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Impact of Different Mulching Materials on Vegitative Growth and Productivity of Some Olive Cultivars Grown in Siwa Oasis

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ABSTRACT

To assess the effectiveness of mulching on the growth and yield of three olive cvs., (Aggizy shami, Kalamata and Picual) and its influence in preserving the soil moisture, a field experiment was conducted during the two growing seasons of 2015 and 2016 in Siwa oasis. Three mulching materials i.e., shale, olive pomace and palm leaves were used and compared with control (non-mulced). In regard to the varieties fruit production, Aggizy shami showed a higher yield in both seasons as compared to Kalamata and Picual. Olive pomace and shale were the most efficient mulching materials in increasing the fruit yield. and the highest increase was found in Kalamata (232% of the control in the first season) when shaleused as a mulching material. Olive pomace was more effective in the second season and caused an increase in the fruit yield of all the tested cv, and the highest increase (70.23 % more than control) was noticed in Aggaizy shami cv. . Results revealed also that Picual cv. was more resistance to water stress as compared with the other cvs, under mulching treatments, however all inltivase were highly affected by the water stress un mulched tacatment .It can be concluded that mulching is an effective way to improve the growth and yield of olive under sandy soil conditions.

Keywords. Olive Varity - mulching material- vegetative growth -yield.

INTRODUCTION

Siwa Oasis is adistrict of matrouh governamente, Egypt. located at thefor sathera west the government. The Oasis is a part of northern edge of the Great Sand Sea. It is a great natural depression that has an altitude of 23m below sea level. It encompasses an area of about 250,000 Feddans, from which is about 30,150 Feddans are currently cultivated with different types of crops. Soil erosion in Siwa oasis has been noticed as one of the major threats to the sustainability of olive orchards. Qattara Depression and Siwa Oasis involve at least 10,000 km^2 covered by sand dunes. Sand dunes is one of the major problems which seriously affect the agricultural activities as well as the growth and the development of the crops (Misak and Draz 1997). Sand dunes which represents 16.5 % of the total area of Egypt is one of the most important obstacles for the agricultural expansion in the country.

Olive is one of the important orchard crops in Egypt, it is more adaptable to the marginal environments as compared to the other fruits. Moreover, this tree could be implanted easily in unsuitable environments due to its capability to grow under stress conditions (Sansoucy, 1984). The low production of olives in sandy soils is generally attributed to the poor soil fertility and low water holding capacity(Karmeli and Keller, 1975) which need to be improved for better plant growth and yield.

Morphologically, sand dunes are subdivided into different land elements such as sand seas (ergs), isolated dunes and dune fields and sandy plains .Several techniques e.g., mulching materials, soil conditioners could be applied to reclaim the sandy dunes slopes. These techniques help in protecting the sandy soils from losing water and increasing the soil fertility. Mulching technique in such areas can be used to control erosion, which is defined as the process of covering the soil surface around the plants with an organic or synthetic material to create an optimum growth conditions for the plant, development, and efficient production. In other mean, Mulch is recognized as any material applied to the soil surface to inhibit the growth of different weeds and conserves the soil moisture and temperature. There are a lot of materials that have been used as mulch, e.g., plastic film, crop residue, straw, paper pellets, gravel-sand, rock fragment, volcanic ash, poultry and live-stock litters, city rubbish, fresh grass, ……etc, (Berglund *et al*. 2006; Yang *et al*. 2006; Fang *et al*. 2007; Blanco-Garcıa *et al*. 2008). However, gravel showed to be more effective to achieve these two purposes (El-Taweel and Farag, 2015; and Pakdel, *et al* 2013).

Raskar and Bhoi 2003 and Saikia *et al*., 2014 demonstrated that the practice of mulching is widely used as a management tool in many parts of the world. It alleviates the negative influence of unsuitable environmental factors on soil by increasing soil temperature through controlling diurnal/seasonal fluctuations in soil temperature. Plastic or straw mulch may effectively improve the microclimate and growth conditions by inducing plant transpiration at the expense of evaporation from the soil. Through a study of the impact of mulching on yield of peanut under sandy soil condition, El- Gammal *et al*., (2015) reported that in olive orchard, straw mulching (wheat or paddy) produced more pod and haulm than polythene mulching (black or transparent) and no mulch treatment. They added that, using straw mulching was contributed to favorable soil water and soil temperature, earlier seedling emergences, more flower and mature pods numbers, lower bulk density and less weeds. In other studies carried out by Yohannes 1999 and Tiquia *et al*. 2002, they suggested that the potential of mulch has been exerting a profound improvement in soil structure, increase organic matter, and establish patterns of nutrient cycling.

