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Determination of Optimum Harvesting Date in Relation to Fruit and Oil Quality of Some Olive Cultivars

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THIS investigation was carried out through 2013 and 2014 seasons on five olive cultivars (Manzanillo, Picual, Coratina, Koroneiki and Arbequina) picked in four dates (each fifteen days) from trees were 12 years old grown in sandy soil, planted at 5x5 meter apart under drip irrigation system in a private orchard located at Cairo/Alexandria desert road. This study has been to determine the optimal harvest time for olive cultivars in which to achieve highest quality of fruits and maximum quantity and quality of oil. The investigating has identified the flowering duration, the changes in physical characteristics of fruits and chemical properties of oil during the different harvesting dates related with the maturity index to calculate the days from full bloom till the optimum harvesting date according to the category of maturity index of each cultivar.

The results observed an increment in length, width, weight of fruit and seed weight from the first to the fourth dates, while no significant difference in seed length, width and flesh/ pit ratio during the two studied seasons. Fruit oil contents were increased and total polyphenols of extracted oil were decreased from the first to fourth harvesting date in all the studying cultivars during the two studied seasons.

As a result, the optimal harvesting date was determined in Manzanillo cultivar after (166 and 170) days, Picual cultivar after (184 and 192) days, Coratina cultivar after (193 and 199) days, Koroneiki cultivar after (216 and 224) days and Arbequina cultivar after (213 and 217) in the two studied seasons respectively, calculated from full bloom.

Keywords: Manzanillo, Picual, Coratina, Koroneiki, Arbequina, Optimum harvesting**.**

Olive tree *(Olea europeae* L.*)* is a species of family (*Oleaceae*) native to the coastal area of Eastern Mediterranean Basin and spread in many world countries. It is considered one of the oldest known cultivated trees in the world, with a great historic importance. It is also considered the symbol of peace. The fruit of olive is of the major agricultural importance in the Mediterranean region as a source of olive oil (Tous and Romero, 1994). Most of olive fruits are utilized as naturally ripe olive in brine or as a source of oil. As a fruit develops some changes occur including length, width, fresh/pit ratio, weight and oil

compositions (Balatsouras *et al.*, 1988 and Preziosi & Tini, 1990). Harvesting has a major role in Extra virgin and virgin olive oil production. By selecting the timing of harvesting the growers determines the quantity and quality of the recent and next season's fruit crop. It's therefore, pertinent that criteria for correct decision about the harvesting date will consider production efficiency and quality style of the produced oil (López-Villalta, 1996 and Ayton *et al.*, 2001).

The major contribute to oil quality is the polyphenol content, this plays a strong role to determines pungency and bitterness of oil (Tovar *et al.*, 2001). Still, only few studies evaluated the simultaneous effect of harvest timing on quality and quantity of olive fruit.

Although some cultivars turned purple-black relatively quickly, but the flesh remained green to pale throughout maturation, so using maturity index helps growers to relate the best timing of harvesting under their own conditions.

The objective of this experimental was to study the changes in some physical and chemical fruit and oil properties during the harvesting dates of Manzanillo, Picual, Coratina, Koroneiki and Arbequina olive cultivars by using Maturity index in order to obtain the optimal harvest time.

Materials and Methods

The present study was carried out during two successive growing seasons 2013 and 2014 on twelve mature trees of five olive cultivars (Manzanillo, Picual, Coratina, Koroneiki and Arbequina). The trees were 12 years old grown in sandy soil and planting distance of 5 x 5 meters a part under drip irrigation system in an orchard located at Cairo- Alexandria road desert. These trees were nearly uniform in their shape and size, disease free and were drip irrigated system using well water. The selected trees received normal fertilization and cultural practices recommended in the orchard.

Soil chemical and physical characteristics and water chemical characteristics were determined by Soil, Water and Environmental Research Institute, Agricultural Research Center, according to the methods as described by Jackson (1973) and were summarized in Tables 1, 2 and 3.

TABLE 1. Chemical characteristics of the tested soil sample collected from the experimental area.

PH 1:2.5	E.C. ds/M (1:5)	Soluble cations (meq/ 100g soil)				Soluble anions (meq/ 100g soil)			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO3^{-}$	$HCO3^{-}$	Cl^{-}	$SO4^{-}$
8	10.50	7.4	4.6	5.00	0.36	-	0.6	7	9.03

TABLE 2. Physical characteristics of the tested soil sample collected from the experimental area.

Coarse sand %	Fine sand %	Silt %	Clay %	Textural class
21.16	50.4	13.2	14.8	Sandy loam

TABLE 3. Chemical characteristics of the tested water sample collected from the experimental area.

PH 2.5:1	E.C. ds/M (1:5)	E.C ppm	Soluble cations (me/L)				Soluble anions (me/ L)				S.A.R
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co_3^{-}	Hco_3^{-}	Cl^{-}	So_4^{-}	
7.68	4.4	2816	10	8	27.1	0.34	-	2.4	32.5	10.6	9.03

The following data were recorded

The duration of flowering period was calculated from start to end of flowering.

