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Studies on Sex Compatiblity of Some Olive Cultivars

[1]Eman S. El-Hady, Laila Haggag F., M.M.M. Abd El-Migeed and [2]I.M. Desouky

[1]Pomology. Dept. National Research Centre, Cairo, Egypt.
[2]Hortic. Dept. Fac. Agric., Ain Shams Univ., Shoubra El-Kheima, Cairo, Egypt.

Abstract: This study was carried out during two successive seasons (2004 and 2006) to evaluate the effect of different pollination types on 16 years old olive oil cultivars, namely Arbeqeina, Bouteillan and Koroneiki .The trees were grown in a sandy soil in an experimental orchard at Ismaillia Governorate, Egypt. These cultivars were showing poor fruit set and low yield problems. During the two studied seasons, each cultivar was subjected to the different types of pollination i.e. self, cross and open pollinations. The obtained results generally showed that Arbequina, Bouteillan and Koroneiki under the experimental conditions are self-incompatible cvs. For proper fruit set, Koroneiki proved to be a good pollinator for Arbequina. Meanwhile, Arbequina seemed to be the best pollinator for Bouleillan. Also, Bouteillan is cross-compatible with Koroneiki for good fruit set. However, Abrbequina seemed to be the best pollinator for Koroneiki highest oil content So, The obtained results suggest that under Ismailia Governorate conditions, planting Arbequina, Bouteillan and Koroneiki cvs. in a mixed plots is recommend for good fruit set and oil content Also using Arbequina pollen grains in a supplementary pollination program proved to be effective in enhanceing Bouteillan olive fruit set.

Key words: Olive, Arbeqeina, Bouteillan , Kononeiki, self, cross, pollination, fruit set, oil content, fruit quality.

INTRODUCTION

Olive cultivation plays an important role in the economy of many countries which most of them belong to the mediterranean region. In Egypt, the latest statistics of the Ministry of Agriculture in 2005 sited that the total acreage grown with olive cvs. reached about 118382 feddans with average yield 3.25 ton/feddan. Olive fruits used for oil extraction and pickling. The oil proportion in the fruit, ranged from 35 to 70% on dry weight basis[17,16,15,3]. Most of olive fruits are used for producing oil and for a little extent for pickling. In the last two decades olive growers put their attention on growing olive oil cultivars where, olive oil is recommended for its nutritional value, in addition to its value in cosmetics industry. Recently, may introduced olive oil cultivars are grown in the newly reclaimed soil in Egypt but such trees are suffering from poor fruit set and low yield problems. In this respect, Ayerza and Coates[2] mentioned that olive trees are self-compatible, but under some climatic conditions a number of olive cultivars have demonstrated problems with pollination and fruit set. In this respet, pollination is one of the most important factors for a good productivity. However, the choice of the pollinator is based on our knowledge of its capacity to fertilize the variety that has to be pollinated[14]. The objective of this investigation was to study the effect of different types of pollination on three olive oil cultivars, namely Arbequina, Bouteillan and Koroneiki to find the proper pollinator for good fruit set, oil content and fruit quality under sandy soil conditions at Esmailia Governorate.

MATERIALS AND METHODS

The present investigation was conducted during 2004 and 2006 seasons in an experimental olive orchard at El Kasseen Experimental Station belonging to Egyptian Horticultural Research, Ministry of Agriculture, Ismailia Governorate, Egypt. The study was conducted on sixteen years old olive oil cultivars namely, Arbequina, Bouteillan and Koroneiki. The selected trees were of uniform size, planted at 5 x 5 maters apart in sandy soil under drip irrigation system and subjected to the same common horticultural practices. Twelve trees (four trees from each cv.) were randomly selected and were subjected to the following types of pollination.

- Self-pollination.
- Cross-pollination.
- Open-pollination.

Corresponding Author: Eman S. El-Hady, Pomology. Dept. National Research Centre, Cairo, Egypt.

These treatments were arranged in a complete randomized block design with four replicates for each cultivar.

