EFFECT OF USING SOME POLLINATORS ON PRODUCTIVITY OF SOME OLIVE CULTIVARS

(Received: 8. 1.2018)

By
A.S. El-Soda, A.M. El-Husseiny and A.A. Hammad

Olive and Semi-Arid Zone fruits Department,Horticulturre Research Institute, Agriculture Research Center,Giza, Egypt.

ABSTRACT

The present study was carried out during two successive growing seasons 2014 and 2015 in a private orchard located at Cairo-Alexandria desert road, 64 km from Cairo, to evaluate the efficiency of pollinator on productivity and quality attributes of eight olive cultivars, namely Aggizi, Dolce, Kalamata, Maraki, Coratina, koroneiki, Picual and Manzanillo. Ten year old olive trees, grown in sandy soil, planted at 6 X 3 meters apart and irrigated by the drip irrigation system were used for this investigation. The results revealed that, there were differences in the onset and duration of flowering among the studied cultivars in both seasons. The earliest cultivar in flowering was Aggizi, while the latest cultivar in this respect was Kalamata Cv. in both seasons. Regarding flowering duration, it was observed that the studied cultivars overlapped in their blooming period where it is varied between 15 and 20 days in 2014 and 14-18 days in 2015. The highest perfect flower percentage was observed in Dolce and Coratina Cvs. With respect to self-incompatibility index, Aggizi, Dolce, Maraki and Koroneiki were self-compatible. Then, Picual and Coratina Cvs. recorded partially self- incompatible, whereas, Kalamata and Manzanillo Cvs. recorded higher degree of self-incompatibility,Cross pollination induced the best results with regard to fruit set %, and fruit weight and oil content in most olive cultivars. It can be recommended that, the suitable pollinator for each cultivar were as follows: Maraki and Aggizi were good pollinators for each other, Koroneiki for Dolce, Manzanillo and Picual. Finally, Dolce was a good pollinator for Kalamata, Coratina and Koroneiki.

***Key words**: olive, pollinator, self-incompatibility index, fruit weight, oil content.*

1.INTRODUCTION

Olive (*Olea europaea* L.) cultivation plays an important role in the economy of many countries most of which belong to the Mediterranean region. In Egypt, the latest statistics of the Ministry of Agriculture in 2015 cited that the total acreage grown with olive Cvs. reached about 227,683 feddans with total production about 698,927 tons.

The efficiency of the olive industry greatly depends on harvesting economic fruit yields that can be used for producing oil and table olives (Taslimpour and Aslmoshtaghi, 2013). Olive fruits are used for oil extraction and pickling. Oil proportion in the fruit ranges from 35 to 70% on a dry weight basis (El-Hady *et al*., 2007).

The olive flowers are perfect (hermaphrodite), or staminate flowers (male). The ratio between perfect to staminate flowers is genetically determined but is also affected by climatic conditions and the level of fruit production in the previous year (Lavee *et al*., 2002) thus, it may vary from year to year, tree to tree, shoot to shoot and inflorescence to inflorescence (Fabbri *et al*., 2004 ;Martin and Sibbett, 2005).

Self-incompatibility is a genetically controlled mechanism that prevents self-fertilization of plants. Most olive cultivars are self-incompatible or partially self-compatible and need to be fertilized by compatible pollinizers to ensure acceptable production (Moutier, 2002; Fabbri *et al*., 2004 and Conner and Fereres, 2005). Furthermore, some cultivars are cross-incompatible and cannot fertilize each other (Cuevas and Polito, 1997). The degree of self -incompatibility in olive is widely influenced by genetic factors and environmental conditions (Lavee *et al*., 2002).

As a result, Self-incompatibility obliges olive growers to plant more than one cultivar in their orchards to ensure sufficient cross-pollination (Martin *et al*., 2005 and Mookerjee *et al*., 2005). Cross-pollination can enhance fertilization as shown by reports indicating higher fruit set resulting in more regular yields even for partially self-fertile cultivars (Cuevas *et al*., 2001 and Breton and Bervillé, 2012)

Some researchers also determined that the use of appropriate pollinator cultivar even in self- fertile cultivars had a positive effect on yield (Ferrara *et al*., 2002). Moreover, previous studies reported an increase in fruit set by using pollinator cultivars hence emphasizing the necessity of having pollinator cultivars for orchard establishment (Lombardo *et al*., 2006; Vulletin *et al*., 2006; Farinelli *et al*., 2008 and Mete *et al*., 2012).

Therefore, the objective of this investigation was to nominate the best pollinizer for olive cultivars (Aggizi, Dolce, Kalamata, Maraki, Coratina, koroneiki, Picual and Manzanillo) and their effect on fruit set, fruit weight and oil content.

2. MATERIALS AND METHODS

The present study was carried out during two successive growing seasons 2014 and 2015 in a private orchard located at Cairo-Alexandria desert road, 64 km from Cairo, to find out the best pollinizer for eight olive cultivars Aggizi, Dolce, Kalamata, Maraki, Coratina, Koroneiki, Picual and Manzanillo and also their effect on fruit set and quality. Ten year old olive trees, grown in a sandy soil, planted at 6 X 3 meters apart and irrigated by the drip irrigation system. Twenty four uniform trees from each cultivar were selected and subjected to the different treatments of pollination. The maximum and minimum temperature in the experimental site during two seasons of study are presented in Fig. (1).

2.1. Pollination procedure

In both studied seasons, in each of the experimental trees had 60 of inflorescences having flowers at the same developmental stage (balloon stage) on one-year-old shoots uniformly distributed around the tree were chosen in the on year. To prevent pollinations, the shoots were bagged before anthesis (at balloon stage), the bags on the shoots were kept until pollination treatment were aimed out. The pollen grains were collected for hand pollination (cross-pollination), the flowers of the pollinator cultivars were collected at balloon stage. The flowers were placed on a paper in the laboratory at room temperature for anthers dehiscing. After one day, the pollen grains of each pollinator were collected in glass tubes separately.

2.2. Pollination treatments:

For open-pollination treatment, the flowers were allowed to receive pollen presumably from all cultivars present in the field and the same number of flowers in other pollination treatments mentioned above were labeled without any treatment (control).