Maturity index was determined as follows:

Fruits were picked in four ripening dates according to cultivar (early & late) of harvesting (Table 4).

TABLE 4. Represents harvesting dates of the five cultivars.

Cultivars	Date (1)	Date (2)	Date (3)	Date (4)
Manzanillo	1/9	15/9	1/10	15/10
Picual	1/10	15/10	1/11	15/11
Coratina	1/10	15/10	1/11	15/11
Koroneiki	1/10	15/10	1/11	15/11
Arbequina	1/10	15/10	1/11	15/11

For each cultivar only healthy, free of infection or physical damage fruits were selected, the maturity index was determined on 100 randomly selected olives fruits in each sample to obtain a numerical value for the olive sample appearance.

Olive fruit were cut in half to expose the internal fresh and sorted into categories using the Table 5.

TABLE 5. Categories of colour fruits.

Olive Colour	Score	Number of Olives	Calculation
Deep Green Skin Color	0	N_1	$0 \times N_1$
Yellow or Yellow-Green Skin Color	1	N_2	$1 \times N_2$
Yellow-Green with Less than Half of the Olive with Reddish Spots or Violet Skin Color	2	N_3	$2 \times N_3$
Red to Purple Skin Color on More than Half of the Olive	3	N_4	$3 \times N_4$
Light Purple to Black Skin Color with White Green Flesh Color	4	N_5	$4 \times N_5$
Black Skin Color and Violet Flesh Color Almost to the Pit	5	N_6	$5 \times N_6$
Black Skin Color and Dark Flesh Color all the Way to the Pit	6	N_7	$6 \times N_7$
Maturity Index			**Sum of numbers above /100**

The total number of olives in each category was counted and recorded. The following equation was there applied to determine the maturity index:

$$\text{Maturity index} = \frac{(0\ x\ n1) + (1\ x\ n2) + \cdots (6\ x\ n7)}{100}$$

where (n) is the number of fruits (Boskou, 2006).

Maturity index was calculated beginning with the change in skin color compared with the relatively late. The study carried out from 1st of September in Manzanillo early cv. and 1st of October for other cultivars when the color change began.

A maturity index of 2.5 to 4.5 is usually used for most olive oils (Sibbett and Ferguson, 1994).

Fruit physical characteristics

Fruit weight was determined by using electric balance with 0.01 (g) sensitivity and the samples included (100 fruits) and the average weight of fruit was calculated.

Fruit length (cm.) fruit diameter (cm.) and stones were extracted to determined stone length (cm.), width (cm.), seed weight (g) and flesh/ pit ratio were calculated.

Chemical characteristics

Oil content (%) in dry weight was extracted by soxelt apparatus from the dry fruit samples using petroleum ether (60-80) as a solvent for 16 hours according to method described by (A.O.A.C., 1998).

Total poly-phenol content were isolated using water and methanol (60 to 40 v:v) from oil in hexan solution (10g/23Ml) according to the method described by Baccouri *et al*. (2008).

Statistical analysis

All data were tested for treatments effects on analyzed parameters by the one-way 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 Discussions

In the present study we have studied the relation between harvest date, Maturity index, flowering duration and fruit oil quality in five olive cultivars (Manzanillo, Picual, Coratina, Koroneiki and Arbequina).

Flowering

Data illustrated in Table 6 and Fig.1 showed that blooming started from March 22th and ended at April 27th in the first season, while in the second season started from March 15th and ended at April 19th. Generally, the influence of climate change was clear which led to the early flowering periods about (5 to 9 days) according to cultivars from 2013 to 2014 seasons.

The Flowering period of Manzanillo cv. started from March 25th till April 11th and March 20th till April 7th in the first and second seasons, respectively, Picual started from April 7th till April 19thin the first season and from March 29th till April 14th in the second season, Coratina started from March 27th till April 12thin the first season and from March 21th till April 8thin the second season, Koroneiki started from March 22th till April 9thin the first season and from March 15thtill April 3th in the second season and Arbequina from March 27th till April 9thand from March 22th till April 6th in the first and second season, respectively. The full bloom was between (6 to 11 days) from the beginning of flowering according to cultivar. The Phonological behavior of olive tree is largely influenced by the environmental factors such as temperature Table 7. These findings are in agreement with Sweeney (2005), who found that the flowering differed according to cultivars and differ from one season to another. Moreover, the phonological behavior of olive tree is largely influenced by environmental factors such as temperature (Ikram *et al.,* 2010). In this experiment, we studied the flowering duration calculating the days from full bloom till the suitable harvesting date according the category of maturity index for each cultivar.

TABLE 6. Flowering of some olive cultivars during 2013 and 2014 seasons.