Pollination Procedure: In both studied seasons, in each of the twelve experimental trees, a number of inflorescences having flowers at the same developmental stage (balloon stage) on one-year-old shoots around the tree were chosen. Unwanted pollinations were prevented by bagging the shoots before anthesis (at balloon stage), keeping the bags on the shoots until pollination treatment. To collect the pollen grains for hand pollination (cross-pollination), the flowers of the pollinators cvs. were collected at balloon stage. In order to let the anthers dehisce, the flowers were placed on a paper in the laboratory at room temperature. After one day, the pollen grains of each pollinator were collected in glass tubes separately.

Pollination Treatments: Self-pollination treatment was performed by bagging the shoots at balloon stage. At anthesis (75% of the flowers were opened), the shoots were shaken; the shaking was repeated two days later to ensure pollination of all flowers.

Cross pollination treatment was carried out by emasculating the flowers 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.

For open-pollination treatment, the flowers was left under the natural conditions of the orchard and the same number of flowers in other pollination treatments mentioned above were labeled without any treatment (control).

Fruit Set: As mentioned, in the pollination treatments, about 450 flowers per each treatment were left for fruit set measurements. The numbers of total flowers were counted at anthesis. Moreover, fruit set percentage was determined as follows:

- Fruit set = {Number of fruit set (20 days after pollination)} / {total number of followers} X 100.

Fruit set was measured as percentage of the number of fruits per 100 flowers on the same shoots at days after pollination.

Oil Content: Fruit oil content on dry weight basis was determined by means of the soxhlett fat extraction apparition using Hexan of 60-80°C boiling point as described by[1].

The obtained results were statistically analyzed and Duncan's[6] multiple range test was used to differentiate means, Duncan[6].

Fruit Quality:

Fruit Weight: was determined by weighing the fruit sample (10 fruits) and average weight per fruit was calculated.

Fruit Volume: Volume of the displaced water when immersing the fruit sample (10 fruits) in a jar filled with water was estimates and average volume per fruit was calculated.

Seed Weight: was determined by weighing the sample (10 seeds) and average weight per seed was calculated.

Pulp Weight: was measured by a venire weighing as a difference between fruit and seed weight.

Pulp/seed Ratio: Values were calculated by dividing the weight of the pulp over the weight of the seed.

Moisture Content: was determined by drying of flesh in an oven at 60-80°C until a constant weight[1].

RESULTS AND DISCUSSIONS

Results:

Fruit Set: Data in Table (1) show the effect of self, cross and open pollinations on fruit set of Arbequina, Bouteillan and Koroneiki olive cultivars during 2004 and 2006 seasons. From results in Table (1), it is obvious in Arbequina cv., that fruit set was markedly increased when Koroneiki pollen grains were used, showing a significant variation comparing with other pollination types.

Concerning Bouteillan cv. data in Table (1) revealed that cross pollination with Arbequina gave the highest significant fruit set than other treatments

As for Koroneiki, results proved that Bouteillan pollen grains produced the highest fruit set compared with other pollination treatments.

Oil Content: Data in Table (1) show the effect of different types of pollination on oil content in fruits of Arbequina, Bouteillan and Koroneiki cvs. during 2004 & 2006 seasons..

Results revealed that highest oil content in Arbequina fruits was obtained from cross-pollination with Koroneiki pollen grains. As for oil content for Bouteillan, the results indicated that open pollination was the most effective in this respect followed in a

