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Evaluation of Some Olive Cultivars and Their Adaptability to Different Types of Soil Under Wady El-Natroon Conditions

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ABSTRACT

This investigation was carried out through 2013 and 2014 seasons on three olive cultivars (Picual, Manzanillo and Koroneiki) and their adaptability to different types of soil (Sandy, Calcareous, and Silt-Loam) under Wady El-Natroon conditions, El-Behaira Governorate, Egypt. Trees were fifteen years old, planted at 6 x 6 meters apart under drip irrigation system in a private orchard. The aim of the present study was to test the influence of various types of soil on the vegetative growth, flowering, fruiting, yield, physical characteristics of fruits, stones, fruit moisture content (%) and oil content (%) on the studied olive cultivars (Picual, Manzanillo and Koroneiki) to determine the most adapted cultivars for these soil types . The results were, vegetative growth parameters varied according to type of soil and olive cultivars under study, whereas Picual olive trees cultivated in sandy soil recorded the highest values of tree height and trunk cross section, while other vegetative growth parameters [shoot length (cm), No. of internodes/ m, No. of leaves/m and leaf area (cm^2)] gave the best values with sandy soil and other cultivars. On the other hand, Koroneiki olive trees cultivated in sandy soil produced the highest fruit set (%), the heaviest yield/tree (in both seasons of the study), the longest inflorescence (in the second season) and the best perfect flowers percentage (when cultivated in sandy and calcareous soil). As for fruit and stone physical characteristics, was no clear trend has been shown the effect of soil types (especially for stone characteristics), whereas it's effect was less than the factor of cultivars. It is worth mention and in contrary with all the previous results, all cultivars produced their best percentage of oil content when cultivated in silt-loam soil compared with the other studied types of soil and Koroneiki cultivar was the best in oil content percentage. Under the same conditions of the present study, it could be concluded that, sandy soil was the best soil type for the studied olive cultivars (Picual, Manzanillo and Koroneiki) followed by calcareous soil. But, regarding to the oil percentage, we can take advantage of the cultivation of olive oil cultivars in silt-loam soil.

Keywords: Manzanillo, Picual, Koroneiki, types of soil.

INTRODUCTION

Olive (*Olea europaea L.*) is one of the most important crops grown in the Mediterranean region, both in terms of total surface area and its socioeconomic and environmental impact. The introduction of olive cultivars is subjected to different ecological and agro ecosystems resulting in positive or negative mutations under different conditions (Weiying *et al*., 1998).

Olea europaea L. is the only species from this genus adapted to the Mediterranean. (Sanz-Cortez et al., 2001). It is an evergreen tree belongs to the family *Oleaceae*, which is considered moderately tolerant to salinity

Olives and olive oil in the Mediterranean region hold an important position in the human diet, involving consumers from countries traditionally linked to the use of these products and, more recently, consumers from other countries with no such tradition. Studies on the Mediterranean diet, first conducted in the United States of America (Keys, 1980) and subsequently in Europe, have demonstrated the fundamental role of extra-virgin olive oil in the human diet to prevent diseases such as hypertension, heart disease, arteriosclerosis and diabetes. Therefore, there were many researches of evaluation under different circumstances and adaptability (Rallo, 1995; Al-Kadi,1997; Eassa, 2000; Ouazzani *et al*.,2001; Lopez *et al* ., 2004 and Hosseini *et* al.,2004)

Over the last three decades, the Egyptian olive agro sub-sector has seen unprecedented development; the total acreage reached 240,004 feddan in 2013 (according to statistical of the Ministry of Agriculture).

In Egypt, Picual and Manzanillo cultivars are considered double purpose cultivars that are used for table and oli extraction, based on the results of the study of (Ikram Saad El-Din *et* al., 2010), also they recommended to cultivate the following cultivars in Sohag area; Kalamata, Tofahhi, Aggizi Shami, Hamed and Dolce for table olive production, and the cultivars Koroneiki and Croatina for oil production.

Generally, tree growth, leaf measurements, flowering and fruiting in olive cultivars were affected by cultivars and weather conditions (Grigges *et al*., 1975) under California conditions, (Shahein *et al*., 1982) King Maruit condition, (Fouad *et al*., 1992, b; and Hassan, 1996) Giza conditions and (Hussein *et al*.,1999) South Sinai conditions. Also, growth, yield, and quality of a plant species differ with soil types, soil nutrient status, and fertilizer management; and a plant species requires suitable soil for higher yield and better quality (Ohshiro *et al*., 2016). There was a strong interaction with soil type and climate conditions. Also, a relatively high variability within the same soil management and soil type class, indicating farm to farm variability in conditions and history of soil management (Gomez *et al*., 2014). However, the impacts of climate and soil were greater than that of cultivar (Leeuwen *et al*., 2004).

The present study was carried out to evaluate some morphological characteristics, flowering, productivity and fruit characteristics of three olive cultivars (Koroneiki, Manzanillo and Picual) and their adaptability to different types of soil (Sandy, Calcareous, and Silt-Loam) under Wady El-Natroon, El-Behaira Governorate to determine the most promising cultivars for such conditions.