Self-pollination treatment was performed by bagging the shoots at balloon stage. Then, the shoots were shaken and this was repeated two days later to ensure pollination of all flowers.

Cross pollination treatment was carried out by emasculating the flowers (300 perfect flowers/ each experimental tree) of the mother cultivar at balloon stage using hand forceps. Buds at other developmental stage were eliminated. Immediately, treatment was performed by applying the appropriate pollen grains to the respective stigma with a fine paint brush, and then covered again with pergamin bags to prevent unwanted pollinations. After 20 days of pollination, the protecting bags were removed. The following parameters were adopted to evaluate the tested cultivars.

2.3. Flowering and fruit set

2.3.1. Flowering phenology

Dates of beginning and full bloom were recorded when 10% of the total flowers were

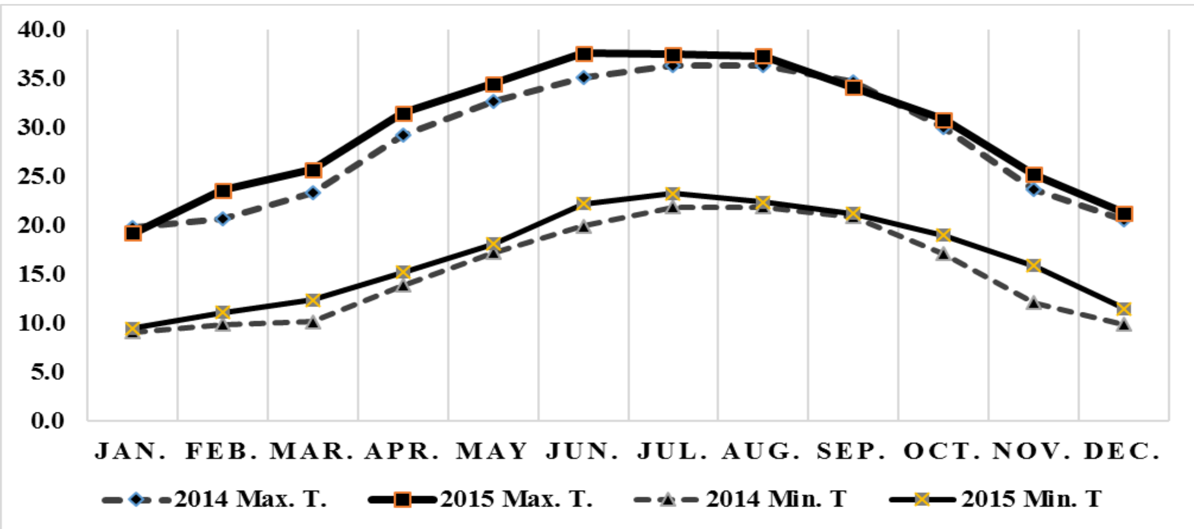

Fig.(1): The maximum and minimum temperature in the experimental site during the two seasons of study 2014 and 2015.

The following pollination treatments were investigated:

Aggizi ♀ X open
Aggizi ♀ X self
Aggizi ♀ X Dolce ♂
Aggizi ♀ X Kalamata ♂
Aggizi ♀ X Maraki ♂
Aggizi ♀ X Coratina ♂
Aggizi ♀ X Koroneiki ♂
Aggizi ♀ X Picual ♂
Aggizi ♀ X Manzanillo ♂

Dolce ♀ X open
Dolce ♀ X self
Dolce ♀ X Aggizi ♂
Dolce ♀ X Kalamata ♂
Dolce ♀ X Maraki ♂
Dolce ♀ X Coratina ♂
Dolce ♀ X Koroneiki ♂
Dolce ♀ X Picual ♂
Dolce ♀ X Manzanillo ♂

Kalamata ♀ X open
Kalamata ♀ X self
Kalamata ♀ X Aggizi ♂
Kalamata ♀ X Dolce ♂
Kalamata ♀ X Maraki ♂
Kalamata ♀ X Coratina ♂
Kalamata ♀ X Koroneiki ♂
Kalamata ♀ X Picual ♂
Kalamata ♀ X Manzanillo ♂

Maraki ♀ X open
Maraki ♀ X self
Maraki ♀ X Aggizi ♂
Maraki ♀ X Dolce ♂
Maraki ♀ X Kalamata ♂
Maraki ♀ X Coratina ♂
Maraki ♀ X Koroneiki ♂
Maraki ♀ X Picual ♂
Maraki ♀ X Manzanillo ♂

Coratina ♀ X open
Coratina ♀ X self
Coratina ♀ X Aggizi ♂
Coratina ♀ X Dolce ♂
Coratina ♀ X Kalamata ♂
Coratina ♀ X Maraki ♂
Coratina ♀ X Koroneiki ♂
Coratina ♀ X Picual ♂
Coratina ♀ X Manzanillo ♂

Koroneiki ♀ X open
Koroneiki ♀ X self
Koroneiki ♀ X Aggizi ♂
Koroneiki ♀ X Dolce ♂
Koroneiki ♀ X Kalamata ♂
Koroneiki ♀ X Maraki ♂
Koroneiki ♀ X Coratina ♂
Koroneiki ♀ X Picual ♂
Koroneiki ♀ X Manzanillo ♂

Picual ♀ X open
Picual ♀ X self
Picual ♀ X Aggizi ♂
Picual ♀ X Dolce ♂
Picual ♀ X Kalamata ♂
Picual ♀ X Maraki ♂
Picual ♀ X Coratina ♂
Picual ♀ X Koroneiki ♂
Picual ♀ X Manzanillo ♂

Manzanillo ♀ X open
Manzanillo ♀ X self
Manzanillo ♀ X Aggizi ♂
Manzanillo ♀ X Dolce ♂
Manzanillo ♀ X Kalamata ♂
Manzanillo ♀ X Maraki ♂
Manzanillo y ♀ X Coratina ♂
Manzanillo ♀ X Koroneiki ♂
Manzanillo ♀ X Picual ♂

opened and 80% of the total flowers were opened respectively. The end of blooming was recorded at the date in which all flowers were completely opened. Flowering periods for each cultivar was calculated by the days between the beginning of flowering and the end of blooming.