Table 1: Effect of pollination type on fruit set and oil content of Arbequina, Bouteillan and Koroneiki olive cultivar during (2004-2006) seasons

cultivars	Type of pollination Year	fruit set (%) 2004	fruit set (%) 2006	Oil content(%) 2004	Oil content(%) 2006
Arbequina	open	7.8c	8.5c	40.75a	42.68a
	Arbequina	1.1d	0.9d	26.27c	21.06c
	Bouteillan	9.8b	10.0b	36.27b	36.45b
	Koroneiki	13.3a	13.8a	44.79a	45.63a
Significance at 5% level	S	S	S	S	S
Bouteillian	open	7.6b	7.5b	43.67a	45.63a
	Bouteillan	0.9d	0.8d	21.02d	22.41d
	Arbequina	10.1a	10.2a	29.45c	32.74c
	Koroneiki	6.7c	6.6c	39.00b	41.28b
Significance at 5% level	S	S	S	S	S
	open	7.0b	7.3b	32.21b	34.38b
Koroneiki	Koroneiki	0.3d	0.2d	19.93c	22.44c
	Arbequina	6.1c	6.0c	40.48a	42.01a
	Bouteillan	8.0a	8.2a	35.34b	37.28b
Significance at(5%)	S	S	S	S	S

Means having the same letters within a column are not significantly different at 5% level.
S: significant

decreasing order by cross pollination with Koroneiki, cross-pollination with Arbequina and self-pollination respectively. Highest oil percentage for Koroneiki was obtained from cross pollination with pollen grains from Arbequina. It is obvious from data in Table (1) that, the least oil content in the three studied olive cvs. was obtained from self-pollination.

From the above results it could be concluded that cross-pollination in Arbequina as well as Koroneiki cvs. had the superiority for oil content on dry weight basis. However, in Bouteillan as a female parent open pollination was effective in this concern.

Fruit Quality: Table (2) shows the effect of self, cross and open pollinations of Arbequina, Bouteillan and Koroneiki olive cvs on some fruit physical properties during 2004 and 2006 seasons.

Fruit Weight: Results in Table (2) indicate that fruit weight in the three olive cultivars was affected significantly by the type of pollination. The heaviest fruit weight for Arbequina was obtained from open pollination. However, Arbequina lightest fruit weight was obtained from cross pollination with Koroneiki. Self pollination in Arbequina gave high fruit weight values similar to those obtained from open pollination. Benteillan fruits obtained from cross-pollination with Koroneiki as well as from self pollination were heavier than those of other pollination types. Fruit weight of Koroneiki obtained from self pollination recorded the highest fruit weight values comparing with cross or open pollination.

Seed Weight: Data in Table (2) show that seed weight of the three olive varieties followed the same trend obtained by different pollination types on fruit weight. Heaviest seed weight for Arbequina, Boutiellan and Koroneiki were obtained from open, cross pollination with Koroneiki and self pollination respectively. This was true in 2004 and 2006 seasons.

Pulp Weight: Results in Table (2) show that high pulp weight values in Arbequina were obtained from self and open pollinations while pulp weight in Bouteillan was markedly increased by cross-pollination with Koroneiki as well as self pollination. However, in Koroneiki, results indicated that pulp weight was not affected significantly by the type of pollination used.

Table 2: Effect of pollination type on some physical fruit characteristics of Arbequina, Bouteillan and Koroneiki olive cultivar during (2004-2006) seasons.