MATERIALS AND METHODS

The present study was conducted during two growing seasons 2013 and 2014 in a private orchard at

Wady El-Natroon, El-Behaira Governorate, Egypt on fifteen years old Koroneiki, Manzanillo and Picual olive trees, propagated by leafy cuttings. Trees were planted at 6 × 6 meters planting distances, and grown in Sandy, Calcareous, and Silt-Loam soils under drip irrigation system.

Trees were free from pathogens and physiological disorders and received the common culture practices concerning pruning, irrigation, fertilization program, and pest control recommended by the Ministry of Agricultural.

Twenty seven uniform trees were chosen in this experiment. Three trees for each cultivar and each soil type during the two mentioned seasons.

General characteristics of the studied soil types

- **Sandy soil :**

Sandy soil contains a high percentage of individual grains of sand of different diameters (2 - 0.05 mm), composed mainly of quartz, more than 85%. This type of soil made up under the hot dry climate conditions and may be exposed to intermitted rainy storms for short periods. It had Undifferentiated Structure and characterized by high permeability, well-aerated, high internal drainage, low in (water holding capacity, surface activity, exchange capacity) and poor in organic matter. Particle Density (1.55-1.8 gm/cm3) which is in relation with the total porosity (32-42%) and it is less than clay soil, specific surface area much less than loam silt soil, field capacity (8-12%), wilting point (4-6%), available water (4-5%) and the filtration speed (2.5-25 cm/hour) 250 times more than clay soil. (Mohamed, 2006)

- **Calcareous soil :**

These lands are located under desert or Mediterranean climate conditions and reach to 650 thousand feddans in Egypt, which are located mainly on the western coastline. Most of reclamation processes tend to these lands because of its response the farming practices and improvement. Calcareous material consists with different forms in different dissolving points such as, [Calcite – Magnesite (10 times like Calcite in dissolving point) – Dolomite (much less than Calcite in dissolving point) – Siderite (iron carbonate) and Attapulgite (responsible in tough crust formation and potassium conversion to non-available forms to plant absorption. This soil characterized by ammonia losses, phosphate conversion to non dissolving form, iron compounds deposition and tough crust surface composition. (Mohamed, 2006)

- **Silt-Loam soil :**

Silt-loam (Tafla) is considered as an Arabian expression that means clayey coherent residues which in, the geology view include silt, loam and clay that could be found mainly near the soil surface at the regions surrounding the Valley and the Delta. It can be also found at wide scale in the Egyptian deserts , the extension of the Upper Egypt from both sides east and west , different parts of Sinai and the Red Sea sedimentary mountains. Regarding to the physical and chemical characteristics of this type of soil, it is not suitable media for plantation directly in many cases because theconsist of high percentage of clay with different properties, stretching, distention, moisture saving, the absence of welding materials (iron oxides, gypsum, calcium carbonate). Also, the high content of sodium chloride in addition, the permeability almost non-existent. (Mohamed, 2006).

The physical and chemical analyses of the experimental soils are presented in Table (1):

Table (1-a). Physical analysis of different soil types .

Soil Type	Depth (cm)	Sand %	Silt %	Loam %	$CaCo_3$
	0-30	91.8	3.2	5.0	5.9
Sand	30-60	86.0	6.5	7.5	5.8
	60-90	97.0	0.5	2.5	2.9
	0-30	25.4	30.0	44.6	5.9
Silt-Loam	30-60	23.4	31.5	45.1	5.8
	60-90	19.1	25.6	55.3	2.9
	0-30	38.5	39.5	21.9	28.2
Calcareous	30-60	38.6	36.6	24.9	28.5
	60-90	23.5	44.6	22.5	29.9

Table (1-b). Chemical analysis of different soil types .

Soil Type	Depth (cm)	OM %	pH	Ec (ds/m)	Anions (mg/L)			Cations (mg/L)			
					HCo_3^-	So_4^{--}	Cl^-	Ca^{++}	Mg^{++}	Na^+	K^+
	0-30	0.28	8.15	10.5	2.1	11.5	90.1	9.9	14.7	76.5	2.6
Sand	30-60	0.24	8.10	11.0	2.3	13.1	92.8	10.6	15.3	79.0	3.3
	60-90	0.14	8.15	12.2	1.1	14.8	109.0	13.8	16.3	91.5	3.3
	0-30	0.67	8.20	6.3	2.0	7.6	52.9	9.7	9.4	41.2	2.2
Silt-Loam	30-60	0.49	8.25	4.1	2.2	5.3	34.0	9.5	10.7	20.0	1.3
	60-90	0.33	8.15	3.9	2.1	5.3	31.9	5.9	6.2	26.2	1.2
	0-30	0.84	8.40	10.8	4.5	27.5	76.9	27.1	23.4	50.9	5.5
Calcareous	30-60	0.49	8.40	9.8	4.9	26.1	66.6	28.3	16.2	51.4	1.9
	60-90	0.27	8.45	6.8	4.2	23.2	40.4	14.4	10.3	39.9	3.2

Analysis of irrigation water is presented in Table (2):

Table (2). Analysis of irrigation water

Cations (mg/L)				Anions (mg/L)			T.S.S. (ppm)	SAR	Ec (ds/m)	pH
K^+	Na^+	Mg^{++}	Ca^{++}	Cl^-	So_4^{--}	HCo_3^-				
0.11	7.27	1.28	2.81	6.21	3.96	1.3	720	5.08	1.125	7.90

(1) Vegetative growth measurements:

- **Tree height (m)**
- **Trunk cross section (cm^2):**

Trunk cross section = 3.1416 $[(P / (2 X 3.1416)]^2$ was calculated by determining the perimeter (P) of the trunk at 30 cm above soil level.

