	3.44^{c}	4.19^{a}	2.56 ^{c}	3.273^{a}	0.89^{abc}	0.9^{a}
C+F	3.78^{abc}	4.29^{a}	2.95^{bc}	3.417^{a}	0.83^{bc}	0.87^{abc}
Sh	3.84^{abc}	4.25^{a}	2.92^{bc}	3.330^{a}	0.92^{a}	0.92^{a}
Sh+F	3.82^{abc}	4.22^{a}	2.96^{bc}	3.327^{a}	0.87^{abc}	0.90^{ab}
Ch	4.02^{ab}	3.60^{b}	3.10^{ab}	2.777^{b}	0.92^{a}	0.83^{bc}
Ch+F	4.24^{a}	3.57^{b}	3.38^{a}	2.777^{b}	0.87^{abc}	0.79^{c}
Co	3.68^{bc}	3.21^{b}	2.78^{bc}	2.373^{c}	0.90^{ab}	0.83^{abc}
Co+F	3.71^{bc}	3.50^{b}	2.85^{bc}	2.687^{bc}	0.86^{abc}	0.81^{bc}
V	4.10^{ab}	4.05^{a}	3.21^{ab}	3.180^{a}	0.89^{abc}	0.87^{abc}
V+F	3.93^{ab}	4.09^{a}	3.12^{ab}	3.297^{a}	0.81^{c}	0.80^{c}
LSD at 5%	0.42	0.38	0.38	0.36	0.076	0.076

Different letters in each column indicate a significant difference (p<0.5)
C = cow manure, C+F = Cow manure + chemical fertilizer, Sh = sheep manure, Sh+F = sheep manure + chemical fertilizer, Ch = chicken manure, Ch+F = chicken manure + chemical fertilizer, Co = control (without any fertilizing), F = control (chemical fertilizer), V = vermicompost, V+F = vermicompost + chemical fertilizer.

Hassan et al. (2015) reported that improvement in flowering by organic fertilization was attributed to stimulation effect of the absorbed nutrients on photosynthesis process which certainly reflected positively on the flowering characteristics. Also, Stark et al. (2008) explained that biodegradation of manure by soil microorganisms lead to slow release of nutrients. Several studies have been reported on

increasing flower quality of olive by using potassium fertilizer (Sarrwy *et al.*, 2010) boron nutrition (Perica *et al.*, 2002) and nitrogen (Fernandez-Escobar *et al.*, 2008).

Fabbri and Benelli (2000) stated that macronutrient minerals influence directly or indirectly the productive stages of olive growth, including flowering and fruit set, through its effects on other physiological processes. A positive response of olive to mineral elements was also reported by another researcher (Ben Rouina *et al.*, 2002; Talaie and Taheri, 2001). Increasing in number of inflorescences/shoot and number of flowers/inflorescences was also reported by Maksoud (2000) in olive by applying different organic manure. Our results were in accordance with their results, as number of inflorescences/shoots was increased by applying manures with chemical fertilizers. Chicken manure was more efficient in this trait. As shown in table 3, richer manure in case of macronutrients was chicken manure, vermicompost, sheep and cow manures respectively. Erel et al. (2008) demonstrated that macronutrient minerals status influences the productive stages of young olive trees. Also, Yermiyahu et al. (2009) stated that flowering intensity and fruit set was affected by availability of the N and P macro elements. In another experiment applying sheep manure in compare to camel and chicken manures increased all flowering parameters (average number of inflorescences/twigs, flowering density, average number of flowers/inflorescences, number of perfect flowers/inflorescence and sex ratio) (Fayad, 2010). In our research perfect flowers/inflorescence and fruit set was increased by applying all mixtures in the second year in compare to the control. Abdel-Nasser and Harash (2001) recommended sheep manure for olive cultivation under arid and semi-arid regions. Our finding showed that combination of manures and chemical fertilizer increase olive flower quantity and quality.