Cultivars	Beginning		Full bloom		End of flowering	
	2013	2014	2013	2014	2013	2014
Manzanillo	25/3	20/3	2/4	29/3	11/4	7/4
Picual	7/4	29/3	14/4	6/4	19/4	14/4
Coratina	27/3	21/3	5/4	30/3	12/4	8/4
Koroneiki	22/3	15/3	2/4	25/3	9/4	3/4
Arbequina	27/3	22/3	2/4	29/3	9/4	6/4

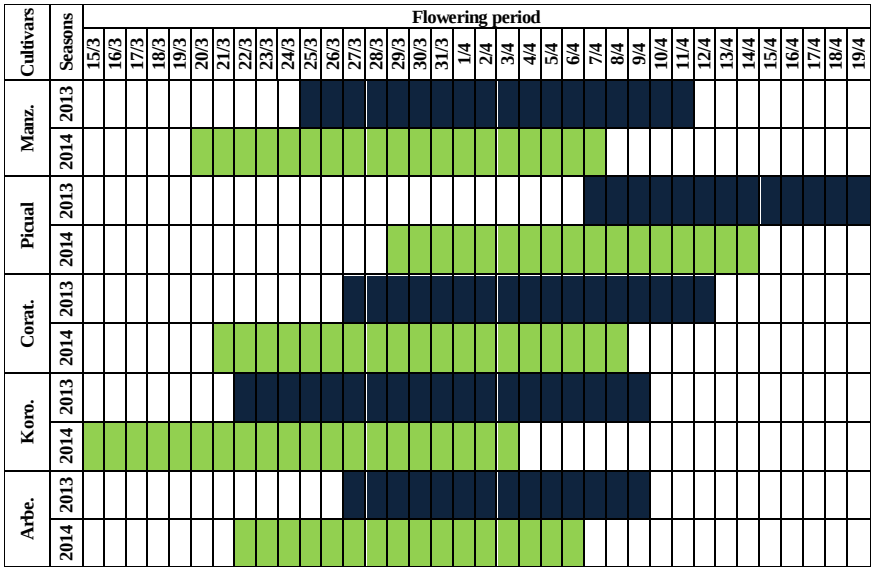

Fig. 1. Flowering periods of some olive cultivars during 2013 and 2014 seasons.

TABLE 7. Average temperatures during 2013 and 2014 seasons.

Months	2013		2014	
	Min.	Max.	Min.	Max.
January	2.5	28.4	1.7	27.5
February	4.1	28.1	4.0	29.5
March	3.6	37.6	15.1	37.5
April	7.3	37.5	9.8	34.3
May	11.6	40.9	13.6	42.3
June	13.1	44.3	15.8	42.4
July	16.0	40.0	24.5	37.5
August	16.0	40.6	18.4	41.2
September	13.7	37.0	15.4	38.0
October	9.2	32.9	9.7	34.3
November	8.1	29.9	8.4	29.3
December	4.0	26.7	3.0	22.9

Maturity Index (MI)

The values of maturity index and harvesting dates for the five cultivars in two studied seasons are shown in Table 8 representing the average maturity index for each cultivar. It was shown that, the fruits of each cultivar were picked beginning of the maturity Index reached to 2.5, Manzanillo cv. beginning to harvest from the middle of September, while, Picual, Coratina and Koroneiki (cvs.) were picked beginning of the middle of October, Moreover, Arbequina cv., was picked beginning of the first of November.

TABLE 8. Maturity Index (MI) of some olive cultivars during 2013 and 2014 seasons.

Cultivars	2013				2014			
	Date 1	Date 2	Date 3	Date 4	Date 1	Date 2	Date 3	Date 4
Manzanillo	2.23	2.50	2.64	3.25	2.30	2.65	2.91	3.50
Picual	1.80	2.66	2.91	3.14	2.25	2.73	3.05	3.35
Coratina	2.40	2.91	3.25	3.50	2.70	2.90	3.45	3.45
Koroneiki	1.80	2.50	2.79	3.25	2.15	2.50	2.83	3.30
Arbequina	1.75	2.11	2.50	3.10	2.20	2.40	2.70	3.00

Maturity Index continues to be used a strong indicator for the optimum time to the harvest. The rate of change of maturity index for each cultivar was considerably differ (Salvador *et al.,* 2001).

A maturity index of 2.5 to 4.5 is usually used for most olive oils. At a maturity of 3.0 to 5.0 olives have reached their maximum oil content. The olives in a grove may reach this maturity index sooner or later in the year depending on weather but olives picked year after year at the same maturity index should produce similarly flavored oil (Sibbett and Ferguson, 1994).

Fruit physical characteristics

The average values obtained for physical parameters analyzed in fruits under study are shown in Tables from 9 to 13.

TABLE 9. Effect of harvesting dates on fruit physical characteristics of Manzanillo during 2013 and 2014 seasons.

Stage	2013													
	Fruit length		Fruit width		Fruit weight		Seed length		Seed width		Seed weight		Flesh/pit ratio	
Date (1)	2.17	c	1.91	b	5.38	c	1.46	b	0.71	b	0.75	c	6.17	a
Date (2)	2.52	b	1.98	b	5.68	b	1.53	a	0.73	a	0.78	bc	6.28	a
Date (3)	2.65	a	2.25	a	6.12	b	1.57	a	0.78	a	0.81	ab	6.56	a
Date (4)	2.66	a	2.25	a	6.26	a	1.58	a	0. 79	a	0.84	a	6.45	a
2014														
Date (1)	2.26	b	2.15	b	5.50	c	1.55	a	0.73	b	0.77	c	6.14	a
Date (2)	2.54	a	2.21	ab	5.84	c	1.58	a	0.74	a	0.86	b	5.79	a
Date (3)	2.68	a	2.23	ab	6.24	b	1.62	a	0.77	a	0.88	ab	6.09	a
Date (4)	2.70	a	2.30	a	6.45	a	1.62	a	0.79	a	0.92	a	6.01	a

TABLE 10. Effect of harvesting dates on fruit physical characteristics of Picual during 2013 and 2014 seasons.