Stem water potential has been considered the best indicator for plant water status even in low water stress level (Moriana *et al*., 2012).The water potential of -1.4 to -2 MPa is identified as a moderate stress condition in olive fields (Giron *et al*. 2015), they also reported that the low fruit load in their experiment is likely due to water stress. Depending on the previous studies, such values of water potential are too high for deficit irrigation in olive trees. No clear reduction of fruit yield has been reported with values around−3.5 MPa during pit hardening (Moriana *et al*., 2003; Iniesta *et al*., 2009), though fruit growth has been reduced with values higher than −3.0 MPa (Moriana *et al*., 2013). The treatment of soil mulch has been reduced water evaporation and increased infiltration, resulting in greater soil moisture (Lal, 1995).

The objectives of this study are to study the effectiveness of using different mulching materials in improving the growth and yield of some olive cvs., preserving the suitable soil moisture under sandy soil conditions, and to test the response of different olive varieties to different mulching treatments.

MATERIALS AND METHODS

Description of the study area

The study was conducted at a private olive farm in Khamisa, western Siwa, Matrouh governorate, located at 25º 24' 2.56"E29º 12' 34.5"N. The age of the trees was٥years, and all the applied treatments were implemented during the 2015 growing season, however the measurements were taking at the two growing seasons i.e., 2015 and 2016.

The area has a typical Mediterranean climate with a mean annual precipitation of 8 mm and a hot dry summer with zero precipitation. The daily average temperature is 21.7° C with a maximum daily temperature of 46.2° C in August and a minimum daily temperature of -1.2° C in January. Soil texture is sandy, and ground water is the only available source of irrigation in the area. The used water had a pH of 6.85 and an electrical conductivity of 5 dS m^{-1}. Irrigation was performed through drip irrigation system using two lines per tree with 2 drippers (12 L h^{-1}) per tree.

Treatments and experimental design

The trees were trained according to cup system and spaced 4m x 5m. The system of drip irrigation and routine cultural practices (nutrition, pruning, disease control) were set up. The study was performed using 3 cultivars: Aggizy shami (table olive), Kalamata and Picual (dual purpose; table and oil). The four treatments of soil management mulching were applied as follow: 1) Control (non-mulching), 2) Mulching with shale at 5cm thick, 3) Mulching with olive pomace at 5 cm thick and 4) Mulching with date palm leaves at 5-7 cm thick. The three mulching materials were lied under the trees along the row, with 1m width. The experiment was laid out in a split-plot design with three replications (each replicate has three trees). The four mulching treatments were allocated in the main plots, while the cultivars were assigned in the sub-plots.

Sampling and Measurements

Stem water potential (WSTEM) was monitored at mid-day on leaves previously enclosed in a Scholander-type pressure chamber (SKPM 1400, Sky Instruments, UK) in reflective envelopes to suppress leaf transpiration, allowing leaf water potential to equilibrate with stem water potential at the point of attachment; equilibration periods took 1–2 h. Since the pressure bomb was placed below the canopy, a few seconds were needed before pressurizing the chamber. Growth measurements were taken every month from March to October on each tree to record crown canopy (m^2). The canopy volume (CV) was also calculated according to the equation: $CV = 2/3\ \pi\ r^2H = 2/3\ \pi\ D^2/4H = 0.536 \times (D)^2 \times H$; where H is the tree height, D1 and D2 are transversal diameters and $D = (D1+D2)/2$. as reported by Uresk *et al*. (1977). At the beginning of the two growing season of 2015 and 2016, ten shoots aged one-year, were selected around the canopy of each tree. The final shoot lengths and basal diameters of the different varieties were measured on April, June, August and October for the two growing seasons.

After harvesting, i.e.,the first week of September for Aggezi shami and the first week of November for kalamata and picual in the two growing seasons, the entire production of each tree was weighted to calculate the yield, then ten fruits per tree were used to measure fruit weight, fruit volume. Pulp/stone ratio was also determined.

Statistical analysis

Statistical analyses and analysis of variance were performed using statistix.8Statistical (Analytical Software, Tallahssee FL,USA). Each treatment means were compared using the Least Significant Difference (LSD) at 5%) according to (Steel and Torrie, 1985).