- **Shoots:**

Twenty shoots were randomly labeled on each tree (replicate) to record average shoot length (cm) and average number of internodes per meter and average number of leaves per meter was calculated as follow:

No. of internodes per meter = 100*no. of internodes per shoot/shoot length (cm)

No. of leaves per meter = 100* no. of leaves density / shoot length (cm)

- **Leaf area (cm^2):**

Three full mature leaves per labeled shoots, (50 leaves from each tree), were taken at random in November during the two studied seasons to determine average leaf area (cm^2) according to Shahein et al. (1982), and Hassan (1996).

(2) Flowering and fruiting:

At the flowering period, all developing inflorescences (panicles) on one- year - old shoots were assigned before onset of flowering to record number of inflorescences per meter, inflorescence length (cm), sex expression which was calculated as percentage of perfect flowers to total flowers according to Rallo and fernandez-Escobar (1985) and percentage of fruit set after 21 days from full bloom as follow:

No. of inflorescences per meter = 100*no. of inflorescences per shoot/shoot length

Perfect flowers percentage = 100* No. of perfect flowers / No. of total flowers

Percentage of fruit set = 100* No. of set fruits/No. of total flowers

(3) Yield and fruit characteristics:

At the first week of November 2013 and 2014 seasons 50 fruits from each tree were taken at random to determine the following characters :-

[Fruit length (cm), fruit diameter (cm), fruit weight (gm)] ; [stone length(cm), stone diameter (cm), stone weight (gm)]; flesh weight (gm) and flesh pit ratio.

Fruit moisture content and oil content (%) in dry weight were also determined according to the A.O.A.C.(1998). The yield per tree was recorded by weight of fruits for each cultivar during the two seasons.

Statistical analysis:

All data were tested for treatments effects on analyzed parameters by the analysis of variance (ANOVA). Difference between treatments were compared by Duncan's Multiple Range Test (Duncan, 1955), according to Snedecor and Cochran (1990).

RESULTS AND DISCUSSION

(1) Vegetative growth:

The average values obtained for vegetative growth parameters analyzed under study are shown in Tables (3 to 5).

- **Tree height (m)**

There was a significant increment in tree height as affected by the types of soil in the two studied seasons (Table, 3). The highest significant average of tree height was observed on trees cultivated under the sandy soil conditions (4.81 m) in 2013 season and under sandy and calcareous soils (5.91 & 4.95 m respectively) in 2014 season. While the silt-loam soil has the lowest values (4.128 & 4.297 m) respectively, in the two studied seasons. Slightly significant increment in tree height between the studied cultivars which noticed with Picual cv.(4.839 m) in the first season and Picual and Manzanillo cvs. (5.094 & 4.767 m, respectively) in the second one. The interaction between the soil types and cultivars produced the highest value of tree height which was obtained from Picual trees cultivated in sandy soil (5.367 & 5.717 m), respectively, in the two studied seasons, while the lowest tree height noticed in Manzanillo and Koroneiki trees cultivated in the silt-loam soil.

- **Trunk cross section (cm^2)**

Cultivars affected significantly in trunk cross section of tree which was observed in the highest values in sandy soil (502.8 and 530.1 cm^2) and with Picual cv. (598.2 and 627.5 cm^2), respectively, in the two studied seasons (Table, 3). While, the lowest values were obtained in the silt-loam soil (282.9 and 296.2 cm^2) and from Manzanillo cv. (228.9 and 260.4 cm^2), respectively, in the two seasons of study. The interaction between soil types and cultivars presented the highest values of trunk cross section of tree which were obtained from Picual trees cultivated in sandy soil (728.7 and 767.5 cm^2), while the lowest values were noticed in Manzanillo trees cultivated in the silt-loam soil (137.6 and 164.7 cm^2), respectively, in the two studied seasons.

Table (3): Effect of different on tree height (m) and trunk cross section (cm) of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	Tree height (m)								Trunk cross section (cm)							
	2013															
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean		Picual		Manzanillo		Koroneiki		Mean	
Sandy	5.367	a	4.600	c	4.463	d	4.810	A	728.7	a	367.8	e	411.9	d	502.8	A
Calcareous	4.850	b	4.383	de	4.313	e	4.516	B	582.8	b	181.4	g	404.7	d	389.6	B
silt-loam	4.300	e	4.033	f	4.050	f	4.128	C	483.1	c	137.6	h	227.9	f	282.9	C
Mean	4.839	A	4.339	B	4.276	B			598.2	A	228.9	C	348.2	B		
	2014															
Sandy	5.717	a	5.033	b	4.523	c	5.091	A	767.5	a	391.2	f	431.5	d	530.1	A
Calcareous	5.067	b	5.100	b	4.683	c	4.950	A	621.9	b	225.3	h	422.7	e	423.3	B
silt-loam	4.500	c	4.167	d	4.223	d	4.297	B	493.2	c	164.7	i	230.6	g	296.2	C
Mean	5.094	A	4.767	AB	4.477	B			627.5	A	260.4	C	391.6	B		