3.3. Fruit parameters

Fruit and flesh weight were significantly (P≤0.05) affected by different treatments (Table 7). The maximum fruit and flesh weight were obtained by applying chicken manure, chicken manure + chemical fertilizers, vermicompost and vermicompost + chemical fertilizer in compare to control in the first year. Treatments of Sheep manure, sheep manure + chemical fertilizer, cow manure, cow manure + chemical fertilizer, vermicompost and vermicompost + chemical fertilizer were more efficient in the second year (Table 7).

Table 7. Effects of different organic and chemical fertilizer on fruit characters and yield of olive cv Zard during two seasons

Treatments	Fruit Length (mm)	Fruit Length (mm)	Frit Yield (kg/tree)	Frit Yield (kg/tree)
	First year	Second year	First year	Second year
C	22.11^{abcd}	21.48^{de}	13.93^{cd}	16.67^{bc}
C+F	22.04^{abcd}	23.49^{a}	13.17^{cd}	25.39^{a}
Sh	22.31^{abcd}	23.50^{a}	17.06^{bc}	25.67^{a}
Sh+F	21.98^{bcd}	23.60^{a}	20.93^{a}	26.06^{a}
Ch	23.15^{ab}	22.28^{cd}	11.12^{d}	16.83^{bc}
Ch+F	23.59^{a}	23.15^{ab}	18.39^{ab}	23.90^{a}
Co	21.18^{d}	21.25^{e}	11.58^{d}	11.28^{e}
Co+F	21.52^{cd}	21.77^{de}	12.46^{d}	12.90^{de}
V	22.39^{abcd}	22.33^{bcd}	12.72^{d}	14.89^{cd}
V+F	22.87^{abc}	22.77^{abc}	16.78^{bc}	19.66^{b}
LSD at 5%	1.408	0.7935	3.602	3.097

Different letters in each column indicate a significant difference (p<0.5)
C = cow manure, C+F = Cow manure + chemical fertilizer, Sh = sheep manure, Sh+F = sheep manure + chemical fertilizer, Ch = chicken manure, Ch+F = chicken manure + chemical fertilizer, Co = control (without any fertilizing), F = control (chemical fertilizer), V = vermicompost, V+F = vermicompost + chemical fertilizer.

Pit weight was significantly (P≤0.05) affected by different treatments (Table 6). The lowest pit weight was recorded by using vermicompost and vermicompost + chemical fertilizer in the first and second seasons and chicken manure + chemical fertilizers in the second season (Table 6).

Fruit length also significantly (P≤0.05) affected by different treatments (Table 7). Among the treatments, chicken manure + chemical and chicken manure improved fruit length more in the first year, while sheep manure + chemical fertilizer, sheep manure and cow manure+ chemical fertilizer were more efficient on fruit length in the second year (Table 7). No significant difference was observed for fruit diameter in different treatments during two seasons (data not shown).

Abd-Alhamid et al. (2015) explained that biofertilizer + 75% chemical fertilizer significantly increased fruit weight, fruit volume, fruit length and fruit diameter of Manzanillo olives in compare to chemical fertilizer, biofertilizer + 50% chemical fertilizer and biofertilizer + 25% chemical fertilizer. Improvement of fruit physical properties of olive trees was also reported by Maksoud (2000), Hegazi et al. (2007), AL-Kahtani and Ahmed (2012) under different organic fertilization. Fayed (2010) stated that olive fruit weight, flesh weight, volume, length and diameter were significantly increased by different organic manures. He found that chicken manure gave the highest level of all physical parameters except L/D ratio followed by sheep, camel manures and control. Our results were in accordance with those obtained by Hegazi et al. (2007) and Fayed (2010) where the chicken manure had the highest effect on fruit parameters.

3.4. Fruit yield

As shown in Table 7 data indicated that fruit yield was significantly (P≤0.05) affected by different treatments in the both years. Sheep manure + chemical fertilizer and chicken manure + chemical fertilizer gave the best results in the first year, while sheep manure + chemical fertilizer, sheep manure, cow manure + chemical fertilizer and chicken manure + chemical fertilizer produced the higher fruit yield in the second year respectively (Table 7).

