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Investigation of self-productivity in some olive cultivars grown under Antalya ecological conditions

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ABSTRACT

Irregular fruit yield in olives is caused by ecology, cultural processes as well as self-inefficiency and not choosing suitable pollinators. Since the self-productivity of olive varieties in different growing areas, this research was carried out to determine the productivity of 'Gemlik', 'Manzanilla', 'Memecik', 'Nizip Yağlık' and 'Tavşan Yüreği' with high commercial value. Selfing and natural pollination were determined in the Akdeniz University Faculty of Agriculture Research and Application Field in Antalya. In self-pollination, the flowers on the clusters were placed into cloth bags at the balloon stage, the pollen was poured into the pouch at the time of flowering, the pouch mouth was closed with a rope and the pouch was shaken to pollinate. Significant differences were determined in % fruit set rates obtained in varieties as a result of selfing and natural pollination. In all olive cultivars used in the experiment, the percentage of fruit obtained from free pollination was higher than self-pollination. 'Gemlik' and 'Tavşan Yüreği' were found to be self-fertile, 'Memecik' and 'Nizip Yağlık' were found to be partially productive, and 'Manzanilla' were found to be self-inefficient. The highest fruit set in both free and selfing was determined in the 'Tavşan Yüreği' cultivar.

1. Introduction

Olive, which has an important role in the field of industry, contributes to human health as well as its contribution to the country's economy. Likewise, olive is a valuable plant that provides economic income as well as being an important food source for the people of the region where it is grown. Although there are numerous species and subspecies within the genus Olea, the olive (*Olea europaea* L.) fruit is the only one whose fruit is edible. The majority of olive cultivars have 2n= 46 chromosomes (Falistocco and Tosti 1996; Mineli et al. 2000; Mete 2009).

Self-productivity in olive varieties differs from year to year and according to different ecologies, and this is due to factors such as lighting, temperature, flower bud formation and climatic conditions during flowering (Antognozzi et al. 1978; Singh et al. 1980; Bini et al. 1981; Bartolini and Guerriero 1995; Ugrinovic et al. 1996; Farinelli et al. 2006).

Olive production per unit area in Turkey is low compared to countries such as Spain and Italy (Gül 2020). Inappropriate land conditions, cultural practices such as pruning, irrigation, fight against diseases and pests and fertilization cause low yields and changes in the severity level of alternate-bearing. Another reason for the low yield is that the fertilization biology of the cultivars being cultivated is not exactly known or the information obtained on this subject is not applied in practice (Kaynaş et al. 1998; Gözel et al. 2008; Mete 2009; Tutar 2010; Türkay 2014). In studies on the fertilization biology of olives, researchers have grouped olive varieties into three groups: self-fertile, partially self-fertile and self-infertile (Zapata and Arroya 1978; Moutier 2002).

The inflorescences in olives are formed in groups of 3-5 on the shoot, and the cluster can have between 10 and 40 flowers depending on the environmental conditions, physiological conditions and variety characteristics. Flowering takes place between April and May, depending on the variety and climatic conditions (Lavee 1996; Kaymak 2011). It was determined that the pollen tubes of the self-infertile olive cultivars develop very slowly and most of them cannot reach the embryo sacs (Porlingis and Voyiatzis 1976). It has been determined that pollen tubes develop faster and reach the ovules when there is foreign pollination in olives, while pollen tubes develop slowly in self-pollination and cannot reach the ovules for fertilization (Cuevas and Polito 1997).

In the 'Yamalak Sarısı' olive variety grown in Aydın province, fruit set was 0.09% in selfing and 0.28% in free-pollination, and it was determined that the variety was partially self-fertile (Kaya and Tekintaş 2006).

In the study conducted on 150 olive cultivars in Italy, 8 cultivars were determined to be absolutely self-incompatible, and the rate of fruit set obtained from free pollination applications was found to be higher than in self-pollination applications. It was emphasized that appropriate pollinator use is necessary, including varieties that are thought to be self-compatible (Lombardo et al. 2006).