2.3.2. Perfect flower percentage

Samples of twenty inflorescences at balloon stage (blooms are completely swollen, white and near to open) from each tree were randomly taken from the middle portion of the shoots to determine the perfect flower percentage according to Rallo and Fernández-Escobar (1985) as follows:

Perfect flowers %= {(Number of perfect flowers) / (total number of flowers)} X 100.

2.3.3.Self-incompatibility index

The degree of self-incompatibility (SI-Index) of the studied cultivars was calculated by using the following formula (Moutier, 2002).

SI-Index = Fruit set in self- pollination /Fruit set in free pollination

The degrees of SI-index are divided into the following categories:

0.3-1 = self –compatible
0.15-0.3 = partially self –incompatible
0- 0.15 =high self –incompatible
0 = completely self-incompatible

Low value close to zero would be an indication of self-incompatibility (Androulakis and Loupassaki, 1990).

2.3.4.Efficiency of open pollination

The efficiency of open pollination of the studied cultivars was calculated by using the following formula according to Lavee *et al*. (2002).

The efficiency of open pollination = Fruit set by open pollination/Fruit set by self- pollination

The efficiency of open pollination is divided into the following categories:-

1- 4 = Low efficiency
5- 10 = Medium efficiency
11- 50 = High efficiency
51- 100 = Very high efficiency

2.3.5.The efficiency of pollinator

The efficiency of pollinator of the studied cultivars was calculated by using the following formula according to Androulakis and Loupassaki (1990).

The efficiency of pollinator = Fruit set by cross pollination/Fruit set by open pollination

The efficiency of pollinator was divided into the following categories

0% -33% = Bad pollinator

33% - 66% = Passable pollinator

66% - 100 % = Good pollinator

2.4. Final fruit set percentage

Fruit set percentage after 60 days from full bloom was determined as follows:

Fruit set % = {(Number of fruit set) / (total number of flowers)} X 100.

2.5. Fruit quality

Harvesting date of olive cultivars depend upon the region and the variety. In this study olive was harvested at the ripe stage (olive with superficial pigmentation on more that 50% of the skin) to determined the:

2.5.1.Average fruit weight (g)

2.5.2.Fruit oil content (%) was extracted by Soxelt apparatus from the dry fruit sample by using petroleum ether 60-80°C boiling point as a solvent for 16 hours according to the method described by (A.O.A.C., 2000).

2.6. Statistical analysis

The complete randomized block design was adopted for the experiment. The statistical analysis of the present data was carried out according to Snedecor and Cochran (1980). Averages were compared using the new L.S.D. values at 5% level.

3. RESULTS AND DISCUSSION

3.1. Flowering and fruit set

3.1.1. Flowering phenology

Data in Table (1) and Fig. (2) presented onset and duration of flowering among the studied cultivars in both seasons. However, blooming started from March 11*th* and ended at April 14*th* in the first season, while it started from March 26th and ended at April 23*th* in second according to the different cultivars. The earliest cultivars was Aggizi Cv. followed by Maraki Cv. in both seasons, whereas the latest cultivars were Kalamata and Koroneiki Cvs. Furthermore, full bloom of the studied olive cultivars started from March 21*th* till April 7*th* in the first season and from 1*st* till 15*th* of April in the second season. The earliest cultivar to reach full bloom was Aggizi while the latest cultivar in this respect was Kalamata in both seasons.

Regarding flowering duration, it was observed that the studied cultivars overlapped in their bloom time. The flowering period of the studied cultivars ranged between 15 and 20 days in 2014 and between 14-18 days in 2015. This was in agreement with Abo-El-Ez and Hassenein (2009), Eassa *et al*. (2011), Selak *et al*. (2011) Mehri *et al*. (2013) and Fayek *et al*. (2014) who reported that olive blooming lasts for about 2 -3 weeks.

The relative order of flowering time was maintained between the cultivars studied.

Differences among cultivars in flower quality has been attributed to physiological and environmental effects but also probably due to genetic differences as suggested by Mehri *et al*. (2013).

3.1.2.Perfect flowers percentage

As shown in Table (2), the percentage of perfect flowers significantly differed among the studied cultivars in both seasons. The highest significant percentage of perfect flowers was attained by Dolce Cv., followed by Coratina Cv., with insignificant differences between them. Whereas, Maraki and Kalamata Cvs. attained significantly the least percentages in both seasons of study. These results are in line with Wu *et al*. (2002) Al- Kasasbeh *et al*. (2005), Eassa *et al*. (2011), Seifi *et al*. (2011); Sayed (2013) and Mehri *et al*. (2013) who reported that the relative proportion of perfect flowers varied according to varieties and seasons. Sex ratio also varied according to genetic factors (Fayek *et al*., 2014), climate and alternate bearing (Al-Shdiefat and Qrunfleh, 2008).

3.1.3. Final fruit set of self and open pollination

As shown in Table (2), it was obvious that percentage of final fruit set was significantly influenced by the type of pollination among the studied cultivars in both seasons.

With respect to fruit set under open pollination, Dolce Cv. attained significantly the highest percentages compared with other cultivars, while Maraki and Picual Cvs. showed significantly the least percentages with insignificance between them in both seasons of the study.

Regarding fruit set under self-pollination, the highest significant percentage was attained by Dolce Cv., whereas Kalamata and Manzanillo Cvs. attained significantly the least percentages with insignificance between them in both seasons of the study.

Results achieved in the current study relative to self-pollination and to increase in fruit set under open pollination confirmed the reports on other olive cultivars (Selak *et al*., 2011; Spinardi and Bassi, 2012; Mehri *et al*., 2013; Taslimpour and Aslmoshtaghi, 2013; Fayek *et al*., 2014 and Mete *et al*., 2016).