RESULTS AND DISCUSSION

Performance of the olive varieties

Hot and dry climate during olive fruit development has a negative impact on the fruit quality and the number of falling fruits before they reach the full maturity. To better understand the effect of such climate, some physiological parameters were recorded including water stress in plants, and the midday stem water potential. Data in Table 1 show the stem water stress, canopy, shoot growth and fruit volume of the studied olive cvs. Picual was the most drought-resistant variety as compared to the other two cvs(i.e. Kalamata and Aggezi Shami). The stem water stress recorded its maximum value in Aggezi shami (-3.0 MPa in August 2015) and then declined gradually to become -1.8 MPa 2.9, and 2.7 for Picual and Kalamata, respectively in October. Mohamed *et al*., 2017 and Girón *et al*., 2015 indicated that water potential values below -2.0 MPa reduces the fruit growth of olive trees. They also found that decreasing the amount of irrigation water negatively affected the growth and yield of olive trees.

Table 1. The main effects of cultivars on canopy, water stress, shoot growth and fruit volume of olive tree during the seasons of 2015 and 2016

	Canopy volume (m^3)								Water stress (MPa)							
	April		June		August		October		April		June		August		October	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Kalamata	1.6 b	٣.4 b	2.1 a	4.2 b	2.6 a	4.5 b	3.6 a	5.3 b			-2.7 a	-2.7 b	-2.8 a	-2.5 a	-1.8 a	-2.0 a
Aggezi Shami	2.7 ab	5.5a	3.7 a	6.3 a	4.3 a	6.9 a	5.4 a	7.8 a			-2.6 a	-2.9 a	-3.0 a	-2.6 a	-1.8 a	-2.0
Picual	2.8 a	4.5 ab	3.4 a	5.2 ab	3.6 a	5.6 ab	4.9 a	6.5 ab			-2.7 a	-2.9 a	-2.9 a	-2.7 a	1.7 a	-2.2 a
	Shoot Growth (cm)								Fruit volume (cm^3)							
Kalamata	16.3 a	25.2 a	18.3a	25.8 a	21.3 a	27.0 a	24.4 a	27.7 a	1.3 b	1.1 c	2.1 c	2.1 c	2.6 c	2.5 c	2.7 b	2.2 c
Aggezi Shami	16.0 a	23.9 ab	19.7a	25.1 ab	22.4 a	25.8 ab	24.4 a	26.9 ab	1.9 a	2.3 a	4.6a	4.6 a	6.2 a	6.3 a	-	6.6 a
Picual	16.9 a	22.9 b	20.1a	23.6 b	22.8 a	24.4 b	25.5 a	25.2 b	1.4 b	1.7 b	3.1 b	3.2 b	3.9 b	4.0 b	3.8 a	3.9 b

Values followed by the same letter(s), within a comparable group of means of any main effect, do not significantly different

In the vegetative growth parameters i.e., Canopy volume (m^3) was higher at Aggezi Shami than to the other two cvs in all months during the two growing seasons (Table 1).No significant difference was recorded among the studied varieties in regard to the shoot growth (cm) in the first season .(2015). while, in the second season Kalamata had the highest shoot growth with no significant difference with Aggezi Shami. Similarily, Aggezi shami followed by Picual recorded the highest fruit volume (Table 1).

Fruit size and the three mounts logical characteristics are the most important criteria that affect the quality of the final product of olive fruits (oil and table). Fruit characteristics i.e., total weight, stone weight, pulp weight and the pulp/stone ratio were different in all of the tested varieties (Table 2). In this context, Aggezi Shami has the heaviest fruit weight, stone weight and pulp weight as compared to the other two cvs. Similarly, this variety had the highest pulp/ stone ratio(was about double of that recorded by Kalamata). regarding fruit yield, Aggezi Shami was the highest as compared to Picual and Klamata varieties.

Table 2. The main effects of cultivars on fruit characteristics and fruit yield of olive tree during the seasons of 2015 and 2016.