Stage	2013													
	Fruit length		Fruit width		Fruit weight		Seed length		Seed width		Seed weight		Flesh/pit ratio	
Date (1)	2.51	c	2.00	c	6.17	c	1.51	c	0.86	b	0.94	b	5.56	c
Date (2)	2.71	b	2.16	b	7.55	b	1.68	b	0.94	a	0.94	b	7.03	a
Date (3)	2.76	ab	2.23	b	8.21	a	1.73	ab	0.95	a	0.96	b	7.55	a
Date (4)	2.79	a	2.35	a	8.23	a	1.80	a	0.97	a	1.11	a	6.41	b
2014														
Date (1)	2.69	c	2.15	b	6.59	d	1.55	c	1. 00	b	0.97	b	5.79	c
Date (2)	2.83	b	2.31	a	8.42	c	1.83	b	1.09	a	0.99	b	7.51	a
Date (3)	2.88	ab	2.31	a	8.86	b	1.85	b	1.09	a	1.03	b	7.60	a
Date (4)	2.95	a	2.37	a	9.12	a	1.94	a	1.10	a	1.20	a	6.60	b

TABLE 11. Effect of harvesting dates on fruit physical characteristics of Coratina during 2013 and 2014 seasons.

Stage	2013													
	Fruit length		Fruit width		Fruit weight		Seed length		Seed width		Seed weight		Flesh/pit ratio	
Date (1)	2.06	c	1.51	b	3.28	d	1.38	c	0.67	b	0.64	b	4.13	a
Date (2)	2.11	c	1.61	ab	3.62	c	1.50	b	0.70	ab	0.66	b	4.48	a
Date (3)	2.22	b	1.67	a	3.70	b	1.58	a	0.73	a	0.71	ab	4.21	a
Date (4)	2.30	a	1.70	a	3.88	a	1.61	a	0.74	a	0.77	a	4.04	a
2014														
Date (1)	2.20	b	1.64	a	3.73	d	1.46	c	0.68	b	0.67	b	4.57	a
Date (2)	2.25	b	1.69	a	3.83	c	1.62	b	0.74	a	0.67	b	4.72	a
Date (3)	2.37	a	1.76	a	3.91	b	1.65	ab	0.75	a	0.74	ab	4.28	a
Date (4)	2.41	a	1.76	a	4.12	a	1.68	a	0.76	a	0.79	a	4.22	a

TABLE 12. Effect of harvesting dates on fruit physical characteristics of Koroneiki during 2013 and 2014 seasons.

Stage	2013													
	Fruit length		Fruit width		Fruit weight		Seed length		Seed width		Seed weight		Flesh/pit ratio	
Date(1)	1.16	c	0.84	c	1.11	c	1.22	a	0.50	b	0.27	c	3.11	a
Date(2)	1.24	b	0.92	b	1.14	c	1.24	a	0.53	ab	0.36	b	2.17	a
Date (3)	1.27	b	0.93	b	1.32	b	1.25	a	0.54	ab	0.36	b	2.67	a
Date (4)	1.33	a	1.03	a	1.53	a	1.26	a	0.56	a	0.44	a	2.48	a
2014														
Date(1)	1.38	c	0.91	b	1.21	c	1.25	a	0.54	b	0.34	c	2.56	a
Date(2)	1.55	b	0.92	b	1.40	b	1.26	a	0.55	ab	0.43	b	2.26	a
Date (3)	1.58	b	0.94	b	1.65	a	1.27	a	0.56	ab	0.53	a	2.11	a
Date (4)	1.73	a	1.13	a	1.70	a	1.28	a	0.58	a	0.56	a	2.04	a

TABLE 13. Effect of harvesting dates on fruit physical characteristics of Arbequina during 2013 and 2014 seasons.