cultivars	Type of pollination	Fruit (w) (gm)		Volume(cm3)		pulp (w) (gm)		Seed (w) (gm)		pulp/seed		Moister(%)	
	Year	2004	2006	2004	2006	2004	2006	2004	2006	2004	2006	2004	2006
Arbequina	open	2.31 a	2.36 a	1.2 a	1.2 a	1.58 a	1.61 a	0.73a	0.75a	2.16c	2.15c	51.85c	52.97c
	Arbequina	2.22 a	2.29 a	0.7 b	0.9 b	1.63 a	1.67 a	0.59b	0.62b	2.76a	2.69a	50.82c	51.88c
	Bouteillan	1.96 b	2.06 b	1.1 ab	1.0 ab	1.36 b	1.43 b	0.60b	0.63b	2.26b	2.27b	53.43b	54.47b
	Koroneiki	1.73 c	1.78 c	0.8 b	0.9 b	1.19 c	1.22 c	0.54c	0.56c	2.2bc	2.18bc	61.04a	62.15a
Significance at 5% level	S	S	S	S	S	S	S	S	S	S	S	S	S
Bouteillan	open	1.26b	1.61b	1.0 b	1.2 b	0.91b	0.93b	0.35b	0.37b	2.60c	2.51c	62.28a	63.40a
	Bouteillan	1.51a	1.18a	1.3a	1.4 a	1.10a	1.14a	0.41a	0.43a	2.68b	2.65b	60.25b	61.37b
	Arbequina	1.15b	1.57b	0.8 b	1.0 b	0.82b	0.85b	0.33b	0.33b	2.48c	2.50c	60.43b	61.05b
	Koroneiki	1.59a	1.30a	1.2 a	1.4 a	1.17a	1.18a	0.42a	0.43a	2.78a	2.74a	62.35a	63.37a
Significance at 5% level	S	S	S	S	S	S	S	S	S	S	S	S	S
Koroneiki	open	1.40a	1.42a	1.4 ab	1.5 ab	0.98a	0.99a	0.42a	0.43a	2.33c	2.30c	58.50a	59.22a
	Koroneiki	1.25b	1.29b	1.8 a	1.7 a	0.91a	0.94a	0.34b	0.35b	2.68b	2.69b	57.36ab	58.98ab
	Arbequina	1.24b	1.26	1.4 ab	1.6 ab	0.92a	0.93a	0.32b	0.33b	2.87a	2.81a	55.35b	57.79b
	Bouteillan	1.08c	1.21c	1.2 b	1.4 b	0.79a	0.89a	0.29b	0.32b	2.72ab	2.78ab	58.80a	59.36a
Significance at 5% level	S	S	S	S	S	S	S	S	S	S	S	S	S

Means having the same letters within a column are not significantly different at 5% level.
S: significant

Fruit Volume: A marked increase in fruit volume for Arbequina as shown in Table (2) was obtained from open and cross-pollination with Bouteillan compared to self or cross-pollination with Koroneiki. High fruit volume for Bouteillan was obtained from self pollination as well as cross pollination with Koroneiki. However cross-pollination with Arbequina pollen grains decreased Bouteillan fruit volume compared to self and cross pollination with Koroneiki. Koroneiki fruit volume was slightly improved by most tested pollination types specially the selfing one. However, cross-pollination with Bouteillan pollen grains decreased fruit volume of Koroneiki compared with Koroneiki selfing-pollination.

Pulp/seed Ratio: Data presented in Table (2) indicate that pulp/seed ratio was affected significantly by the type of pollination in the three olive varieties. Highest pulp/seed ratio values for Arbequina, Bouteillan and koroneiki, recorded (2.76, 2.69), (2.78, 2.74) and (2.87, 2.81) for self, cross-pollination with Koroneiki and cross-pollination with Arbequina in (2004, 2006) seasons respectively.

Moisture Percentage: Results in Table (2) show the effect of different types of pollination on moisture percentage of Arbequina, Boutellan and Koroneiki olive cvs during 2004 and 2006 seasons. In Arbequina cv. it could be observed that cross pollination with Koroneiki gave the highest percentage of moisture. However, self and open pollinations gave low moisture percentages without significancy among both of them. Meanwhile, cross pollination in Arbequina with Bouteillan pollen grains gave intermediate moisture percentage values, lower than that obtained by cross pollination with Koroneiki but higher than those obtained by self and open pollinations. Concerning Bouteillan cv., it is obvious that cross pollination with Koroneiki as well as open pollination gave high similar moisture percentages values, while self and cross pollinations with Arbequina gave low similar moisture percentages. As for Koroneiki cv. results cleared that there were little differences among various pollination treatments on moisture percentage expect, cross pollination with Arbequina tended to decrease moisture percentage in Koroneiki comparing with cross pollination with Bouteillan.