	Fruit characters								**Fruit yield (kg/Tree)**	
	Fruit weight (g)		**Stone weight (g)**		**Pulp weight (g)**		**pulp Stone Ratio**			
	2015	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Kalamata	3.8 c	3.2 a	0.9 c	0.8 c	2.9 c	2.2 c	3.1 c	3.9 c	0.8 a	0.71 a
Aggezi Shami	8.7 a	8.1 a	1.2 a	1.1 a	7.2 a	6.6 a	5.8 a	7.3 a	3.2 b	10.2 a
Picual	4.9 b	5 b	1.0 b	0.98 b	3.9 b	3.7 b	4.0 b	5.8 b	1.7a	2.1

Values followed by the same letter(s), within a comparable group of means of any main effect, do not significantly different

Effect of mulching materials

Generally, mulching technique reduced the stem water potential over all the examined cultivars, the stem water stress was the highest with palm leaves mulhine and control (Table 3). However, other mulching treatments revealed that using the shale and the pomace as mulching materials were most effective in reducing the soil water loss. Baumhardt and Jones, 2002 and Kar and Singh, 2004 revealed that using the byproducts as a mulching material decreased the soil evaporation and increased the soil water retention. Moreover, Yamanaka *et al*. (2004) noticed a decrease in the evaporated soil water in a gravel mulched soil as compared to bare soil.

Table 3. The main effects of mulching materials on canopy, water stress, shoot growth and fruit volume of olive tree during the seasons of 2015 and 2016.

	Canopy volume (m^3)								**Water stress (MPa)**							
	April		**June**		**August**		**October**		**April**		**June**		**August**		**October**	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Control	1.5 b	2.9b	1.7b	3.6b	2.2b	4.2b	3.1b	5.6a			-2.9a	-3.0a	-3.1a	-2.9a	-1.9 a	-2.3a
Shale	1.8 b	4.6ab	2.8ab	5.5ab	3.3ab	5.9ab	4.5ab	6.7a			-2.2b	-2.7a	-2.7b	-2.2b	-1.5 b	-1.8 c
Waste olive pomace	3.5 a	5.6a	4.5a	6.4a	4.8a	6.7a	6.1a	7.4a			-2.7a	-2.8a	-2.9a	-2.6ab	-1.7ab	-2.1b
Palm leavs	2.6ab	4.6ab	3.2a	5.5ab	3.7ab	5.8ab	4.9ab	6.5a			-2.8a	-2.9a	-٢.9a	-2.7ab	-2.0 a	-2.1 b
	Shoot Growth (cm)								Fruit volume (cm^3)							
Control	13.3b	22.2b	16.5b	24.1bc	18.9b	25.5ab	21.0b	26.6ab	1.5b	1.4b	3.4b	3.4ab	4.6b	4.4a	2.9a	4.4a
Shale	16.4a	25.3a	19.2	25.8ab	23.2a	26.7ab	27.5a	27.7a	2.0a	1.9a	3.9a	3.6a	5.4a	4.5a	3.4a	4.5a
Waste olive pomace	17.6a	26.1a	20.6a	26.6a	23.3a	27.2a	25.3ab	28.1a	1.4b	1.7a	2.9c	3.0b	3.3c	4.1a	3.3a	3.9a
Palm leavs	18.0a	22.2b	21.1a	22.9c	23.2a	23.6b	25.3ab	23.9b	1.3b	1.7a	2.9c	3.2ab	3.6c	4.1a	3.4a	4.1a

Values followed by the same letter(s), within a comparable group of means of any main effect, do not significantly different

Table 3 also showed the impact of different mulching materials on canopy volume, shoot growth and fruit characteristic. The canopy and shoot growth were the maximum when the waste olive pomace was used as a mulching material (Table 3). However, in both seasons, the fruit volume recorded its highest value when the shale was used as a mulching material

In corresponding a fruit characters i.e., fruit weight, stone weight, pulp weight and pulp stone ratio were significantly affected by the mulching materials (Table 4), Using shale as a mulching material produced the highest significant values of the characters except for stone weight in 2015 season and stone/ pulp ratio in 2016 season. However, the fruit yield showed no significant response to the mulching materials

Table 4. The main effects of mulching materials on fruit characters and fruit yield of olive tree during the seasons of 2015 and 2016.

	Fruit characters								**Fruit yield (kg/Tree)**	
	Fruit weight (g)		**Stone weight (g)**		**Pulp weight (g)**		**pulp Stone Ratio**			
	2015	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Control	5.8 ab	5.1 b	1.08 a	0.89 b	4.7 b	3.9 b	4.2 b	5.7 a	2.1 a	3.7 a
Shale	6.1 a	5.8 a	1.0 b	0.98 a	5.1 a	4.4 a	5.0 a	5.6 a	1.92 a	3.7 a
Waste olive pomace	5.6 b	5.4 ab	1.06 ab	1.0 a	4.3 c	4.1 ab	4.0 b	5.4 a	1.97a	6.2 a
Palm leavs	5.7 b	5.4 ab	1.09 a	0.98 a	4.4 bc	4.2 ab	4.0 b	5.4 a	0.7 a	3.3 a

Values followed by the same letter(s), within a comparable group of means of any main effect, do not significantly different

Effect of interaction between olive varieties and mulching materials

Table (5) shows the impact of different mulching materials on the water stress of olive cvs. The results reveal that shale was more effective material in reducing the water stress in all the studied cvs.