Studies on olive orchards have shown that fertilizers had an important effect on olive production (Elloumi *et al.,* 2009). Ulger et al. (2004) and Fayed (2010) observed fertilizer effectiveness on fruit set and fruit yield in olive tree. Abou El- Khashab et al. (2005) and Hegazi et al. (2007) reported that organic fertilization maintained adequate mineral contents in the leaves of olive and increase fruit yield**.** Our results were in agreement with Fayed (2010) where sheep manure was the best for olive production.

Sheep manure + chemical fertilizer and chicken manure + chemical fertilizer gave the best results on the yield in the first year. The increase in fruit yield was probably due to the reason of more availability of nutrients by treatments throughout the growing season. This phenomenon was found by sheep manure + chemical fertilizer, sheep manure, cow manure+ chemical fertilizer and chicken manure + chemical fertilizer in the second year. Manures help to keep water and nutrients in the holes and olive tree roots can easily have access to water and nutrient. It can be concluded that combination of chemical fertilizers and organic matters improve soil conditions for root activity of trees in the prepared holes therefore vegetative and reproductive growth will be enhanced. Based on obtained results, digging three holes in root zone area and filled with organic manure and chemical fertilizers will be recommended in calcareous soil to overcome on unsuitable soil conditions.

3.5. Fruit dry matter and moisture content

The fruit dry matter and moisture content (%) were significantly (P≤0.05) affected by treatments during two years (Table 8). Fruit dry matter was higher in the second year in comparison with the first year under combination of manure and chemical fertilizers. The highest percentages of dry matter were recorded by using chicken manure, chicken manure + chemical fertilizer, vermicompost + chemical fertilizer, cow manure+ chemical fertilizer and sheep manure + chemical fertilizer in compare to the control and manure alone. In this case moisture content of fruit showed the opposite manner with the fruit dry matter (Table 8).

El-Sombaty et al. (2012) reported that olive fruit dry matter was different under nutrient fertilization. Also, different fruit moisture content of olive was recorded by AL-Kahtani and Ahmed (2012) under different mixtures of organic fertilizers. Our results show that fruit dry matter has been increased by applying manures with the chemical fertilizers.

3.6. Olive oil

Olive oil in dry matter was significantly affected by treatments in the second year (Table 9). Fruit from trees treated by sheep manure + chemical fertilizer and vermicompost gave the highest percentage of oil based on dry matter, followed by cow manure + chemical

fertilizer, vermicompost + chemical fertilizer, sheep manure and cow manure in the second year, while there weren't any significant differences in the first year. Likewise, oil percentage based on fresh matter was significantly affected by treatments in the two seasons. The highest fruit oil percentage was obtained by chicken manure, chicken manure + chemical fertilizer and vermicompost + chemical fertilizer in comparison with the others in the first year. The combination effect of manure and chemical fertilizer was more efficient on the oil percentage in the second year, so that sheep manure + chemical fertilizer, vermicompost + chemical fertilizer and cow manure+ chemical fertilizer gave the highest effect (Table 9).

Table 8. Effects of different organic and chemical fertilizer on fruit parameters of olive cv Zard during two seasons

Treatments	Fruit Dry Matter (%)	Fruit Dry Matter (%)	Fruit Moisture (%)	Fruit Moisture (%)
	First year	Second year	First year	Second year
C	32.69^{c}	34.73^{d}	67.31^{a}	65.27^{a}
C+F	34.23^{bc}	37.34^{ab}	65.77^{ab}	62.66^{cd}
Sh	35.49^{ab}	35.07^{d}	64.51^{bc}	64.93^{a}
Sh+F	35.29^{ab}	36.93^{abc}	64.71^{bc}	63.07^{bcd}
Ch	33.00^{c}	38.18^{a}	67.00^{a}	61.82^{d}
Ch+F	35.12^{ab}	37.42^{ab}	64.88^{bc}	62.58^{cd}
Co	33.33^{c}	34.84^{d}	66.67^{a}	65.16^{a}
Co+F	35.30^{ab}	35.71^{cd}	64.70^{bc}	64.29^{ab}
V	34.97^{b}	36.14^{bcd}	65.03^{b}	63.86^{abc}
V+F	36.73^{a}	37.54^{ab}	63.27^{c}	62.46^{cd}
LSD at 5%	1.470	1.387	1.470	1.387

Different letters in each column indicate a significant difference ($p<0.5$)
C = cow manure, C+F = Cow manure + chemical fertilizer, Sh = sheep manure, Sh+F = sheep manure + chemical fertilizer, Ch = chicken manure, Ch+F = chicken manure + chemical fertilizer, Co = control (without any fertilizing), F = control (chemical fertilizer), V = vermicompost, V+F = vermicompost + chemical fertilizer.