'Domat' (Mete 2009) and 'Gemlik' olive cultivars were found to be partially self-fertile (Çavuşoğlu 1970; Sütçü 1983), and 'Kilis Yağlık' cultivars were found to be self-productive (Mete and Çetin 2017).

In self-pollination, fruit set rates of 0.95% in 'Lastovka' variety, 1.38% in 'Leccino' variety, 2.16% in 'Levantinka' variety and 1.11% in 'Oblica' variety were determined. The highest fruit set rates in cross-pollination were 7.15% in 'Lastovka x Levantinka', 7.18% in 'Leccino x Oblica', 6.91% in 'Levantinka x Lastovka' and 3.96% in 'Oblica x Lastovka'. The results revealed the necessity of having a pollinator variety in the olive orchard facility (Vulletin Selak et al. 1994). Although the 'Hayat' olive cultivar is self-fertile, it has been determined that the use of 'Ayvalık', 'Memecik' and 'Gemlik' cultivars as pollinators increases productivity (Mete et al. 2016).

The cultivars 'Arbequina', 'Bouteillan' and 'Koroneiki' were found to be self-infertile in Egypt. 'Koroneiki' for 'Arbequina', 'Arbequina' for 'Bouteillan', and 'Bouteillan' for 'Koroneiki' were found to be suitable pollinators (El-Hady et al. 2007).

In Iran, 'Zard' and 'Fishomi' olive cultivars were found to be self-fertile, while 'Roghani' and 'Shiraz' olive cultivars were found to be unproductive (Taslimpour and Aslmoshtaghi 2013).

The effects of selfing, emasculation, pollinator cultivars ('Manzanilla', 'Kalamata' and 'Koroneiki') and free pollination on fruit set were investigated in the 'Picual' olive cultivar. There was no fruit set in emasculation application, the highest fruit set rate was obtained from free pollination (Atawia et al. 2016).

In different regions of Serbia, 1.45% fruit set was obtained in free pollination and 0.1% fruit set in 'Arbequina' cultivar (Lazovic et al. 2017).

In Şanlıurfa, 'Yuvarlak Halhalı' cultivar was self-infertile, 'Domat' and 'Gemlik' cultivars were found to be partially self-fertile, and 'Nizip Yağık' was self-fertile (Korkmaz and Ak 2018).

In 'Eğriburun Nizip' cultivar, the amount of fruit per cluster was determined as 0.007 in selfing and 0.458 in free pollination, and it was determined that more fruit was obtained from free pollination (Gül 2020).

Since the self-productivity of olive varieties differs in different growing areas, the self-fertility status of the olive cultivars 'Gemlik', 'Manzanilla', 'Memecik', 'Nizip Yağlık' and 'Tavsan Yuregi', grown under Antalya conditions, were determined in this study.

2. Materials and Methods

2.1. Materials

The 31-year-old varieties of 'Gemlik', 'Manzanilla', 'Memecik', 'Nizip Yağlık' and 'Tavşan Yüreği', which are located in the Research and Application Land of Akdeniz University Faculty of Agriculture, were used in this experiment. The trees are pruned in a vase shape. During the experiment, cultural processes such as pruning, fertilization and irrigation were applied to the trees in sufficient quantities and at appropriate times. The research site is 3 km from the sea, at 36^0 54 028' north latitude and 030^0 38 810' east longitude and its altitude is 38 m. According to a soil analysis made in a commercial firm, the soil structure is clay-loam, the organic matter content (2.69%) is low, and the pH is 8.23.

2.2. Methods

In order to determine the fruit set rates of the varieties, the branches 80 cm above the ground and surrounding the tree 360^o were selected and the flowers on the cluster formed on the annual shoots on these branches were counted. In the second week of June, the percentage of fruit set was calculated by determining how many of these flowers had turned into fruit.