Vegetative growth parameters (canopy volume (m^3) and shoot length (cm) were highly affected by adding the mulching materials. Using the olive pomace as a mulching material produced the highest values of the canopy volume for Aggezi shami and picual cvs. However in Kalamata, the canopy volume was the highest when the shale was used as a mulching material. These results are true for both growing seasons i.e., 2015 and 2016 as well as at the three times of measurements in April, June, August and October (Table 6).

Table 5. Effect of interaction between cultivars and mulching materials water stress (MPa) during the seasons of 2015 and 2016

	Water stress (MPa)					
	June		August		October	
Kalamata	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Control	-3.0a	-3.٠ a	-3.1 a	-3.0 a	-2.4 a	-2.5 a
Shale	-2.2c	-2.٥ d	-2.7 ab	-2.1 b	-1.3 a	-1.7 c
Waste olive pomace	-2.6b	-2.٧ cd	-2.9 ab	-2.4 ab	-1.4 a	-2.1 abc
Palm leavs	-3.0a	-2.8 abc	-2.8 ab	-2.5 ab	-2.1 a	-1.9 bc
Aggezi Shami						
Control	-2.9a	-2.8 abc	-3.2 a	-2.7 ab	-1.7 a	-2.1 abc
Shale	-2.2c	-3.٠ a	-2.5 b	-2.3 ab	-1.5 a	-1.7 c
Waste olive pomace	-2.6 b	-2.٩ abc	-3.2 a	-3.0 a	-2.0 a	-2.0 abc
Palm leavs	-2.6b	-3.0 ab	-3.1 a	-2.5 ab	-2.0 a	-2.1 abc
Picual						
Control	-2.7 ab	-3.1 a	-3.1	-3.0 a	-1.5 a	-2.2 ab
Shale	-2.2 c	-2.7 bcd	-3.0	-2.3 ab	-1.7 a	-2.0 abc
Waste olive pomace	-2.9 ab	-2.9 abc	-2.8	-2.5 ab	-1.7 a	-2.2 abc
Palm leavs	-2.9ab	-2.9 ab	-3.0	-3.0 a	-1.9 a	-2.3 ab

Means followed by the same letters are not significantly different according to the least significant difference (LSD) at 0.05 levels

Table 6. Effect of interaction between cultivars and mulching materials on canopy (cm2) during the seasons of 2015 and 2016

Cultivar and treatment	Canopy volume (m^3)							
	April		June		August		October	
Kalamata	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Control	1.3 b	2.4 c	18bc	2.9 d	1.25	3.2 c	2.5 cd	4.4 b
Shale	2.0 ab	4.7 abc	3.0bc	5.5 abcd	3.52	6.0 abc	4.5 bcd	6.5 ab
Waste olive pomace	1.6 b	3.2 bc	2.0bc	4.2 bcd	2.41	4.4 bc	3.3 cd	5.7 ab
Palm leavs	2.0 ab	3.4 bc	1.9	4.3 bcd	2.5	4.5 abc	3.5 bcd	4.7 ab
Aggezi Shami								
Control	2.1 ab	3.9 bc	1.8	4.7 d	2.5	5.8 abc	3.7 bcd	7.7 ab
Shale	1.2 b	5.2 abc	3.4	5.9 abcd	3.82	6.3 abc	5.2 abcd	7.4 ab
Waste olive pomace	3.4 ab	7.6 a	4.8	8.3 a	5.75	8.7 a	7.0 ab	9.0 a
Palm leavs	3.5 ab	5.3 abc	4.6	6.2 abc	5.2	6.7 abc	6.1 abc	7.2 ab
Picual								
Control	1.3 b	2.6 c	1.4	3.3 cd	1.75	3.6 bc	2.5 d	4.6 b
Shale	1.8 b	4.0 bc	2.2	5.0 abcd	2.7	5.5 abc	3.4 bcd	6.1 ab
Waste olive pomace	5.5 a	6.2 ab	6.06	6.7 ab	6.3	7. ab	8.2 a	7.5 ab
Palm leavs	2.7 ab	5.1 abc	3.3	6.0 abcd	3.7	6.4 abc	5.1 abcd	7.8 ab