- **Shoot length (cm)**

Shoot length was affected significantly by the different types of soil (Table, 4), where the highest values were recorded with trees cultivated in sandy soil (32.69 and 33.10 cm), respectively in 2013 and 2014 seasons. Also, there was a significant effect of cultivar in the second season, which produced the highest value by Manzanillo trees (31.73 cm). However, the cultivars didn't affect significantly in the first year of the study. The highest values of shoot length which presented by the interaction between soil types and cultivars was achieved by Manzanillo trees cultivated in sandy soil (35.00 and 39.67 cm) respectively in the two studied seasons.

Table (4): Effect of different on shoot length (cm) and number of internodes/meter of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	Shoot length (cm)								No. of internodes /meter							
	2013															
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean		Picual		Manzanillo		Koroneiki		Mean	
Sandy	33.40	b	35.00	a	29.67	d	32.69	A	11.67	e	18.33	a	18.67	a	16.22	A
Calcareous	29.92	d	28.33	e	31.80	c	30.02	B	9.00	f	17.33	b	17.33	b	14.56	B
silt-loam	22.53	h	23.52	g	26.57	f	24.21	C	6.66	g	14.67	d	15.33	c	12.22	C
Mean	28.62	A	28.95	A	29.34	A			9.111	B	16.78	A	17.11	A		
	2014															
Sandy	29.63	c	39.67	a	30.00	c	33.10	A	12.00	d	19.87	a	19.33	a	17.00	A
Calcareous	27.82	d	31.33	b	32.00	b	30.38	B	8.333	e	17.67	b	18.33	b	14.78	B
silt-loam	24.10	f	24.20	f	25.97	e	24.76	C	7.667	e	15.00	c	15.00	c	12.56	C
Mean	27.18	C	31.73	A	29.32	B			9.333	B	17.44	A	17.56	A		

- **Number of internodes /meter**

There was a significant increment in no. of internodes/meter which was affected by the types of soil in the two studied seasons (Table, 4). The highest significant averages were observed on trees cultivated under the sandy soil conditions (16.22 and 17.00) in 2013 and 2014 seasons, respectively. While, the silt-loam soil has the lowest values (12.22 and 12.56) respectively, in the two studied seasons. Slightly significant decrement in no. of internodes/meter between the studied cultivars which noticed with picual cv. (9.111 and 9.333) respectively, in the two studied seasons. The interaction between the and cultivars showed the highest values of tree height which were realized from Manzanillo cv. (18.33 and 19.87) and Koroneiki cv. (18.67 and 19.33) cultivated in sandy soil, respectively, in 2013 and 2014 seasons.

- **Number of leaves/meter**

Significant effect in no. of leaves/meter was observed by trees cultivated in different types of soil where it was presented by sandy soil which showed the highest value (28.00 and 30.22), respectively, in the two studied seasons (Table, 5),. Also, cultivars have slightly significant effect in the first season with Koroneiki and Picual cvs. which produced the highest values (27.00 and 25.78), respectively. However, there is no significant effect between the studied cultivars in the second seasons of the study. The interaction between type of soils and cultivars recorded the highest values with Manzanillo and Koroneiki cultivated in sandy soil in the first year and Picual trees cultivated in sandy soil in the second year of the study.

- **Leaf surface area (cm^2)**

The highest value of leaf surface area was noticed significantly in trees cultivated in sandy soil in both seasons year (Table, 5). However, Picual cv. produced the highest leaf area in 2013 and 2014 seasons. Regarding to the interaction between types of soil and cultivars, Picual trees cultivated in sandy soil gave the highest leaf area value in the second season. While, it was the best in sandy and calcareous soils (4.400 & 4.233 cm^2, respectively) in the first season of the study.

The obtained results are in line with the findings of Ikram Saad El-Din, *et al*., (2010) El.Sayed *et al*. (2006) and Hussein (1994) who reported that Koroneiki and Manzanillo cvs. had the lowest leaf area

Table (5): Effect of different on number of leaves/meter and leaf area (cm^2) of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	No. of leaves/m								Leaf area (cm^2)							
	2013															
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean		Picual		Manzanillo		Koroneiki		Mean	
Sandy	27.33	b	28.33	a	28.33	a	28.00	A	4.400	a	3.067	cd	3.200	c	3.556	A
Calcareous	26.33	c	23.00	e	27.33	b	25.56	B	4.233	a	2.833	de	2.767	e	3.278	AB
silt-loam	23.67	e	23.33	e	25.33	d	24.11	C	3.500	b	2.567	e	2.600	e	2.889	B
Mean	25.78	AB	24.89	B	27.00	A			4.044	A	2.822	B	2.856	B		
	2014															
Sandy	31.67	a	30.33	b	28.67	c	30.22	A	3.933	a	3.300	cd	3.233	d	3.489	A
Calcareous	28.67	c	27.33	d	28.33	c	28.11	B	3.767	b	2.733	e	2.833	e	3.111	B
silt-loam	24.67	e	23.33	f	25.00	e	24.33	C	3.400	c	2.467	f	2.567	f	2.811	C
Mean	28.33	A	27.00	A	27.33	A			3.700	A	2.833	B	2.878	B		

(2) Flowering and Fruiting:

The average values obtained for flowering and fruiting parameters analyzed under study are shown in Tables (6 and 7).