2.2.1. Selfing and natural pollination

The research was carried out on trees in the fruiting year (on-year). A few days before the so-called white balloon period for selfing, the flowers on the stems of 3 randomly selected shoots on each tree were counted, enclosed in cloth bags and labeled (Figure 1a). Natural pollination was also applied on the same trees (Figure 1b). In order to increase the rate of selfing, the isolated branches were shaken by hand at regular intervals until the day the sacs emerged. Three shoots were selected randomly from each tree, and flower counts were made on the cluster and labeled (Sütçü 1983; Mete 2009). In both applications, the last counts were made at the end of June, after the fruit set period had passed, the sacs on the isolated branches were removed and the flower counts were carried out. Since the olive flowers are very small, they were counted one by one with a needle tip.

a) Selfing **b**) Natural pollination

Figure 1. Natural pollination and selfing in olives

The self-productivity index (R) formula of cultivars per cluster was calculated according to Moutier (2002) (Table 1).

$$R = \frac{\text{Fruit setting rate obtained from selfing}}{\text{Fruit setting rate obtained from natural pollination}}$$

Table 1. Self-productivity status (R) value categories

Self-efficiency index (R) value category	R
0<0.15	Self-infertile
0.15<0.30	Partially self-fertile
0.30<1.0	Self-fertile

2.2.2. Statistical analysis

The experiment was carried out according to the randomized plot design with 3 replications. Three different trees from each variety were selected, 1 shoot was determined from 3 different directions of each selected tree, and a total of 15 trees from 5 different varieties and 9 shoots for each of 2 different methods were studied. Statistical analysis of the data was made by applying Student's grouping test in JMP (8.0), statistical program and angle transformation was used in the statistical analysis of % values.

3. Results and Discussion

Significant differences in % fruit set rates were determined as a result of self-pollination and natural pollination applications in all cultivars used in the experiment, and the results were found to be statistically significant ($P \leq 0.05$). The percentage of fruit set obtained from natural pollination in all olive cultivars in the experiment was found to be higher than the selfing application. The highest fruit set rates in both natural pollination (5.63%) and selfing (2.30%) were obtained from the 'Tavşan Yüreği' variety (Table 2).

In the 'Gemlik' cultivar, 3.05% fruit set obtained from free pollination was higher than 1.84% fruit set obtained as a result of self-pollination, and this excess was found to be statistically significant ($P \leq 0.05$). Since the obtained R value was 0.60, the variety was determined as self-fertile (Table 2). In accordance with the results, while Gül (2020) found the 'Gemlik' variety productive, some researchers found it partially self-fertile (Çavuşoğlu 1970; Sütçü 1983; Cirik and Gülcan 1988; Kaya and Tekintaş 2006; Mete 2009; Korkmaz and Ak 2018; Gencer 2020). Although the 'Gemlik' variety was found to be self-fertile in the research, due to the high rate of natural pollination, the necessity of using appropriate pollinators was determined.

Table 2. % Fruit set rates and self-productivity indexes determined as a result of natural pollination and selfing in olive varieties in the experiment

Cultivars	Natural pollination	Selfing	R (Self-productivity index)
'Gemlik'	3.05Ba*	1.84Bb	0.60 (Self-fertile)
'Manzanilla'	2.75Ba	0.35Eb	0.12 (Self-infertile)
'Memecik'	3.32Ba	0.97Cb	0.29 (Partially self-fertile)
'Nizip Yağlık'	1.97Ca	0.59Db	0.29 (Partially self-fertile)
'Tavşan Yüreği'	5.63Aa	2.30Ab	0.40 (Self-fertile)

*The difference between applications is significant ($P \leq 0.05$). Capital letters indicate importance according to variants and lower-case letters according to applications.