3.1.4.Self-incompatibility index

According to the results in Table (3), the eight olive cultivars under study can be classified into three groups: first group, self- compatible with SI-index ranged from 0.3 to 1.0 for Dolce, Koroneiki, Aggizi and Maraki Cvs. Second group, partially self- incompatible with SI-index ranged from 0.15

Table (1): Date of start flowering, full bloom and end of flowering of eight olive cultivars in 2014 and 2015 seasons

Cultivar	Start of flowering		Full bloom		End of flowering	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Aggizi	11-Mar	26-Mar	21-Mar	1-Apr	30-Mar	8-Apr
Dolce	25-Mar	4-Apr	1-Apr	10-Apr	8-Apr	18-Apr
Kalamata	29-Mar	7-Apr	7-Apr	15-Apr	13-Apr	23-Apr
Maraki	19-Mar	30-Mar	28-Mar	6-Apr	5-Apr	12-Apr
Coratina	23-Mar	4-Apr	1-Apr	11-Apr	9-Apr	21-Apr
Koroneiki	27-Mar	7-Apr	4-Apr	13-Apr	14-Apr	22-Apr
Picual	25-Mar	5-Apr	2-Apr	11-Apr	12-Apr	21-Apr
Manzanillo	23-Mar	1-Apr	30-Mar	8-Apr	6-Apr	15-Apr

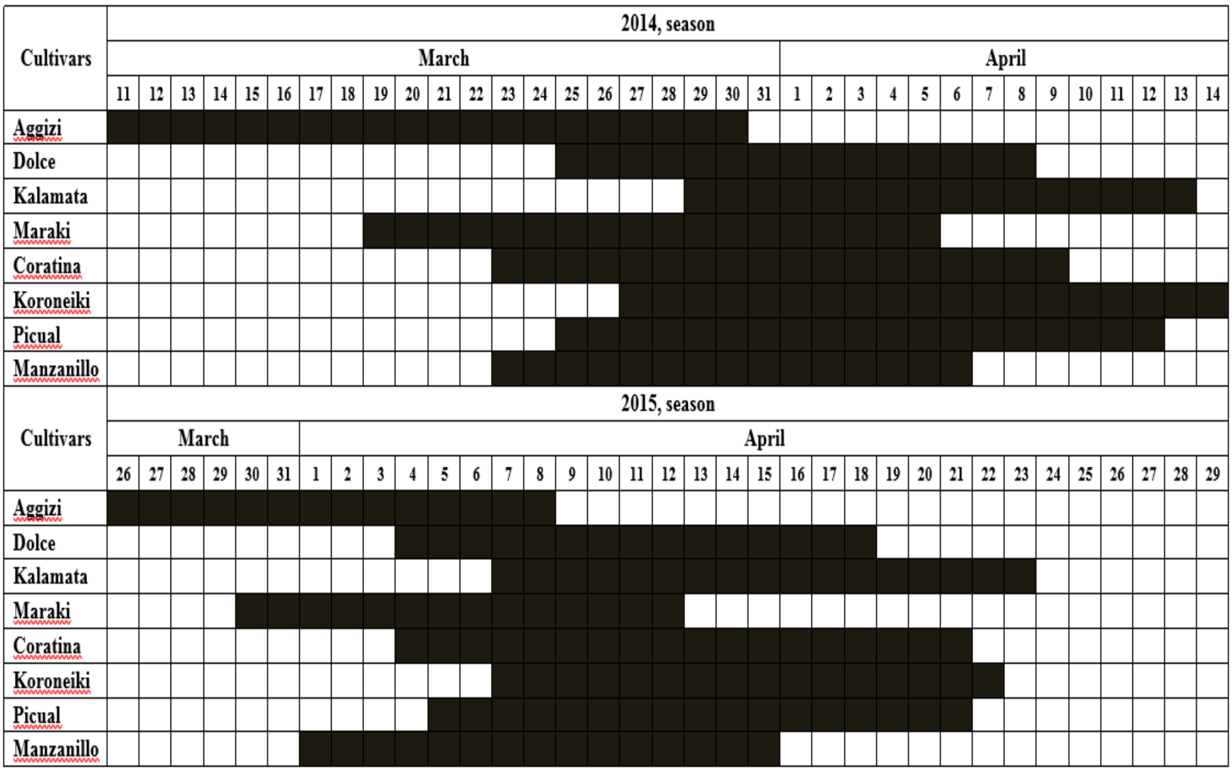

Fig.(2): Date of start flowering, full bloom and end of flowering for eight olive cultivars in 2015 and 2015 seasons.

Table (2): Percentages of perfect flower and fruit set of eight olive cultivars during 2014 & 2015 seasons.

Cultivar / Year	Perfect flower (%)		Fruit set (%) Self-pollination		Fruit set (%) Open pollination	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**
Aggizi	88.76	87.36	3.16	3.05	6.32	6.27
Dolce	95.48	96.53	13.72	13.98	20.58	18.17
Kalamata	61.36	63.04	0.28	0.25	6.62	7.23
Maraki	59.05	57.46	1.04	1.17	2.58	3.95
Coratina	95.28	96.21	0.95	1.04	4.83	5.28
Koroneiki	89.39	87.89	6.07	6.75	8.54	9.32
Picual	72.25	71.16	1.07	1.23	3.73	4.07
Manzanillo	82.51	81.03	0.23	0.22	5.31	6.83
new LSD (0.05) =	4.83	5.67	0.71	0.83	1.19	1.21

Table (3): Self-incompatibility index of eight olive cultivars during 2014 & 2015 seasons.

Cultivar	Self-incompatibility (SI-Index)		State	Range
	2014	2015		
Aggizi	0.50	0.49	self –compatible	0.3 - 1
Dolce	0.67	0.77	self –compatible	0.3 - 1
Kalamata	0.04	0.03	high self –incompatible	0 - 0.15
Maraki	0.40	0.30	self –compatible	0.3 - 1
Coratina	0.20	0.20	partially self –incompatible	0.15 - 0.3
Koronaiki	0.71	0.72	self –compatible	0.3 - 1
Picual	0.29	0.30	partially self –incompatible	0.15 - 0.3
Mananillo	0.04	0.03	high self –incompatible	0 - 0.15

to 0.3 for Picual and Coratina Cvs. Third group, high self-incompatible with SI-index less than 0.15 for Kalamata and Manzanillo Cvs. in both seasons of the study.