- **Number of inflorescences /meter**

There was a significant increment in no. of inflorescences/meter as affected by the types of soil in the two studied seasons (Table, 6). The highest significant averages were observed on trees cultivated under the sandy soil conditions (38.11 &43.89) in 2013 &2014 seasons, respectively, while the silt-loam soil has the lowest values. Different effect was observed significantly between cultivars in the two studied seasons, whereas Manzanillo cv. gave the highest no. of inflorescences (38.33) in 2013 season, while it was achieved by Koroneiki cv. (45.22) in 2014 season. The interaction between the and cultivars presented the highest value of no. of inflorescences by Manzanillo trees cultivated in sandy soil (44.67) in 2013 season and Koroneiki trees in the same soil (53.33) in 2014 season.

- **Length of inflorescence (cm)**

Slightly significant was observed by different types of soil, the highest significant averages were presented by trees cultivated in sandy soil (Table, 6). However, cultivars didn't give any significant effect on length of inflorescences in the two studied seasons. In the second season, the highest value which presented by the interaction between and cultivars was produced by Koroneiki trees cultivated in sandy soil (3.267 cm).

Table (6): Effect of different on number of inflorescences/meter and length of inflorescences (cm) of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	No. of inflorescences /m								Length of inflorescence (cm)							
	2013															
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean		Picual		Manzanillo		Koroneiki		Mean	
Sandy	31.33	e	44.67	a	38.33	b	38.11	A	2.783	bc	3.000	ab	3.300	a	3.028	A
Calcareous	21.33	f	36.33	c	32.67	de	32.11	B	2.333	d	2.650	cd	3.200	a	2.728	AB
silt-loam	21.33	g	34.00	d	27.67	f	27.67	C	2.433	d	2.400	d	2.567	cd	2.467	B
Mean	26.67	C	38.33	A	32.89	B			2.517	A	2.683	A	3.022	A		
	2014															
Sandy	44.33	b	34.00	d	53.33	a	43.89	A	2.867	b	2.900	b	3.267	a	3.011	A
Calcareous	36.00	d	29.67	e	43.67	b	36.44	B	2.833	b	2.533	c	1.900	e	2.422	B
silt-loam	21.33	f	28.00	ef	38.67	c	31.33	C	1.867	e	2.167	d	2.833	b	2.289	B
Mean	35.89	B	30.56	C	45.22	A			2.522	A	2.533	A	2.667	A		

- **Percentage of perfect flowers and fruit set**

The lowest values of perfect flowers% and fruit set% were produced significantly by trees cultivated in silt-loam soil in both seasons of the study (Table, 7). However, significant differences were obvious in cultivars rather for Koroneiki trees resulted in significantly higher percentage of perfect flowers and fruit set (31.22 &40.78 % and 23.89 &37.67%, respectively) in 2013 & 2014 seasons compared to Manzanillo and Picual cvs. in a descending order. Regarding to the interaction between types of soil and cultivars, Koroneiki trees cultivated in sandy and calcareous soils gave the highest perfect flowers % in 2013 season. While, it gave the highest fruit set % when cultivated in sandy soil in both seasons of study.

These results are in agreement with El-Sayed M. E. et al., (2006), who found that Koroneiki gave the highest percentage of perfect flowers and Hartmann et al., (1980) who reported that, the relative proportion of perfect flowers and staminate flowers varies with cultivars and with the particular year according to cultural practices. Also, Ikram Saad El-Din, *et al., (2010),* who reported that, fruit set was significantly higher in Koroneiki cv.

Table (7): Effect of different on percentage of perfect flowers of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	Perfect flowers (%)							Fruit set (%)						
	2013													
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean	Picual		Manzanillo		Koroneiki		Mean
Sandy	12.33	f	29.27	c	34.33	a	25.31 A	12.43	e	20.97	c	25.67	a	19.69 A
Calcareous	11.33	g	31.33	b	34.67	a	25.78 A	12.68	e	17.44	d	24.67	b	18.26 A
silt-loam	10.67	g	18.67	e	24.67	d	18.00 B	9.752	f	10.03	f	21.33	c	13.71 B
Mean	11.44	C	26.42	B	31.22	A		11.62	C	16.15	B	23.89	A	
	2014													
Sandy	27.95	e	38.60	c	41.33	b	35.96 A	21.42	e	17.24	f	45.00	a	27.89 A
Calcareous	20.67	f	40.33	b	47.33	a	36.11 A	17.67	f	27.31	d	37.33	b	27.44 A
silt-loam	19.33	f	28.33	e	33.67	d	27.11 B	12.75	g	31.33	c	30.67	c	24.92 B
Mean	22.65	C	35.76	B	40.78	A		17.28	C	25.29	B	37.67	A	

(3) Yield and Fruit characteristics:

The average values obtained for physical parameters analyzed in fruits under study are shown in Tables (8 to 13).

