

Determination of Pollinators for 'Tavşan Yüreği' Olive Variety

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Abstract

This study aimed to determine the self-fertility status of 'Tavşan Yüreği' olive variety and to identify suitable pollinator varieties. In this study, controlled pollination applications were carried out with 'Erkence', 'Gemlik', 'Memecik' and 'Uslu' olive varieties, and self-pollination and open pollination applications were performed to determine the self-fertility status of the variety. As a result of controlled pollination applications, 'Uslu' olive variety achieved the highest fruit set rates of 3.14% and 3.09% in both years. 'Gemlik' and 'Memecik' olive varieties, in both years, achieved adequate fruit set rates of 2.17-2.87% and 2.85-2.25% respectively, placing them in the good pollinator category. In self-pollination applications, fruit set rates obtained were determined to be in self-incompatibility category according to 'relative fertility index' category for the 'Tavşan Yüreği' olive variety. These results indicate that in orchards planted with the 'Tavşan Yüreği' olive variety, due to the variety's self-incompatibility, the 'Uslu', 'Gemlik', and 'Memecik' olive varieties should be included as pollinator varieties at a rate of 10%, in that order of priority. Pollen viability and germination tests were performed by using 2,3,5 Triphenyl Tetrazolium Chloride (TTC) and agar in petri dishes (15% sucrose + 1% agar + 100 ppm H₃BO₃) methods in the study. Although pollen viability and germination rates varied depending on the year and variety, they were found to be at a sufficient level for fertilization and fruit set.

1. Introduction

The olive plant (*Olea europaea* L.), cultivated for centuries in the Mediterranean basin and in our country, is a strategic agricultural product for 'Türkiye'. According to the Turkish Statistical Institute (TÜİK, 2024), Türkiye has 209,987,858 olive trees, producing 2,583,682 tons of olive oil and 1,166,318 tons of table olives. One of the most common problems in olive plants is the high degree of self-infertility in terms of pollination biology. In a study examining the self-fertility of 13 olive varieties, 8 varieties were found to be self-infertile in terms of

pollination biology (Gül, 2020). In another study, Moutier (2002), determined the effect of different pollinators on 16 olive varieties, stated that and 11 olive varieties showed a high degree of self-incompatibility after self-pollination, open pollination, and cross-pollination applications, emphasizing the necessity of using pollinator varieties in the orchard. Mete et al. (2016) stated that the Hayat olive variety, obtained from hybridization studies, is self-fertile, however using a pollinator variety in the orchards would be suitable for increasing pollination efficiency and fruit set Selak et al. (2013), examined the effects of

temperature and genotype (variety) on pollen performance and stated that increasing temperatures reduce the pollen germination rate, thus decreasing productivity, and also found that pollen tube development was less in self-pollination applications. In a very recent study conducted by the Olive Research Institute in Türkiye, 8 out of 16 olive varieties were identified as self-infertile, 4 as partially self-fertile, and 3 as self-fertile (Uluçay et al., 2024).

The 'Tavşan Yüreği' olive variety is an important table olive variety widely cultivated, especially in the Western Mediterranean region. This study was conducted to reveal the pollination biology of the variety and to determine suitable pollinators for this variety.

2. Materials and Methods

This study was conducted in the Zeytinpark Area of Antalya between 2023 and 2025. 'Memecik', 'Gemlik', 'Uslu', and 'Erkence' olive varieties were used as pollinator varieties for the 'Tavşan Yüreği' olive variety, and both open-pollination and self-pollination applications were tested in conjunction with the pollinator varieties. Due to the periodicity of the 'Tavşan Yüreği' olive variety, no studies could be conducted in 2024.