Self-incompatibility is a genetically controlled mechanism that prevents self-fertilization in plants. Most olive cultivars are self-incompatible or partially self-compatible and need to be fertilized by compatible pollenizers to ensure acceptable production (Moutier 2002, Fabbri *et al*., 2004 and Conner and Fereres 2005). Furthermore, some cultivars are cross-incompatible and cannot fertilize each other (Cuevas and Polito 1997). Our study showed that Kalamata and Manzanillo Cvs. had a high degree of self-incompatibility, thus confirming the presence of self-incompatibility in olives, as reported for other cultivars (Ateyyeh *et al*., 2000). The degree of self -incompatibility in olive is widely influenced by genetic factors and environmental conditions (Lavee *et al*. 2002).

3.1.5. Efficiency of open pollination

Data in Table (4) illustrate significant difference in open pollination efficiency among the studied cultivars in both seasons. The highest efficiency ranged from 11 to 50 which was attained by Kalamata and Manzanillo Cvs., while Coratina Cv. had a medium efficiency which ranged from 5 to 10, whereas the least efficiency that ranged from 1 to 4 was obtained with Dolce, koroneiki, Aggizi, Maraki and Picual Cvs. in both seasons of the study. Most studies show good efficacy for open pollination and vary depending on the pollinator species (Trigui and Msallem, 1995). Also, open pollination was more effective in increasing fruit set about 70 times compared with self-pollination (Camposeo *et al*., 2012). In addition, Mhnna *et al*. (2014) showed that open-pollination showed higher final efficiency in increasing production; 11 times higher in "Picholine languedoc" Cv. and 5 times higher in "Khodairi "and "Sourani Abo-Shauke" Cvs. compared to self-pollination.

3.2. Pollination treatments

3.2.1. Final fruit set percentage(Self, cross and open pollination)

The highest significant percentage of final fruit set was attained by cross pollination as compared with adopted pollination types *i.e.* open pollination and self-pollination Table (5). As compared with tested pollinizers, Dolce Cv. resulted the most suitable pollinizer that increase final fruit set for Aggizi, Maraki, Coratina, Koroneiki and Picual Cvs. On the contrary, Manzanillo Cv. was un-suitable pollenator for many cultivars under study *i.e.* Aggizi, Dolce, Kalamata, Maraki, Koroneiki and Picual Cvs. in both seasons of the study.

Table (4): Efficiency of open pollination of eight olive cultivars during 2014 & 2015 seasons.

Cultivar	Efficiency of open pollination		State	Range
	2014	2015		
Aggizi	2.00	2.06	Low efficiency	1- 4
Dolce	1.50	1.30	Low efficiency	1- 4
Kalamata	23.64	28.92	High efficiency	11- 50
Maraki	2.48	3.38	Low efficiency	1- 4
Coratina	5.08	5.08	Medium efficiency	5- 10
Koronaiki	1.41	1.38	Low efficiency	1- 4
Picual	3.49	3.31	Low efficiency	1- 4
Mananillo	23.09	31.05	High efficiency	11- 50

Table (5) :Effect of pollination type on the final fruit set (%) of eight olive cultivars during 2014 & 2015 seasons.

Pollination type	Cultivar ♀															
	Aggizi		Dolce		Kalamata		Maraki		Coratina		Koroneiki		Picual		Manzanillo	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Open pollination	6.32	6.27	20.58	18.17	6.62	7.23	2.58	3.95	4.83	5.28	8.54	9.32	3.73	4.07	5.31	6.83
Aggizi	3.16	3.05	11.27	11.83	2.83	2.51	2.76	3.23	1.93	1.41	8.07	8.74	0.85	0.54	0.83	0.77
Dolce	15.65	16.75	13.72	13.98	4.57	5.32	5.25	5.71	5.49	6.23	10.65	11.02	13.17	13.02	1.55	1.80
Kalamata	3.92	4.81	12.35	11.97	0.28	0.25	1.86	2.54	3.21	2.67	8.84	8.57	1.74	1.91	1.24	1.04
Maraki	5.47	5.55	13.31	13.04	3.02	3.41	1.04	1.17	1.33	1.29	8.03	8.39	1.65	1.47	0.87	0.93
Coratina	3.31	3.73	6.55	6.75	2.32	2.05	1.76	2.33	0.95	1.04	4.32	5.37	2.72	2.33	0.82	0.85
Koroneiki	12.36	11.17	14.62	14.03	3.58	3.42	8.04	8.19	2.15	1.65	6.07	6.75	3.81	3.04	2.25	2.95
Picual	2.27	2.05	11.35	11.09	1.15	1.07	1.62	1.57	1.17	1.32	9.61	10.17	1.07	1.23	1.35	1.19
Manzanillo	1.23	1.81	4.78	5.78	1.12	1.03	1.45	1.32	1.64	1.81	5.62	5.75	1.55	1.19	0.23	0.22
new LSD (0.05) =	3.17	3.42	6.91	4.23	2.07	1.94	2.81	2.53	0.61	0.79	0.89	0.74	0.87	0.91	3.81	5.09

The beneficial effect of cross-pollination on fruit set in most olive cultivars may be explained by greater fertilization than in self-pollination, where the pollen tubes of other cultivars grow down the style faster than self-pollen tubes under the same temperature conditions as noted by Bradley *et al*. (1961). A significant variability in fruit set was found regarding the response of any receptor cultivar to pollination with a specific pollenizer (Selak, *et al*. 2011). Some researchers working on pollination biology of olive reported that self-fertility and cross pollination could vary based on the effect of environmental conditions (Lavee *et al*., 2002). Increased final fruit set after free pollination and cross-pollination when compared with self-pollination have also been widely reported for different olive cultivars in other regions (Moutier, 2002; Farinelli *et al*., 2006; Lombardo *et al*., 2006 and Mete *et al*., 2012).

3.2.2.Fruit quality

Data in Tables (6 and 7) revealed that some fruit quality attributes expressed as fruit weight and fruit oil content were significantly affected by the type of pollination among the studied cultivars in both seasons.

With respect to fruit weight (Table 6), cross pollination showed the highest significant value of fruit weight as compared with open pollination and self-pollination except Maraki cv which recorded the heaviest fruit weight with open pollination, while the least in significant value of fruit weight for all cultivars was noticed by self- pollination treatment except Dolce which recorded the lowest fruit weight with Koroneiki. As compared with the tested pollinizers, Aggizi, Coratina and Koroneiki produced the heaviest fruit weight when pollinated with Kalamata. While, Dolce, Kalamata, Picual and Manzanillo recorded the heaviest fruit weight when pollinated with Aggizi. When Maraki pollinated with Dolce or Aggizi the heaviest fruit were noticed.