The fruit set rate (2.75%) obtained as a result of natural pollination in 'Manzanilla' cultivar was considerably higher than that obtained from selfing (0.35%) and the obtained values were found to be statistically significant ($P \leq 0.05$). Since its R value was 0.12, 'Manzanilla' was included in the category of unproductive iself (Table 2). Consistent with the results, Lavee and Datt (1978), Androulakis and Loupassaki (1990), and Cuevas et al. (2009), found the cultivar 'Manzanilla' to be unproductive, while Wu et al. (2002) found it partially unproductive. Also, Tous et al. (1998), stated that the 'Manzanilla' variety gave irregular yields in Spain. As a result of the research, the low fruit set as a result of selfing of the 'Manzanilla' variety showed that suitable pollinators must be kept in the garden in order to increase the yield. For this purpose, Ersoy et al. (1998), determined that suitable pollinators for 'Manzanilla' were 'Uslu' and 'Ayvalık' varieties.

Fruit sets obtained as a result of natural pollination (3.32%) and selfing (0.97%) in 'Memecik' cultivars showed a statistically significant difference ($P \leq 0.05$). 'Memecik' with an R value of 0.29 was determined to be partially self-fertile (Table 2). In accordance with the results, most researchers determined the 'Memecik' variety to be partially self-fertile (Çavuşoğlu 1970; Sütçü 1983; Cirik and Gülcan 1988; Kaya and Tekintaş 2006; Korkmaz and Ak 2018; Mete et al. 2019). However, the fruit set rate obtained from natural pollination was (3.32%), for 'Memecik', which shows that, it is imperative to have suitable pollinators in the garden.

In the 'Nizip Yağlık' cultivar, (1.97%) fruit set was detected in natural pollination and (0.59%) in selfing, and the determined values were statistically significant ($P \leq 0.05$). Since the R value was 0.29, the cultivar was found to be partially self-fertile (Table 2). In accordance with the results obtained, while most researchers found the 'Nizip Yaglik' cultivar to be partially self-fertile (Çavuşoğlu 1970; Sütçü 1983; Cirik and Gülcan 1988; Kaya and Tekintaş 2006; Mete 2009; Mete et al. 2019), on the contrary, Korkmaz and Ak (2018) found the variety to be self-fertile. It revealed the necessity of having suitable pollinators in the garden in order to have a higher free pollination fruit set in the cultivar 'Nizip Yaglik', which had the same R value as 'Memecik'.

The fruit set rate of (5.63%), obtained as the result of natural pollination in 'Rabbit Heart' cultivar, was higher than the (2.30%) set rate obtained from selfing and the value found was statistically significant ($P \leq 0.05$). Since the R value of 'Tavşan Yüreği' is 0.40, the variety is in the self-fertile category (Table 2). Although the 'Tavşan Yüreği' variety is self-fertile, the high rate of free pollination indicates that appropriate pollinator use is necessary in the garden.

4. Conclusions

In the olive cultivars examined in the experiment, the percentage of fruit set obtained from natural pollination was higher than self-pollination. The highest fruit set rates in both natural pollination (5.63%) and selfing (2.30%) were obtained from the 'Tavşan Yüreği' variety. 'Gemlik' and 'Tavşan Yüreği' were determined as self-fertile, 'Memecik' and 'Nizip Yaglik' were partially self-fertile, and 'Manzanilla' was self-inefficient. As a result of natural pollination in some varieties, the % fruit set rate is high, and therefore it has been concluded that suitable pollinators are absolutely necessary for efficient and sustainable production.

In the study, the self-fertility results of the olive cultivars 'Gemlik', 'Manzanilla', 'Memecik', 'Nizip Yağlık' and 'Tavşan Yüreği,' grown in Antalya, showed similarities and differences with the results obtained in other regions. For this reason, it has been determined that it is necessary to investigate the self-productivity status of each variety in the region where it is grown.

Since cross pollination was not implemented during the research, the pollination rates of the cultivars could not be determined. However, this situation should be taken into account in the commercial garden facility and planting should be carried out according to the mutual pollination rates of the varieties.

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