Discussion: In the present investigation cross-pollination proved to be essential for improving fruit set in the three studied ovile cultivars. Previous studies Griggs[10], Lavee and Datt[13], Girgis[9]: support such results. The beneficial effect of cross-pollination on fruit set in most olive cultivars may be explained by greater fertilization in cross-pollination 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.,*[4]. Similarlly, Hartmann and Optiz[11] reaffirmed former studies at California, they proved that cross pollination of some olive varieties increased fruit set in some years. The obtained results also corresponded well with the findings of other workers[2] who mentioned that significant more olives were produced in Manzanillo branches pollinated with Arbequina pollen grains compared with the control (open pollination). From the above results it could be concluded that cross pollination gave a marked increase in fruit set in the three studied olive cultivars. However, the superiority for cross pollination than open pollination seemed to be depended on the source of pollen grains used (Pollinator). On the other hand, results showed that the least fruit set was obtained under self pollination. When discussing the obtained results of oil content based on dry weight basis it is obvious that cross pollination proved to be effective in improving oil content in Arbequina and Koroneiki cultivars as a female parents. On the contrary, in Bouteillan cv. cross pollination with Arbequina or Koroneiki resulted in reduction in oil content. This means that Arbequina or Koroneiki are not suitable pollinators for Bouteillan in terms of oil content compared to open pollination (control). Results proved that Arbequina is a good pollinator for Koroneiki, meanwhile, Koroneiki is a good pollinator for Arbequina for high oil content. Such results support what have been mentioned by Khalil[12], Eassa[7], Girgis[9] and El-Agamy[8] where cross-pollination, increased oil content compared to self-pollination. Concerning fruit quality, the obtained results indicated that fruit weight, fruit volume, seed weight, pulp weight and pulp/seed ratio in Arbequina, Bouteillan and Koroneiki cvs. were affected markedly by the type of pollination used. In Arbequina, fruit, seed and pulp weight values were greater under open pollination. The obtained results showed that Bouteillan as well as Koroneiki are not suitable pollinators for Arbequina in terms of fruit, seed and pulp weight parameters. However, self-pollination seemed to effective for Arbequina pulp/seed ratio rather than other types of pollinations used. Results developed that Koroneiki is a good pollinator for Bouteillan physical fruit characteristics (fruit weight, seed weight, pulp weight fruit size and pulp seed / ratio. The obtained results are in harmony with the findings of Cuevas and Oller[5] who concluded that pollination is a tool for improving fruit size. Koroneiki fruit and seed weight values were improved by self pollination while open or cross pollination did not show any beneficial effect in this concern. Pulp weight in Koroneiki was not affected by the type of pollination. On the other hand, pulp/seed ratio tended to improve by cross pollination. This may be due to the effect of pollen grains on decreasing seed weight rather than increasing pulp weight. It is obvious that cross-pollination resulted in higher fruit moisture content in Arbequina and Bouteillan olive cultivars than in self-pollination. Fruit physical characteristics in general varied in the three studied cultivars due to the type of pollination used. Koroneiki pollen grains in cross pollination with Arbequina as female parent tended to increase fruit moisture percentage. However, Arbequina as a pollinator tended to decrease fruit moisture percentages in cross-pollination with Bouteillan or Koroneiki. The obtained results are in agreement with the findings of El-Agamy *et al.,*[8] who mentioned that fruit moisture content was lower in self pollination compared to crossing one. However, the present results are not in harmony with the findings of Girgis[9], who mentioned that Koroneiki was found to decreases moisture content in its combinations.

In conclusion, our results generally show that Arbequina, Bouteillan and Koroneiki under the experimental conditions are self-incompatible cvs. However, Koroneiki proved to be a good pollinator for Arbequina in terms of fruit set and oil content. Meanwhile, Arbequina seemed to be a good pollinator for best fruit set in Bouteillan. However, Bouteillan is cross-compatible with Koroneiki for good fruit set. Also, Abrbequina is the best pollinator for Koroneiki for highest oil content. Our the results suggest that under Ismailia Governorate conditions, for good fruit set and oil content, planting Arbequina, Bouteillan and Koroneiki cvs. in a mixed plots is recommend. Also using Arbequina pollen grains in a supplementary pollination program will greatly enhance Bouteillan olive fruit set.

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