Stage	2013													
	Fruit length		Fruit width		Fruit weight		Seed length		Seed width		Seed weight		Flesh/pit ratio	
Date (1)	1.65	c	0.85	c	1.15	b	1.17	c	0.55	b	0.27	c	3.26	a
Date (2)	1.75	b	0.93	bc	1.53	ab	1.26	b	0.60	ab	0.33	b	3.64	a
Date (3)	1.81	b	1.00	b	1.57	ab	1.32	ab	0.62	a	0.37	b	3.24	a
Date (4)	1.95	a	1.10	a	1.67	a	1.35	a	0.63	a	0.43	a	2.88	a
2014														
Date (1)	1.71	c	0.84	c	1.20	d	1.19	c	0.56	b	0.28	b	3.29	a
Date (2)	1.84	bc	1.05	b	1.32	c	1.32	b	0.62	ab	0.29	b	3.55	a
Date (3)	1.89	b	1.20	ab	1.58	b	1.36	ab	0.64	a	0.37	a	3.27	a
Date (4)	2.14	a	1.23	a	1.71	a	1.38	a	0.64	a	0.41	a	3.17	a

Fruit length

There was an increase in the length of fruits between the cultivars by the dates of harvesting in the two years of investigation. In Manzanillo cv., there was no difference between the third and fourth date in the first season, while in the second season, the first date was the least and no difference between other dates. Also noticed that, the fruit length in Picual cv., increased almost linearly from 2.51 to 2.97 and 2.69 to 2.95 cm in the first and second seasons, respectively. An increment was observed in Coratina cv., ranged from 2.06 to 2.30 in the first season and 2.20 to 2.41cm. There were no differences between the third and fourth dates in the second season. Meanwhile, Koroneiki cv. was from 1.16 to 1.33 and 1.38 to 1.73 cm in both seasons, respectively and Arbequina cv. from 1.65 to 1.95 and 1.71 to 2.14 cm from the first to the last harvesting dates in the two studied seasons, respectively.

Fruit width

There was a slight increasing in fruit width during the two studied season 2013&2014 in the cultivars under study. In Manzanillo cv., there were no difference between first & second date and third &fourth date in the first season and from 2.15 to 2.30 cm in the second season. Meanwhile, in Picual cv., the increase in fruit width was 2.0 to 2.35 cm in the first season and with no difference between the dates from second to fourth in the second season, while the first date was the least. In Coratina cv., the first date was the least, and with no difference between others in the first season, while no difference between them in the second season. In Koroneiki cv., it was 0.84 to 1.03 in the first season and 0.91 to 1.13 cm in the second season. In Arbequina cv., it was from 0.85 to 1.10 and 0.84 to 1.23 from the first to the fourth harvesting date in 2013and 2014 seasons, respectively.

Fruit weight

The fresh fruit weight generally increased with the progression during the dates of harvesting in 2013 & 2014 seasons. In Manzanillo cv. fresh fruit weight increased from 5.38 to 6.26 (g) in the first season and 5.50 to 6.45 (g) in the second season. There were no difference between the (second & third) harvesting dates in the first season and (first & second) harvesting dates in the second season, while in Picual cv., it was increased during the harvesting dates from 6.17 to 8.23 (g) in the first season, and 6.59 to 9.12 (g) in the second season, the analyzed observed that, no difference between third and fourth harvesting dates. Meanwhile, an increasing in Coratina cv., was occurred from 3.28 to 3.88 (g) and 3.73 to 4.12 (g), respectively in the two studied seasons, in Koroneiki cv., it was from 1.11 to 1.53 in the first season and 1.21 to 1.70 (g) in the second season with no difference was observed between the third and fourth dates in the second season, and in Arbequina cv., the increasing in fresh fruit weight was from 1.15 to 1.67 (g) and 1.20 to 1.71 (g) in both season, respectively.

Seed length

There were an increasing in the seed length during the fruit growth and the fourth date of harvesting has the highest increase in all cultivars. In Manzanillo cv., the first date was the least in seed length, statically no difference among other dates in the first season, while, there were no significant increase in all harvesting dates in the second season. The increase in Picual cv. was from 1.51 to 1.80 cm and 1.55 to 1.94 cm in both seasons. Meanwhile, in Coratina cv. there were no difference between third and fourth date in the first season, but the increasing in the second season was occurred from 1.46 to 1.68 cm. In Koroneiki cv. the increasing in seed length was from 1.22 to 1.26 and 1.25 to 1.28 cm. Also, seed length in Arbequina cv., increased from 1.17 to 1.35 and 1.19 to 1.38 cm, respectively, during the two studied seasons from the first to the fourth dates of harvesting.

Seed width

A slight increasing in seed width was observed during the harvesting dates in all cultivars. In Manzanillo cv., and Picual cv., the first harvesting date was the least one, while no difference among other three dates in both seasons. Meanwhile, in Coratina cv., there were no differences between third and fourth dates of harvesting in the first season, while in the second season the first one was the least and no difference among other harvesting dates. Moreover, an increasing in seed width was noticed from 0.50 to 0.56 and0.54 to 0.58cm in both seasons of Koroneiki cv., and in Arbequina cv., there were no difference among the third and fourth dates of harvesting in 2013 &2014 seasons.

Seed weight

A considerable rapid increasing in seed weight from the first to fourth date of harvesting was observed, the highest weight in all cultivars in "2013" and "2014"

seasons was recorded in the fourth date. In Manzanillo cv., it ranged from 0.75 to 0.84 and 0.77 to 0.92g. While in Picual cv. no difference in seed weight was observed between dates from the first to third dates in the two seasons. Concerning in Coratina cv., it was from 0.64 to 0.77 and 0.67 to 0.79 g in both seasons. While, in Koroneiki cv., an increasing in seed weight from 0.27 to 0.44 g in the first season was observed, but in the second season there were no difference between the third and fourth harvesting dates. Meanwhile, Arbequina cv., the increasing from the first to last date was 0.27to 0.43 and 0.28 to 0.41g in both seasons, respectively.