Means followed by the same letters are not significantly different according to the least significant difference (LSD) at 0.05 levels

In both seasons, using shale and waste olive pomace as mulching materials increased the shoot growth over the control, this increase was almost the double in Kalamata variety when the olive pomace was used (Table 7). From all the aforementioned results, it can be inferred that the used mulching materials increased all the vegetative growth parameters as compared to the non-mulched treatment in all the studied cvs. Similar results were obtained by Moslem *et al*. (2012) who reported that, all organic and non-organic mulching treatments significantly increased the number of leaves of fig trees compared with control. In addition, El-Taweel and Farag 2015 reported that shoot length and number of internodes of pomegranate Wonderful cultivar were significantly influenced by the mulching treatments i.e., rice straw, palm fronds, transparent polyethylene sheets and gravel. They also reported that the highest shoot length and internodes length were recorded with gravel mulched soil during the two seasons and concluded that gravel acts as an activation material which increased shoot length and number of internodes. Same results were obtained by Verma *et al*. (2005), who concluded that mulching improved the distribution of roots and nutrient absorption in the apple trees which resulted in improving the vegetative growth of the tree.

Table (8) shows the impact of using different mulching materials on the fruit volume (cm^3) for all the studied olive cvs under the sand dune condition in the two growing seasons of 2015 and 2016. Olive varieties responded differently to the treatments in regard to the fruit volume i.e., Kalamata had the highest fruit volume when the olive pomace was used, while for Picual, this parameter was the highest when the soil was mulched with shale. Aggezi variety showed a limited response to the mulching as compared to the other varieties.

The interaction between olive varieties and mulching materials was significant for all the fruit characters i.e., fruit weight, stone weight, pulp weight and pulp stone ratio (Table 9). The highest values of these characters were recorded in Aggezi Shami with using the shale as a mulching material. However the control produced the highest stone weight in 2015 and pulp stone ratio in 2016 for the same varieties.

Table 7. Effect of interaction between cultivars and mulching materials on shoot growth (cm) during the seasons of 2015 and 2016

Cultivar and treatment	Shoot Growth (cm)							
	April		June		August		October	
Kalamata	2015	2016	2015	2016	2015	2016	2015	2016
Control	12.9 e	25 ab	13.0 e	27.1 abc	13.8 d	28.8 ab	14.6 d	30.2 ab
Shale	13.5 d	24.2 b	17.3 d	24.8 abc	21.2 bc	24.8 abc	24.5 bc	25.6 abc
Waste olive pomace	19.2 a	28.1 a	22.0 ab	29.5 a	25.4 ab	31 a	28.7 ab	31.1 ab
Palm leavs	18.2 abc	23.3 bc	21.0 abc	24.3 abc	24.9 abc	24.6 abc	29.9 ab	25.1 abc
Aggezi Shami								
Control	13.5 e	20.2 c	18.3 cd	22.3 bc	21.2 bc	22.6 bc	24.1 bc	23.6 bc
Shale	16. bcde	26.4 ab	18.4 bcd	28.5 ab	22.0 abc	29.3 ab	25.9 abc	31.5 a
Waste olive pomace	15.6 cde	26.2 ab	18.6 bcd	26.3 abc	21.4 bc	27.6 abc	21.8 bc	29.8 abc
Palm leavs	19.1 ab	23.4 bc	23.6 a	24.4 abc	24.9 abc	24.6 abc	25.8 abc	25.6 abc
Picual								
Control	14.7 de	23.4 bc	18.4 bcd	24.5 bc	21.8 abc	26.3 abc	24.2 bc	26.9 abc
Shale	18.0 abc	24.3 b	21.8 abc	25.8 abc	26.6 a	27 abc	32.2 a	28.8 abc
Waste olive pomace	18.1 abc	23.8 b	21.4 ab	24.1 abc	23.0 abc	24.2 bc	25.0 abc	24.3 abc
Palm leavs	16.8abcd	20.1 c	19.0 bcd	21.6 c	19.8 c	21.7 c	20.4 bc	22.1 c

Means followed by the same letters are not significantly different according to the least significant difference (LSD) at 0.05 levels

Table 8. Effect of interaction between cultivars and mulching materials on fruit volume (cm3) during the seasons of 2015 and 2016