- **Yield/tree (Kg.)**

There was a significant increment in yield/tree which was affected by the types of soil in the two studied seasons (Table, 8). The highest significant average was noticed on trees cultivated under the sandy soil conditions (16.06 and 24.89 kg). However, the silt-loam soil has the lowest value (8.951 and 14.07 kg) in 2013 and 2014 seasons respectively. Also, cultivars affected significantly with Koroneiki cv. which produced the highest value of yield (18.38 & 25.74 kg). While, Picual trees have the lowest one (8.208 & 12.08 kg) respectively, in the two studied seasons. The interaction between soil types and cultivars showed the highest value of yield /tree which was realized from Koroneiki trees cultivated in sandy soil (33.33 kg) in 2014 season.

Table (8): Effect of different on percentage of fruit set and yield/tree (kg) of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	Yield/tree (Kg)							
	2013							
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean	
Sandy	10.50	e	15.67	b	22.00	a	16.06	A
Calcareous	7.723	g	13.00	c	21.47	a	14.06	B
silt-loam	6.400	h	8.787	f	11.67	d	8.951	C
Mean	8.208	C	12.48	B	18.38	A		
	2014							
Sandy	15.00	e	26.33	b	33.33	a	24.89	A
Calcareous	10.90	g	18.33	d	25.23	c	18.16	B
silt-loam	10.33	g	13.20	f	18.67	d	14.07	C
Mean	12.08	C	19.29	B	25.74	A		

- **Fruit length and width (cm)**

Slightly significant differences were observed in fruit length and width (Table, 9). Trees cultivated in sandy and Calcareous soils gave the highest values of fruit length in 2013 season and fruit width in both seasons of the study. However, Picual cv. gave significantly highest average of fruit length (2.823 & 2.833 cm) and width (2.249 & 2.286 cm) respectively, in 2013 & 2014 seasons. As a result of interaction between soil types and cultivars, Picual cv. cultivated in sandy soil gave the highest fruit length (2.893 &2.910 cm) and the highest fruit width when it was cultivated in calcareous soil (2.327 cm) in both seasons of the study.

- **Stone length and width (cm)**

Slightly significant effect had observed between stone lengths of trees cultivated in different types of soil (Table, 10), where silt-loam soil gave the highest values in the two studied seasons. While, no differences between soils were observed in stone width. On the other hand, Picual trees gave the highest values of stone length (1.812 & 1.832 cm) and width (1.040&1.063 cm) in 2013 & 2014 seasons, respectively.

Table (9): Effect of different types of soil on fruit length and width (cm) of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	Fruit length (cm)								Fruit width (cm)							
	2013															
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean		Picual		Manzanillo		Koroneiki		Mean	
Sandy	2.893	a	2.633	d	1.920	e	2.482	A	2.280	b	2.243	c	1.237	f	1.920	A
Calcareous	2.833	b	2.590	d	1.813	f	2.412	AB	2.327	a	2.230	c	1.160	g	1.906	A
silt-loam	2.743	c	2.730	c	1.673	g	2.382	B	2.140	d	2.037	e	1.207	f	1.794	B
Mean	2.823	A	2.651	B	1.802	C			2.249	A	2.170	B	1.201	C		
	2014															
Sandy	2.910	a	2.637	d	1.927	f	2.491	A	2.290	b	2.177	d	1.260	f	1.909	A
Calcareous	2.843	b	2.587	e	1.820	g	2.417	B	2.327	a	2.193	d	1.187	g	1.902	A
silt-loam	2.747	c	2.737	c	1.747	h	2.410	B	2.240	c	2.010	e	1.213	g	1.821	B
Mean	2.833	A	2.653	B	1.831	C			2.286	A	2.127	B	1.220	C		

Table (10): Effect of different on stone length and width (cm) of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	Stone length (cm)								Stone width (cm)							
	2013															
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean		Picual		Manzanillo		Koroneiki		Mean	
Sandy	1.760	b	1.580	e	1.583	e	1.641	B	1.063	a	0.9500	c	0.7133	e	0.9089	A
Calcareous	1.720	c	1.617	d	1.517	f	1.618	B	0.9833	b	0.9567	bc	0.7100	e	0.8835	A
silt-loam	1.957	a	1.580	e	1.567	e	1.701	A	1.073	a	0.9167	d	0.6700	f	0.8867	A
Mean	1.812	A	1.592	B	1.556	B			1.040	A	0.9411	B	0.6978	C		
	2014															
Sandy	1.777	b	1.500	f	1.637	d	1.638	B	1.077	a	0.9267	cd	0.7367	e	0.9133	A
Calcareous	1.743	c	1.610	de	1.527	f	1.627	B	1.017	b	0.8967	d	0.7167	ef	0.8767	A
silt-loam	1.977	a	1.587	e	1.287	e	1.717	A	1.097	a	0.9567	c	0.6933	f	0.9156	A
Mean	1.832	A	1.566	B	1.583	B			1.063	A	0.9267	B	0.7156	C		

- **Fruit and Stone weight (gm)**

There were no significant differences between in fruit weight during 2014 season and stone weight during both seasons of the study (Table, 11). While Picual cv. gave the highest values in those parameters (fruit & stone weight) and Koroneiki gave the lowest ones in the two studied seasons.