Flesh/ pit ratio

No change in flesh/pit ratio among harvesting dates was observed in Manzanillo, Coratina, Koroneiki and Arbequina cvs. during the two studied seasons, while in Picual cv., no difference between the second and third dates of harvesting which produced the highest value in the two seasons. Moreover the first harvesting date was the lowest value of flesh/pit ratio in the two seasons of investigation.

These results are in line with the finding of Hartmann & Opitz (1977), Sofiene *et al.* (2011) and Laila *et al.* (2014), they found that the increasing in fruits is due to the fruit moisture content and this increase reducing at the end of maturation process where the fruits become Violet or Purple due to the accumulation of anthocyanin. Roca and Minguez (2001), found that the exogenous factor such as high temperature or sever proportion conditions may decrease the growth rate of olive fruit.

Chemical characteristics

Oil Content (dry weight)

According to Table 14 and Fig. 2 (a&b) it could be seen a significant increase in oil percentage between the studied cultivars calculated on dry weight basis from the first to the last date of harvesting.

TABLE 14. Effect of harvesting dates on oil contents during 2013 and 2014 seasons.

Stage	2013									
	Manzanillo		**Picual**		**Coratina**		**Koroneiki**		**Arbequina**	
Date(1)	21.36	b	23.46	b	25.41	c	30.00	c	29.08	c
Date(2)	23.98	ab	28.20	a	31.54	b	32.33	b	35.14	b
Date (3)	24.56	a	30.18	a	39.24	a	34.04	a	39.4	a
Date (4)	24.64	a	30.70	a	40.43	a	34.40	a	39.94	a
2014										
Date(1)	22.47	c	24.75	b	26.27	c	31.34	c	31.08	c
Date(2)	24.77	b	29.32	a	32.55	b	33.37	b	36.40	b
Date (3)	25.43	a	31.00	a	39.11	a	35.48	a	39.14	a
Date (4)	25.46	a	31.92	a	40.30	a	35.34	a	40.43	a

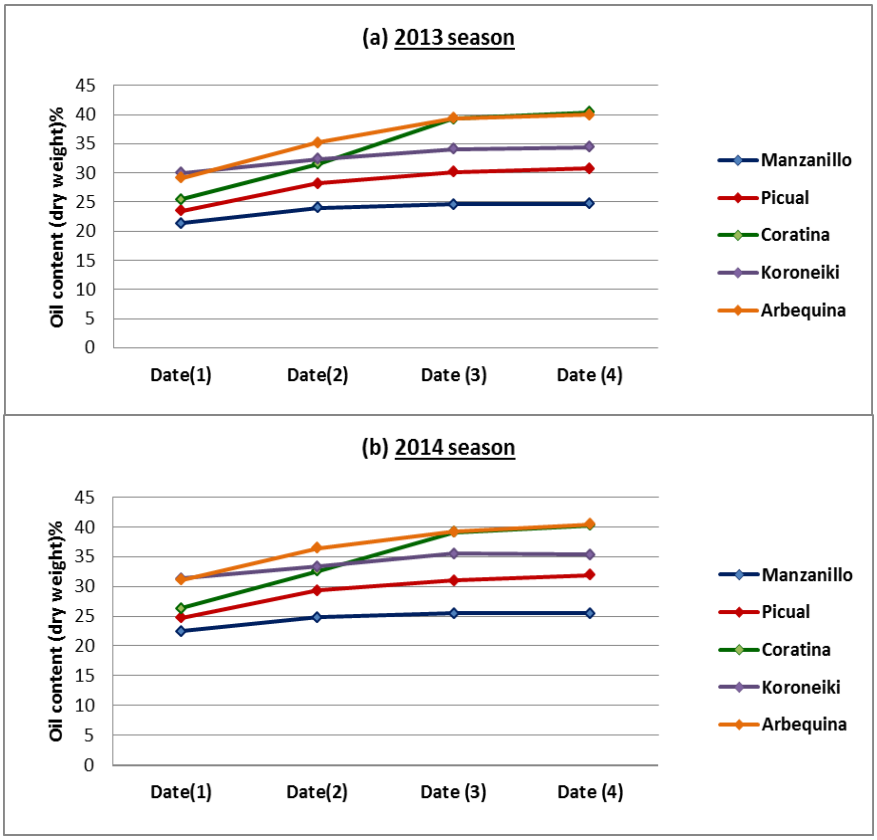

Fig. 2. (a&b). Effect of harvesting dates on oil contents during 2013 and 2014 seasons.

Rate of oil accumulation differed according to tested cultivar and season of study, and the results that obtained in this work are in conformity with those of Hartminn, and Opitiz (1977) who reported that oil increased and reached its maximum as the fruits becomes completely black. On the other hand, (Gutièrrez *et al.*, 1999, Yousfi & Garcia, 2006, Desouky *et al.*, 2009 and Laila *et al.*, 2014) found that oil increase in fruit during the ripping process when the fruits become Violet or Purple.