Cultivar and treatment	Fruit volume (cm^3)							
	June		July		August		September	
Kalamata	2015	2016	2015	2016	2015	2016	2015	2016
Control	1.0 e	1.08 d	2.4 def	2.4 cd	2.8 def	2.6 fg	2.6 d	2.1 e
Shale	1.8 bc	1.04 d	2.0 ef	1.6 d	2.9 def	2.0 g	2.9 cd	1.8 e
Waste olive pomace	1.1 de	1.2 cd	1.8 f	2.2 cd	2.1 f	2.9 efg	2.7 cd	2.4 e
Palm leavs	1.2 de	1.2 cd	2.1 ef	2.2 cd	2.5 ef	2.5 fg	2.5 d	2.4 e
Aggezi Shami								
Control	2.2 ab	2.0 b	5.4 a	4.9 a	7.8 a	7.0 a	-	7.4 a
Shale	2.5 a	2.6 a	6.0 a	5.1 a	8.7 a	6.7 ab	-	7.3 a
Waste olive pomace	1.5 cd	2.1 ab	3.1 cd	4.1 ab	3.5 cd	5.7 bc	-	5.9 b
Palm leavs	1.6 cd	2.1 ab	4.1 b	4.4 ab	4.8 b	5.8 abc	-	5.9 b
Picual								
Control	1.3 cde	1.2 cd	2.4 def	2.8 cd	3.3 cde	3.7 ef	3.2 c	3.6 d
Shale	1.7 c	2.1 ab	3.7 bc	4.1 ab	4.7 b	4.9 cd	3.9 b	4.4 c
Waste olive pomace	1.5 cd	1.2 bc	3.8 bc	2.8 cd	4.1 bc	3.6 ef	3.8 b	3.5 d
Palm leavs	1.1 e	1.8 bc	2.6 de	3.2 bc	4.3 cd	4.0 de	4.4 a	4.1 cd

Means followed by the same letters are not significantly different according to the least significant difference (LSD) at 0.05 levels

Table 9. Effect of interaction between cultivars and mulching materials on fruit characters during the seasons of 2015 and 2016

Cultivar and treatment	Fruit character							
	Fruit weight (g)		Stone weight (g)		Pulp weight (g)		pulp Stone Ratio	
Kalamata	2015	2016	2015	2016	2015	2016	2015	2016
Control	3.8 def	3.2 f	0.94 de	0.8 ef	2.9 fg	2.2 f	3.1 f	4.0 de
Shale	4.0 def	2.8 f	0.93 de	0.7 f	3.09 efg	1.9 f	3.3 ef	4.0 de
Waste olive pomace	3.8 fe	3.6 ef	0.91 e	0.95 cde	2.9 fg	2.4 ef	3.2 f	3.8 e
Palm leavs	3.6 f	3.2 f	0.92 de	0.82 def	2.7 g	2.3 ef	2.7 f	3.97 de
Aggezi Shami								
Control	8.9 ab	7.8 b	1.36 a	0.99 cd	7.5 ab	6.3 b	5.5 b	8.3 a
Shale	9.3 a	9.4 a	1.14 bc	1.2 a	8.2 a	7.6 a	7.2 a	7.3 b
Waste olive pomace	8.3 b	7.4 b	1.24 ab	1.09 bc	6.5 c	5.9 b	5.3 bc	6.8 b
Palm leavs	8.3 b	8.0 b	1.3 ab	1.1 ab	6.6 bc	6.4 b	5.1 bc	6.7 b
Picual								
Control	4.8 cd	4.2 de	0.96 de	0.89 de	3.8 de	3.1 de	4.04 de	4.8 cd
Shale	5.1 c	5.2 c	0.93 de	0.97 cd	4.1 d	3.8 cd	4.6 d	5.6 c
Waste olive pomace	4.7 cde	5.3 c	1.03 cde	0.97 cd	3.7 def	4.1 c	3.6 def	5.6 c
Palm leavs	5.1 c	5.1 cd	1.06 cd	0.95 cde	4.06 d	3.9 cd	3.8 d	5.4 c

Means followed by the same letters are not significantly different according to the least significant difference (LSD) at 0.05 levels

Table (10) show the effect of treatments on tree fruit yield in the two seasons of 2015 and 2016. Generally, shale and olive pomace increased the fruit yield for all the studied cvs in the two seasons. Shale increased the fruit yield of Kalamata and Aggezi by 232 and 78.37%, respectively over the control in the first season. However, olive pomace increased the fruit yield of Picual by 178% over the control in that season. Moreover, in the second season, the treatment of waste olive pomace increased the yield of the three cvs i.e., Kalamata, Aggezi and Picual by 42.80, 70.23 and 65%, respectively over the control. It is quite to clear that the olive pomace was more effective in the second year of application, and this supports the idea that olive waste pomace had a positive effect on increasing the K content of the soil, and usually this effect takes place in the first and second seasons after the application

(Camposeo and Vivaldi 2011). The present results are in line with many previous works by corrted out (Pang *et al*., 2012), (Aly *et al*., 2010), and (Liu *et al*., 2014).