Concerning fruit oil content (Table 7), the least significant magnitude of oil content was cleared with self-pollination when compared with other pollination treatments except Koroneiki which gave the least oil content when pollinated with Aggizi in both seasons of the study. Generally, Koroneiki, Maraki and Coratina proved to be good pollinators to obtain the highest fruit oil content. When Aggizi and Maraki were pollinated with Coratina, the highest oil content was observed. The highest oil content for Dolce, Kalamata and Koroneiki were showed when pollinated by Maraki. The best pollinator for Coratina, Picual and Manzanillo was Koroneiki which gave the highest oil content with previous cultivars. The obtained results are in harmony with the findings of Cuevas and Oller (2002) who concluded that pollination is a tool for improving fruit weight. Also, El-Hady *et al*. (2007) reported that open pollination recorded the highest fruit weight than self-pollination for Koroneiki olive cultivar. In addition they showed that the highest oil percentage for Koroneiki was obtained from cross pollination with pollen grains from Arbequina as compared with other pollination types including open pollination and self-pollination. Moreover, Eassa *et al*. (2011) found that the use of Dolce cv. as a pollinator for Kalamata cv. gave the highest significant values for fruit weight and fruit dimensions.

3.2.3.Efficiency of pollinator

Data in Table (8) illustrated that, the most suitable pollinator for Aggizi was Dolce, Kalamata, Maraki and Koroneiki. In addition, Maraki and Koroneiki were most suitable pollinator for Dolce. Also, for Kalamata was Dolce as a good pollinator. Furthermore, the best pollinator for Maraki was Aggizi, Dolce, Kalamata and Koroneiki. For Coratina was Dolce. For Koroneiki, the best pollinator was Aggizi, Dolce, Kalamata, Maraki and Picual. moreover, for Picual was Dolce, Coratina and Koroneiki good pollinator. Otherwise, the passable pollinator for Manzanillo was Koroneiki

As a conclusion, our results generally showed that: Aggizi, Dolce, Maraki and Koroneiki Cvs. were self-compatible. Meanwhile, Picual and Coratina Cvs. had a partially self- incompatible. While, Kalamata and Manzanillo Cvs. had a high degree of self-incompatibility. Cross pollination had the best results with regard to fruit set % , fruit weight and oil content in most olive cultivars. Ultimately, in light of the results of this study we can recommend the suitable pollinator for each studied cultivar as follows:

- Maraki and Aggizi were good pollinator for each other.
- Koroneiki for Dolce, Manzanillos and Picual
- Dolce for Kalamata, Coratina and Koroneiki

Table (6): Effect of pollination type on fruit weight (g) of eight olive cultivars during 2014 & 2015 seasons.

Pollination type	Cultivar ♀															
	Aggizi		Dolce		Kalamata		Maraki		Coratina		Koroneiki		Picual		Manzanillo	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Open pollination	9.76	9.94	3.13	3.17	4.28	4.33	5.93	5.85	3.77	3.69	0.88	0.92	4.61	4.58	4.69	4.75
Aggizi	6.32	6.10	3.93	3.83	4.35	4.42	5.56	5.37	4.48	4.54	1.09	1.08	5.78	5.89	5.72	5.69
Dolce	10.35	10.11	2.96	3.09	4.04	4.18	5.39	5.43	4.16	4.22	0.89	0.93	4.52	4.33	4.46	4.48
Kalamata	10.49	10.27	3.52	3.48	3.56	3.49	5.17	5.21	4.76	4.81	1.23	1.19	4.43	4.42	4.31	4.41
Maraki	8.75	8.53	3.17	3.14	4.31	4.37	3.78	3.81	3.95	4.06	0.87	0.89	5.51	5.67	3.63	3.72
Coratina	8.80	8.94	3.26	3.32	4.18	4.26	4.84	4.78	3.41	3.38	0.96	0.97	4.65	4.57	4.48	4.52
Koroneiki	7.40	7.62	2.81	2.87	3.94	3.84	4.67	4.73	3.99	4.03	0.76	0.81	4.84	4.92	3.39	3.51
Picual	8.91	8.87	3.29	3.46	3.78	3.72	4.85	4.82	4.33	4.51	0.92	0.94	3.99	4.04	5.54	5.46
Manzanillo	8.70	8.75	3.24	3.44	3.98	3.87	5.19	5.06	3.98	3.87	0.83	0.87	4.81	4.93	3.26	3.37
new LSD (0.05) =	0.13	0.11	0.21	0.23	0.03	0.02	0.39	0.51	0.21	0.17	0.11	0.08	0.23	0.19	0.13	0.19

Table (7): Effect of pollination type on fruit oil content (%) of eight olive cultivars during 2014 & 2015 seasons.

Pollination type	Cultivar ♀															
	Aggizi		Dolce		Kalamata		Maraki		Coratina		Koroneiki		Picual		Manzanillo	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Open pollination	16.44	16.37	30.53	32.35	30.62	31.40	48.51	48.07	45.92	46.64	47.31	45.12	38.80	36.47	34.61	35.36
Aggizi	12.41	13.67	23.34	22.47	23.62	22.25	35.11	36.35	30.83	31.62	29.35	30.37	26.21	25.78	22.52	20.48
Dolce	18.33	18.35	21.15	20.56	26.83	26.93	41.47	43.57	40.91	39.55	40.85	39.12	34.86	34.18	20.47	22.39
Kalamata	19.87	20.47	29.56	28.15	18.38	18.29	42.20	44.50	41.47	40.43	41.17	39.96	33.82	35.19	30.21	29.15
Maraki	22.18	20.77	36.33	36.51	37.65	37.06	32.74	33.26	47.42	47.96	49.34	48.91	39.11	39.47	36.93	36.75
Coratina	23.47	23.82	33.79	33.64	36.76	36.12	51.07	51.83	29.36	30.72	48.12	47.82	38.86	38.62	34.52	36.61
Koroneiki	22.63	22.76	31.52	32.65	35.62	35.62	48.93	49.18	49.74	50.61	36.15	38.45	46.37	48.81	37.97	37.69
Picual	20.37	19.08	28.71	29.69	32.69	31.71	44.37	43.31	42.62	42.89	46.17	46.39	24.17	25.35	31.19	29.95
Manzanillo	19.66	18.72	26.45	27.44	29.21	29.36	38.87	40.25	42.57	42.23	39.26	41.83	34.77	35.57	18.39	18.45
new LSD (0.05) =	0.91	1.07	2.57	2.89	0.91	0.97	2.19	2.66	2.33	2.68	1.23	1.12	2.79	3.95	1.09	1.03

Table (8): Efficiency of pollinator of eight olive cultivars.