Table (11): Effect of different types of soil on fruit and stone weight (gm) of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	Fruit weight (gm)								Stone weight (gm)							
	2013															
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean		Picual		Manzanillo		Koroneiki		Mean	
Sandy	8.370	a	6.333	c	1.657	d	5.453	A	1.560	b	1.217	c	0.7367	d	1.171	A
Calcareous	6.877	b	6.367	c	1.350	e	4.864	B	1.690	a	1.243	c	0.4200	f	1.118	A
silt-loam	6.817	b	6.300	c	1.327	e	4.814	B	1.633	ab	1.157	c	0.5733	e	1.121	A
Mean	7.354	A	6.333	B	1.444	C			1.628	A	1.206	B	0.5767	C		
	2014															
Sandy	6.600	a	6.000	c	1.527	d	4.709	A	1.553	b	1.013	e	0.7267	f	1.098	A
Calcareous	6.067	c	6.100	bc	1.333	e	4.500	A	1.707	a	1.233	c	0.4067	h	1.116	A
silt-loam	6.003	c	6.233	b	1.310	e	4.516	A	1.583	b	1.130	d	0.5800	g	1.098	A
Mean	6.225	A	6.111	A	1.390	B			1.614	A	1.126	B	0.5711	C		

- **Flesh weight (gm) and Flesh/pit ratio**

Types of soil had no significant differences were observed in flesh weight during the second season of the study or in flesh/pit ratio during the both seasons (Table, 12). However, Manzanillo gave the best flesh/pit ratio (4.305 & 4.464) respectively, in 2013&2014 seasons, and the highest flesh weight with Picual cv. in the 2014 season. While, Koroneiki cv. gave the lowest values of those physical characteristics in both seasons of the study.

Table (12): Effect of different on flesh weight (gm) and flesh/pit ratio of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	Flesh weight (gm)								Flesh/pit ratio							
	2013															
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean		Picual		Manzanillo		Koroneiki		Mean	
Sandy	6.790	a	5.150	b	0.9200	c	4.287	A	4.366	ab	4.347	ab	1.249	e	3.321	A
Calcareous	5.187	b	5.023	b	0.930	c	3.713	B	3.070	c	4.121	b	2.218	d	3.136	A
silt-loam	5.217	b	5.000	b	0.7533	c	3.657	B	3.243	c	4.448	a	1.314	e	3.002	A
Mean	5.731	A	5.058	B	0.8678	C			3.560	B	4.305	A	1.594	C		
	2014															
Sandy	5.067	a	4.987	a	0.890	c	3.648	A	3.255	d	4.921	a	1.099	h	3.092	A
Calcareous	4.660	b	4.990	a	0.9267	c	3.526	A	2.555	f	3.955	c	2.282	g	2.930	A
silt-loam	4.420	b	5.103	a	0.7300	c	3.418	A	2.792	e	4.516	b	1.259	h	2.856	A
Mean	4.716	A	5.027	A	0.8489	B			2.867	B	4.464	A	1.546	C		

- **Fruit moisture content (%)**

Fruit moisture content was affected significantly by the different types of soil where it was at the highest values with trees cultivated in calcareous soil (67.15 and 61.58 %) respectively in 2013 and 2014 seasons (Table, 13). Also, there was a significant effect with cultivars in the both seasons of the study which produced the highest value by Manzanillo trees (70.94 & 63.60 %) respectively. So, the highest value of fruit moisture content which presented by the interaction between types of soil and cultivars was achieved by Manzanillo trees cultivated in calcareous soil (72.56 and 68.68 %), respectively in 2013 & 2014 seasons.

- **Percentage of oil content**

The best percentage of oil content was observed with trees cultivated in silt-loam soil (32.20 & 31.11 %) respectively, during 2013 & 2014 seasons (Table, 13), which it was in contrary of the previous parameters. However, Koroneiki cv. gave the highest values (40.80 & 37.62 %), respectively, in both seasons compared to Picual and Manzanillo cultivars respectively, in a descending order. Therefore, the interaction between types of soil and cultivars revealed that Koroneiki trees cultivated in silt-loam soil gave the best percentage of oil content (41.80 & 39.33 %), respectively, during 2013 & 2014 seasons.

The present findings are in agreement with those obtained by Ikram Saad El-Din,et al., (2010) who found that, Koroneiki gave the highest yield and oil content percentage in dry weight while it recorded the lowest values of fruit length, width, weight; stone length, width; flesh weight and flesh/stone ratio. On the other hand, Manzanillo recorded the highest percentage of fruit moisture content compared with Picual and Koroneiki. Also, El-Sayed M. E. et al., (2006) reported that, Koroneiki gave the heaviest yield and the highest percentage of oil content compared to Manzanillo and Picual. But, it exhibited the least values of fruit length and width, weight; seed weight and flesh weight and flesh/pit ratio and the lowest percentage of fruit moisture. Similar findings was found by Fouad et al., (1992, b) who mentioned that, moisture content of olive fruits varied considerably in different olive cultivars.