Oil begins to accumulate in fruit in September (Laila *et al.*, 2014) and increased during the harvesting stages in olive cultivars.

Fruit oil content of Manzanillo cvs., increased from 21.36 to 24.64 and 22.47 to 25.46%, with no difference between the third and fourth harvesting date in both seasons. In Picual cvs., oil percent was from 23.46 to 30.70 % in the first season, while in the second season the increase from the first to last harvesting date from 24.75 to 31.92%, but there were no different among second, third and fourth dates

in the two seasons, Meanwhile, in Coratina cv., was 25.41 to 40.43 and 26.27 to 40.30% from the first to last date in both seasons. Moreover, in Koroneiki cvs., was 30.0 to 34.40 and 31.34 to 35.34% and there were no difference between third and fourth date during two studied season, and in Arbequina cvs., was from 29.08 to 39.94 and 31.08 40.43% in first and second season, respectively but no difference was observed between the third and fourth dates.

Total polyphenol content (TPC)

The genetic makeup of the olive plant determines the total polyphenol potential of its oil since genes are involved the synthesis of these chemicals in fruit. Some olive varieties like Picual, Coratina, Koroneiki and Manzanillo produce oils high in total polyphenols, while others do not, such as Arbequeen (Liliana, 2013). The low total polyphenol group contains varieties suitable for table olive.

Phenolic compounds are strong antioxidants which protect biological system edible oils from oxidation damages as well as produce the flavor characteristics of virgin olive oil (Soni *et al.,* 2006, Matos *et al.,* 2007, Gômez *et al.,* 2008, Dabbou *et al.,* 2010 and Nabil *et al.,* 2012).

Obtained data in Table 15 and Fig. 3 (a&b) showed that TPC of oil from all cultivars of fruits decreased during ripening stage in Manzanillo cv., it was from 298 to 150 ppm and from 290 to 145 ppm, while, in Picual cv., it was from 315 to 146 and from 320 to 140 ppm. Moreover, in Coratina cv., it was from 381 to 185 ppm and from 390 to 184 ppm, in Koroneiki cv., was from 360 to 130 ppm and from 367 to 130 ppm and in Arbequina cv., it was from 180 to 65 ppm and from 190 to 60 ppm from the first to last harvesting dates in the two studied seasons, respectively.

Several studies revealed that total phenol content of olive oil depending on variety, maturity of fruits, climate conditions and oil extraction (Aguilera *et al.,* 2007, Baccouri *et al.,* 2008, Dabbou *et al.,* 2010 and Zaringhalami *et al.,* 2015).

TABLE 15. Effect of harvesting dates on total polyphenol content (ppm) during 2013 and 2014 seasons.

Stage	2013									
	Manzanillo		**Picual**		**Coratina**		**Koroneiki**		**Arbequina**	
Date(1)	298	a	315	a	381	a	360	a	180	a
Date(2)	223	b	245	b	303	b	298	b	117	B
Date (3)	177	c	167	c	215	c	178	c	87	C
Date (4)	150	d	146	d	185	d	130	d	65	D
2014										
Date(1)	290	a	320	a	390	a	367	a	190	A
Date(2)	255	b	250	b	295	b	299	b	99	B
Date (3)	163	c	161	c	200	c	172	c	81	C
Date (4)	145	d	140	d	184	d	130	d	60	D