Table 9. Effects of different organic and chemical fertilizer on oil percentage of olive cv Zard during two seasons

Treatments	Oil % /dry flesh	Oil % /dry flesh	Oil % /fresh flesh	Oil % /fresh flesh
	First year	Second year	First year	Second year
C	41.33^{a}	42.83^{ab}	13.51^{b}	14.89^{bc}
C+F	41.00^{a}	43.43^{ab}	14.05^{ab}	16.22^{a}
Sh	41.83^{a}	43.00^{ab}	14.84^{ab}	15.08^{ab}
Sh+F	41.67^{a}	44.17^{a}	14.70^{ab}	16.31^{a}
Ch	40.83^{a}	41.33^{bc}	15.63^{a}	15.79^{ab}
Ch+F	41.83^{a}	41.00^{bc}	15.65^{a}	15.34^{ab}
Co	40.00^{a}	39.33^{c}	13.32^{b}	13.70^{c}
Co+F	40.67^{a}	41.50^{bc}	14.35^{ab}	14.83^{bc}
V	43.33^{a}	44.33^{a}	15.15^{ab}	16.02^{ab}
V+F	42.17^{a}	43.33^{ab}	15.48^{a}	16.27^{a}
LSD at 5%	3.962	2.343	1.661	1.157

Different letters in each column indicate a significant difference ($p<0.5$)
C = cow manure, C+F = Cow manure + chemical fertilizer, Sh = sheep manure, Sh+F = sheep manure + chemical fertilizer, Ch = chicken manure, Ch+F = chicken manure + chemical fertilizer, Co = control (without any fertilizing), F = control (chemical fertilizer), V = vermicompost, V+F = vermicompost + chemical fertilizer.

The present results were in agreement with those obtained by Fayed (2010) which sheep manure was the superior effect on oil content. Manure and compost not only supply many nutrients for crop production, including macro and micronutrients, but also, they are valuable sources of organic matter. Increasing soil organic matter improves soil structure and drainage, increases the water-holding capacity, provides a source

of slow release nutrients, and enhances growth of earthworms and other beneficial soil organisms. Oil synthesis is a process that influenced by water and nutrients. In this experiment manures helped to keep water and release nutrient, so fruit parameters were positively affected.

4. Conclusion

The suitable method of putting fertilizer to the trees is very importance due to the presence of lime in the soil, much bicarbonate in the irrigation water and little organic matter. Fruit trees are suffering because of incorrect use of broadcasting fertilizers, due to sedentary of most fertilizers, especially phosphate and micronutrients. Deep placement of organic and chemical fertilizers is one of the methods, in which improve availability of water and nutrient to the roots. In this study, localized using of manures with chemical fertilizers made the better media for root activity and absorption of water and minerals. The results showed that combination of mineral element with organic manure was more efficient than manure alone or chemical fertilizing. Chicken (10 kg/tree) manure improved vegetative and reproductive traits in the first year. Therefore, farmers may consider using annually chicken manure as a fertilizer for olive production. Fruit yield was higher with sheep (12 kg/tree) and cow (15 kg/tree) manures especially in combination fertilizers in the second years. This combination leads to increased storage of water and nutrients in the root zone. Nutrients will be easily available in the holes due to maintenance of water and less contact of minerals to the soil. Thus, quantitative and qualitative performance will be improved. Oil percentage based on dry matter was higher by applying sheep (12 kg/tree) and cow (15 kg/tree) manures and vermicompost (12 kg/tree) with or without mineral fertilizes. Oil synthesis was higher in mentioned treatments. It is probably because of adequate water and nutrients held in the holes. Finally, present results revealed that localized application of chicken and others organic manures have significant effect on olive production in calcareous soil.

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