Pollinizer	Cultivar							
	Aggizi	Dolce	Kalamata	Maraki	Coratina	Koronaiki	Picual	Manzanillo
Aggizi	---	Pp	Pp	Gp	Pp	Gp	Bp	Bp
Dolce	Gp	---	Gp	Gp	Gp	Gp	Gp	Bp
Kalamata	Gp	Pp	---	Gp	Pp	Gp	Pp	Bp
Maraki	Gp	Gp	Pp	---	Bp	Gp	Pp	Bp
Coratina	Pp	Pp	Bp	Pp	---	Pp	Gp	Bp
Koronaiki	Gp	Gp	Pp	Gp	Pp	---	Gp	Pp
Picual	Pp	Pp	Bp	Pp	Bp	Gp	---	Bp
Manzanillo	Bp	Bp	Bp	Pp	pp	pp	pp	---

Gp: good pollinator Pp: passable pollinator Bp: bad pollinator

4. REFERENCES

A.O.A.C. (2000). Association of Official Anabitical Chemists, 17th Edition, Revision I. Washington D.C., USA, P. 495-510.

Abo-El-Ez A. and Hassnein A.M. (2009). Flowering and fruiting of some olive (*Olea europaea* L.) cultivars grown under Sohag conditions. J. Appl. Sci. Res., 5 (12): 2412-2420.

Al- Kasasbeh M. F., Ateyyeh A.F. and Qrunfleh M. M. (2005). A study on self- and cross-pollination of three olive cultivars in Jordan. Dirasat Agric. Sci., 32, (2): 222-228.

Al-Shdiefat S. M. and Qrunfleh M.M. (2008). Alternate bearing of the olive (*Olea europaea* L.) as related to endogenous hormonal content. Jordan j. Agri. Sci., 4 (1), 12-25.

Androulakis I. I. and Loupassaki M.H. (1990). Studies on the self-fertility of some olive cultivars in the area of Crete. Acta Horti., 286: 59–162.

Ateyyeh A., Stoesser R. and Qrunfleh M. (2000). Reproductive biology of the olive (*Olea europaea* L.) cultivar Nabali Baladi. J. Appli. Bot., 74: 255- 270.

Bradley M.V., Griggs W.H. and Hartmann H.T. (1961). Studies of self and cross pollination of olive under varying temperature conditions. Calif. Agric., 15(3): 4-5.

Breton C.M. and Bervillé A. (2012). A new hypothesis elucidates self-incompatibility in the olive tree regarding S-alleles dominance relationships as in the sporophytic model. C R. Biol., 335:563–572.

Camposeo S., Ferrara G., Palasciano M. and Godini A. (2012). About the biological behavior of cultivar Coratina. Acta Hort., 949: 129-133.

Conner D. J. and Fereres E. (2005). The physiology of adaptation and yield expression in olive. Horti. Rev., 31: 155-229.

Cuevas J.,Diaz-Hermoso A. J. and Galian D. (2001). Response to cross pollination and choice of pollinisers for the olive (*Olea europaea* L.) cultivars Manzanilla de Sevilla, Hojiblanca and Picual. Olivae, 85, 26–32.

Cuevas J. and Oller R. (2002). Olives set and its impact on seed and fruit weight. Acta Horti., 586: 485-488.

Cuevas J. and Polito V. S. (1997). Compatibility relationships in Manzanilllo olive. Hort Sci., 32(6): 1056-1058.

Eassa K. B., El-Tweel A.A.and Gowda A. M. (2011). Studies on self- and cross-pollination for Kalamata olive cultivar grown in a sandy soil. J. Agric. Res. Kafer El-Sheikh Univ., 37(1): 127-140.

El-Hady E.S., Abd El-Migeed M.M.M. and Desouky I. M. (2007). Studies on sex compatibility of some olive cultivars. Res. J. Agri. Biol. Sci., 3(5): 504-509.

Fabbri A., Bartolini G., Lambardi M. and Kailis S. G. (2004). Olive propagation manual. Collingwood, Landlinks Collingwood-Autralia, p. 141.

Farinelli D., Boco M. and Tombesi A. (2006). Results of four years of observations on self – sterility behaviour of several olive cultivars and significance of cross - pollination. Proceedings of Second International Seminar Olive Bioteq 2006, Mazara del Vallo (TP), 5-10 November, Italy,pp. 275-282.

Farinelli D., Tombesi A. and Hassani D. (2008). Self-sterility and cross-pollination responses of nine olive cultivars in central Italy. Acta Horti., 791: 127-136.

Fayek M. A., Abdel-Mohsen M. A.,Laz S. I. and El-Sayed S. M. (2014). Morphological, agronomical and genetic characterization of Egyptian olive clones compared with the international cultivars. Egypt. J. Hort., 41 (1): 59- 82.

Ferrara E., Papa G. and Lamparelli F. (2002). Evaluation of the olive germplasm in the Apulia Region biological and technological characteristics. Acta Hort., 586: 159-162.

Lavee S., Taryan J., Levin J. and Haskal A. (2002). The significance of cross-pollination for various olive cultivars under irrigated intensive growing conditions. Olivae, 91: 25-36.

Lombardo N., Alessandrino M., Godino G. and Madeo A. (2006). Comparative observations regarding the floral biology of 150 Italian olive (*Olea europae* L.) cultivars. Adv. Hort. Sci., 20 (4) : 247-255.

Martin G. C., Ferguson L. and Sibbet, G. S. (2005). Flowering, pollination, fruiting, alternate bearing and abscission. *In*: Sibbett GS, Ferguson L; Coviello J. L.; Lindstrand M. (eds.) Olive production manual. Oakland, University of California, Agri. and Nat. Res. Pp. 49-54.