Table (13): Effect of different on the percentage of fruit moisture and oil content of (Picual, Manzanillo and Koroneiki cvs.) during 2013 and 2014 seasons.

Parameter	Fruit moisture content (%)								Oil content (%)							
	2013															
Cvs / Soil	Picual		Manzanillo		Koroneiki		Mean		Picual		Manzanillo		Koroneiki		Mean	
Sandy	62.26	g	68.56	c	58.87	i	63.23	C	29.77	f	22.74	i	41.23	b	31.15	B
Calcareous	65.69	d	72.56	a	63.20	f	67.15	A	31.29	d	23.68	h	39.38	c	31.45	B
silt-loam	63.53	e	71.69	b	60.87	h	65.36	B	30.46	e	24.34	g	41.80	a	32.20	A
Mean	63.38	B	70.94	A	60.98	C			30.51	B	23.50	C	40.80	A		
	2014															
Sandy	54.11	g	60.73	d	54.77	f	56.54	C	28.41	f	21.52	i	36.47	c	28.80	C
Calcareous	63.76	b	68.68	a	52.30	h	61.58	A	29.18	e	22.43	h	37.07	b	29.56	B
silt-loam	56.62	e	61.37	c	56.45	e	58.15	B	29.82	d	24.17	g	39.33	a	31.11	A
Mean	58.16	B	63.60	A	54.51	C			29.13	B	22.71	C	37.62	A		

CONCLUSION

Under the same conditions of the present study, it could be concluded that, sandy soil was the best soil type for the studied olive cultivars (Picual, Manzanillo and Koroneiki) followed by calcareous soil. But regarding to the oil percentage, we can take advantage of the cultivation of olive oil cultivars in silt-loam soil.

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تقييم بعض أصناف الزيتون ومدى تأقلمها لأنواع مختلفة من التربة تحت ظروف وادى النطرون

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اجريت هذه الدراسة خلال موسمى ٢٠١٣ ـ ٢٠١٤ على ثلاثة أصناف من الزيتون (البيكوال ، المنزانيللو ، الكروناكى) ومدى تأقلمهم لانواع التربة المختلفة (الرملية ، الجيرية ، الطفلية) تحت ظروف وادى النطرون بمحافظة البحيرة . وكان عمر الأشجار ١٥ عام مزروعة على مسافات ٦ × ٦ متر تحت نظام الرى بالتنقيط بمزرعة خاصة. وقد أجرى هذا البحث لدراسة تأثير أنواع التربة المختلفة (الرملية ، الجيرية ، الطفلية) على النمو الخضرى والتزهير والاثمار والمحصول وكذلك الصفات الطبيعية للثمار والبذور ومحتواها الرطوبى ونسبة الزيت لاصناف الزيتون محل الدراسة (البيكوال ، المنزانيللو ، الكروناكى) ، وذلك لتحديد أنسبها لهذه الأنواع من التربة . وقد لاحظت النتائج اختلاف القياسات الخضرية تبعا لانواع التربة المختلفة والأصناف محل الدراسة حيث سجل صنف البيكوال المنزرع بالتربة الرملية أعلى القيم فى (طول الشجرة ، وقطر الجذع) بينما باقى قياسات النمو الخضرى (طول الفرع ، عدد السلاميات فى المتر الطولى ، عدد الاوراق فى المتر الطولى ، مساحة الورقة) سجلت أفضل القيم للتربة الرملية مع باقى الأصناف . وعلى صعيد آخر فإن صنف الكروناكى المنزرع بالتربة الرملية أعطى أعلى نسبة اثمار وأغزر محصول للشجرة (خلال موسمى الدراسة) ، وأعطى أطول قياس للنورة (بالموسم الثانى من الدراسة) ، وأفضل نسبة للأزهار الكاملة (عند زراعته فى كل من التربة الرملية والجيرية) . أما بالنسبة الى القياسات الفيزيقية للثمرة والبذرة فلم يكن هناك اتجاه واضح لتأثير عامل اختلاف التربة (خاصة بالقياسات الفيزيقية الخاصة بالبذرة) حيث كان تأثير عامل التربة اقل من تأثير عامل اختلاف الأصناف. ومما هو جدير بالذكر وعلى العكس من كل النتائج السابقة ، فإن كل الأصناف سجلت افضل نسبة زيت لها عند زراعتها بالتربة الطفلية مقارنة بباقى انواع التربة الاخرى محل الدراسة ، وكان صنف الكروناكى أفضل الاصناف فى نسبة الزيت. ويمكن التوصية تحت نفس الظروف لهذه الدراسة أن التربة الرملية كانت أفضل نوع تربة لأصناف الزيتون تحت الدراسة (بيكوال، مانزانيلو، كروناكى) تليها التربة الجيرية. ولكن فيما يتعلق بالنسبة المئوية للزيت، فإنه يمكن الاستفادة من زراعة أصناف زيت الزيتون في التربة الطفلية.