Table 10. Effect of interaction between cultivars and mulching materials on fruit yield (Kg/tree) during the seasons of 2015 and 2016.

Cultivar and treatment	Fruit yield (kg/Tree) 2015	2016
Kalamata		
Control	0.59 b	0.7 c
Shale	1.96 ab	0.3 c
Waste olive pomace	0.67 b	1. 0 c
Palm leavs	0.1 b	0.85 c
Aggezi Shami		
Control	1.85 b	8.4 b
Shale	3.3 a	8.9 b
Waste olive pomace	3.08 a	14.3 a
Palm leavs	1.56 b	9.4 b
Picual		
Control	0.78 b	2.0 c
Shale	0.47 b	2.0 c
Waste olive pomace	2.17 ab	3.3 c
Palm leavs	0.7 b	1.02 c

Means followed by the same letters are not significantly different according to the least significant difference (LSD) at 0.05 level

In general, it can be stated that mulching improved the fruit yield and fruit characteristics of different olive varieties grown under sandy soil condition. These findings support the idea that mulching increases the soil moisture, microbial quantity (Pang *et al*., 2012, El-Taweel and Farag, 2015), enhances the intensive metabolic processes (Pang *et al*., 2012). Other indirect positive effects of mulching include increasing the water use efficiency by increasing the water holding capacity of the soil (Unger, 1974). Also, mulching may improve water use efficiency by preventing the weed seedling growth by inhibiting light penetration of the soil surface (Ossom *et al*. 2001)

CONCLUSION

The results of this study highlighted the positive effects of mulching materials on both soil and plants. Olive pomace and shale improved the vegetative growth, fruit characteristics and yield of all the tested olive varieties. Olive pomace showed its positive effects mainly in the second season, supporting the idea that it enhanced the availability of soil potassium, therefore olive pomace could be considered a suitable mulching material under the condition of samd duns

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تأثير مواد مختلفة من التغطية على نمو النبات وإنتاجية بعض اصناف الزيتون المنزرعة فى واحد سيوه

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لتقييم اثر التغطية في تحسين النمو و المحصول لثلاث اصناف من الزيتون (عجيزي شامي و كلاماتا و البيكوال) وتأثيره في الحفاظ على رطوبة التربة. حيث اجريت تجربة حقلية خلال موسمي النمو ٢٠١٥ و ٢٠١٦ في واحة سيوة.الواقعة في الجنوب الغربي لمحافظة مطروح بجمهورية مصر العربية والتى تتميز بانها مثال لمناطق الكثبان الرملية في اقصي غرب بحر الرمال الاعظم واستخدمت فيها ثلاث مواد للتغطية من مكونات البيئة و هى الطفلة, تفلة الزيتون و جريد النخيل و مقارنتها بمعاملة الكنترول (بدون تغطية). ,وقد اظهرت النتائج ان الصنف العجيزي الشامي اعلى انتاجية مقارنة بالاصناف الاخرى (كلاماتا و البيكوال). الطفلة و تفلة الزيتون كانتا اكثر مواد التغطية تاثيرا في زيادة المحصول وكانت اعلى زيادة في صنف الكلاماتا بنسبة ٢٣٢%عن الكنترول في الموسم الاول باستخدام التغطية بتفلة الزيتون و الطفلة و كانت الانتاجية اعلي في الموسم الثاني و لوحظت اعلي زيادة في صنف العجيزي الشامي بنسبة (٧٠.٢٣%عن الكنترول). و اوضحت الدراسة ايضا ان البيكوال كان اكثر الاصناف مقاومة للاجهاد المائي بالمقارنة مع غيره من الاصناف الاخري تحت معاملات التغطية. الا ان جميع الاصناف تأثرت بشدة بالاجهاد المائى فى حالة عدم استخدام مواد التغطية. ومن هنا يمكن الاستنتاج بأن التغطية هى وسيلة فعالة لتحسين نمو وانتاج الزيتون تحت ظروف الاراضى الرملية.