Martin G. C. and Sibbett G.S. (2005). Botany of the olive. In: Sibbett G.S., Ferguson L. Coviello J.L., Lindstrand M. (eds.) Olive production manual. University of California, Oakland, Agri. and Nat. Res. Pp. 15-19.

Mehri H., Soltane A., Charari Richene F. and Mhanna K. (2013). Preliminary trials on the reproductive behaviour of five olive cultivars conducted in E1 jouf region (KSA). Amer. J. Plant Physiol., 8(3):93- 104.

Mete N., Misirli A. and Çetin O. (2012). Determining the biology of fertilization and pollinators in some olive cultivars. Proceedings of the 4^{th} international conference on Olive Culture and Biotechnology of Olive Tree Products" "Olive bioteq, October 31 st – November a^{th} 2011. Chania- Greece pp:69-74

Mete N., Şahin M. and Çetin O. (2016). Determination of self-fertility of the 'Hayat' olive cultivar obtained by hybridization breeding. Tekirdağ Ziraat Fakültesi Dergisi J. of Tekirdag Agri. Fac., 13 (03): 60-64.

Mhnna M., Douay F. and Al-Qaim F. (2014). The efficiency of open pollination in improving the fruit set of some olive cultivars under the Syrian coast conditions. Tishreen Univ. J. Res. and Sci. Stud. – Biol. Sciences Series, 36 (1): 215-230.

Ministry of Agriculture (2015). Total area and production for fruits in Egypt. economic and statistic department.

Mookerjee S., Guerin J., Collins G., Ford C. and Sedgley M. (2005). Paternity analysis using microsatellite markers to identify pollen donors in an olive grove. Theor. Appli.Genet., 111: 1174-1182.

Moutier N. (2002). Self-fertility and inter-compatibilities of sixteen olive varieties. Acta Horti., 586: 209-212.

Rallo L. and Fernández-Escobar R. (1985). Influence of cultivar and flower thinning within the inflorescence on competition among olive fruit. J. Amer. Soc. Horti. Sci., 110: 303–308.

Sayed H. A. (2013). Characterization and evaluation of some local and imported olive germplasm. Ph. D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Seifi E., Guerina J., Kaiser B. and Sedgley M. (2011). Sexual compatibility and floral biology of some olive cultivars. New Zealand J. Crop Horti. Scie., 39 (2): 141–151.

Selak G. V., Perica S., Ban S. G., Radunic M. and Poljak M. (2011). Reproductive success after self-pollination and crosspollination of olive cultivars in Croatia. HortScience, 46 (2): 186–191.

Snedecor G.W. and Cochran W.G. (1980). Statistical Methods. 7^{th} ed., The Iowa State Univ. Press., Ames , Iowa, U.S.A., pp. 593.

Spinardi A. and Bassi D. (2012). Olive fertility as affected by cross-pollination and boron. The Sci. World J., Article, 1-8.

Taslimpour M. R. and Aslmoshtaghi E. (2013). Study of self-incompatibility in some Iranian olive cultivars. Crop Bree. J., 3(2): 123-127.

Trigui A. and Msallem M. (1995). Cross pollination of Tunisian varieties chemlali de Sfax and Meski. Preliminary Results olivae, 57: 12-15.

Vulletin Selak G., Perica S., Poljak M., Goreta S., Radunić M. and Hartl M. D. (2006). Compatibility relationships within and between olive (*Olea europaea* L.) cultivars. Hort. Sci., 44(2): 500 -502.

Wu S. B., Collins G. and Sedgley M. (2002). Sexual compatibility within and between olive cultivars. J. Hort. Sci. Biotech., 77(6): 665–673.

تأثير إستخدام بعض الملقحات على إنتاجية بعض أصناف الزيتون

أحمد صلاح الدين السودة- عبد الخالق الحسينى- أشرف عبد الفتاح حماد

قسم بحوث الزيتون وفاكهة المناطق شبه الجافة- معهد بحوث البســاتين – مركز البحوث الزراعية – مصر

ملخص

أجريت هذه الدراسة خلال موسمين متتاليين 2014 و 2015 في مزرعة خاصة في طريق القاهرة الإسكندرية الصحراوي على بعد 64 كم من القاهرة لتقييم كفاءة الملقح على الإنتاجية وصفات الجودة لثمانية أصناف من الزيتون وهي العجيزى، دولسي، كالاماتا، مراقي، كوراتينا، كورونـاكي، بيكوال ومنزانيللو. كانت عمر أشجار الزيتون 10 سنوات، مزروعة في تربة رملية، على مسافة 3 ×6 متر وتروى بنظام الري بالتنقيط.أظهرت النتائج وجود اختلافات في كل من بداية وفترة التزهير بين الأصناف في كلا الموسمين وكان صنف العجيزي اكثرهم تبكيرا في التزهير بينما صنف الكالاماتا اخر الاصناف تزهيرا. كما لوحظ أن الأصناف تتداخل في فترة إزهارها وتراوحت فترة التزهير ما بين ١٥-٢٠ يوم في موسم ٢٠١٤ بينما كانت من ١٤- ١٨ يوم في موسم ٢٠١٥ وشوهدت أعلى نسبة مئوية للازهار الكاملة مع اصناف دولسي وكوراتينا. أما فيما يخص مؤشر عدم التوافق الذاتي، كانت اصناف عجيزي و دولسي ومراقي و كروناكي متوافقة ذاتيا وأصناف بيكوال وكوراتينا غير متوافقة جزئياً. بينما كالاماتا و منزانيللو على درجة عالية من عدم التوافق الذاتي. وكان التلقيح الخلطى له افضل النتائج لنسبة العقد و جودة الثمار لأغلب اصناف الزيتون. وبالمقارنة بين الملقحات المختبرة يمكن التوصية بالملقح المناسب لكل صنف كما يلي: المراقي و العجيزي ملقح جيد لبعضهما البعض وكان كروناكي مناسب للدولسي ومنزانيللو و بيكوال واخيرا دولسي لاصناف كالاماتا و كوراتينا و كروناكي.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (68) العدد الرابع (أكتوبر2017): 397-409.