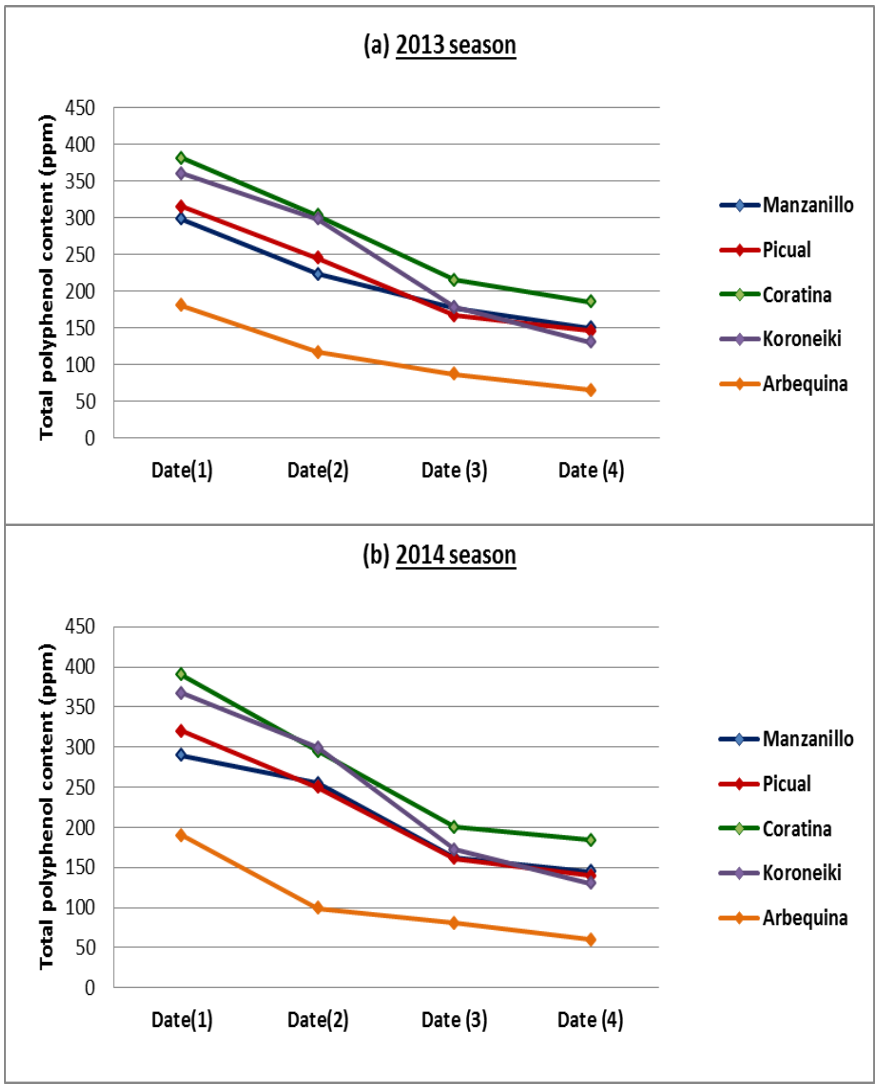

Fig. 3. (a&b). Effect of harvesting dates on total poly Phenol content (ppm) of olive cultivars during 2013 and 2014 seasons.

Conclusion

From the above results, it could be concluded that, the fruits of different cultivars changes in physical and chemical properties at the different times of harvesting. The fourth date was the best in fruit physical characterizes, while, no difference between the third and fourth date was observed in fruit oil content. According to Maturity Index, it could be decided that the optimal harvesting time

of olive cultivars under study in which to achieve high fruits and maximum quality and quantity of oil. This time in Manzanillo cv. was from the beginning of the second date (15/9), till the end of the third date (15/10).While, in Picual, Coratina and Koronekii (cvs.) were the beginning of second date till the end of third date (15/10 to 15/11). Moreover, in Arbequina cv., was the beginning of the third date (1/11) till the end of the fourth date (15/11). So, we can say that, Manzanillo cultivar can be picked after (166 and 170) days, Picual cultivar after (184 and 192) days, Coratina cultivar after (193 and 199) days, Koroneiki cultivar after (216 and 224) days and in Arbequina cultivar after (213 and 217) days from full bloom in the two studied seasons and that seems to be an optimum harvesting time.

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تحديد الموعد الامثل للجمع وعلاقته بجودة الثمار والزيت لبعض أصناف الزيتون

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اجريت هذه الدراسه خلال موسمى٢٠١٣ و٢٠١٤ على خمسة اصناف من الزيتون (منزانيللو –بيكوال – كوراتينا – كروناكى- اربكويين) تم جمعها خلال اربعة مواعيد للجمع (كل خمسة عشر يوما) من اشجار عمر ١٢ سنة منزرعه فى ارض رملية على مسافة ٥× ٥متر تحت نظام الرى بالتنقيط بمزرعة خاصة بطريق القاهرة/الاسكندرية الصحراوى. ويهدف هذا البحث الى التوصل لافضل ميعاد لجمع الاصناف موضوع الدراسة وذلك للحصول على اعلى جودة للثمار وكذلك اعلى كمية وجودة للزيت عن طريق دراسة فترة التزهير ودراسة الخصائص الفيزيائية للثمار والكيميائية للزيت خلال مواعيد الجمع المختلفة وربطها بمقياس النضج لحساب عدد الايام من تاريخ قمة التزهير وحتى افضل ميعاد للجمع طبقا لمعادلة مقياس النضج لكل صنف. وقد اوضحت النتائج زيادة فى طول وعرض ووزن الثمار وكذلك وزن البذرة بينما لم تكن هناك زيادة ملحوظة فى طول وعرض البذرة وكذلك نسبة اللحم للبذرة خلال موسمى الدراسة. كما أن هناك تزايد فى نسبة الزيت مع تناقص محتوى البولى فينولات الكلية من الميعاد الاول الى الميعاد الرابع للجمع لكل الاصناف خلال موسمى الدراسة. ومن خلال الدراسة يمكن تحديد ميعاد الجمع الامثل للاصناف كما يلى:
صنف منزانيللو يتم جمعه بعد (١٦٦ و ١٧٠يوم) وصنف البيكوال يتم جمعه بعد (١٨٤ و ١٩٢ يوم) وصنف كوراتينا يتم جمعه بعد (١٩٣ و ١٩٩ يوم) وصنف الكروناكى يتم جمعه بعد (٢١٦ و ٢٢٤ يوم) وصنف الاربكويين يتم جمعه بعد (٢١٣ و ٢١٧ يوم) فى كلا الموسمين على الترتيب حساباً من ميعاد قمة التزهير.