The 'Tavşan Yüreği' olive variety was registered by the Batı Akdeniz Agricultural Research Institute (BATEM) in 1993. It is a variety that performs very well in terms of fruit quality criteria and is mostly valued in the green table olive category in the region. Although it has a low oil content, the variety yields high-quality oil (Figure 1). Paper bags were used in isolations for self-pollination and other controlled pollination applications (Figure 1a), and in each application, the number of inflorescences and the total number of flower buds were determined on annual shoots approximately 30 cm long (Figure 1b). After the counts, each application was labelled (Figure 1c). Subsequently, isolations were carried out on pollinator olive varieties to obtain pollen, and controlled pollination applications were performed on the main variety using the obtained pollen. A large number of pollen grains were isolated to protect against rain, and the collected pollen was stored in secure warehouses. These isolations were discontinued at the end of the flowering period.

The self-fertility status of the variety and the level of effectiveness of pollinator varieties were calculated according to the productivity index (R) mathematical model, and the findings were evaluated according to Moutier (2002) (Table 1). In this model, the self-fertility status of the variety is obtained and interpreted by dividing the fruit set rate



Figure 1. Conducting controlled pollination applications (a), inflorescences intensity (b), beginning of blooming (c), labeling (d) fruits and unfertilized parthenocarpic fruits 10 days after full bloom (e), fertilized and unfertilized parthenocarpic fruits (e), changes in fruit and seed with the effect of pollinator varieties 3 months after fruit set (f).

Table 1. Classification of self-fertility and activity level of pollinators.

| | | | | | | |
|-----|----------------------|------|------------------------------|------|--------------------|------|
| (R) | 0.00 | 0.15 | 0.15 | 0.30 | 0.30 | 1.00 |
| | Self-incompatibility | | Partially self-compatibility | | Self-compatibility | |
| (R) | 0.00 | 0.33 | 0.33 | 0.66 | 0.66 | 1.00 |
| | Bad pollinator | | Passable pollinator | | Good pollinator | |

$$R = \frac{\text{Percent fruit set obtained from self - Pollination or pollinator}}{\text{Percent fruit set obtained from open - Pollination cultivar}}$$

obtained with self-pollination by the fruit set rate obtained with open pollination. The classification of pollinator varieties is obtained by dividing the fruit set rate obtained from the pollinator variety by the fruit set rate obtained from open pollination. All numerical values obtained are interpreted according to Table 1.

The 2,3,5 Triphenyl Tetrazolium Chloride (TTC) test was used to determine the pollen viability levels of the olive varieties used in the study (Norton, 1966). Similarly, a solution of 15% sucrose + 1% agar + 100 ppm H₃BO₃ (boric acid) was used to determine pollen germination power (Mete, 2009).

The experiment was conducted on a randomized block design with five replications. Variance analysis was applied to the obtained data and Student's t test was used to compare the means. Average values were evaluated after arc-sin transformation.

3. Results and Discussion

Data on pollen viability and germination rates of the 'Tavşan Yüreği' olive variety and other pollinator varieties used in the study are given in Table 2. Statistically significant differences ($P < 0.001$) were observed in all treatments.

In 2023, the highest pollen viability rate was observed in the 'Erkence' and 'Tavşan Yüreği' olive varieties, which are in the same statistical group. The 'Memecik' olive variety is in the second statistical group. The 'Gemlik' olive variety is in the next group, and the 'Uslu' variety, which has the lowest viability rate, is in the last statistical group.

In 2025, the highest pollen viability rate was observed in 'Gemlik' and 'Tavşan Yüreği' olive varieties, followed by 'Uslu' and 'Erkence', while the

lowest viability rate was found in the 'Memecik' olive variety.

When pollen germination rates were examined, in the first year of the study, 'Gemlik' and 'Tavşan Yüreği' olive varieties were in the first statistical group, exhibiting the highest germination rate values. These varieties were followed by 'Memecik' and 'Uslu' varieties, which were in a lower statistical group. The 'Erkence' olive variety, in the last statistical group, had the lowest germination rate value. In 2025, the highest pollen germination rate was observed in the 'Gemlik' olive variety, which is in the first statistical group. The 'Uslu' olive variety was in the second statistical group, while the 'Memecik' and 'Erkence' olive varieties were in a sub-group. In the last statistical group, the lowest germination rate was observed in the 'Tavşan Yüreği' olive variety.

When the pollen viability and germination rate values obtained in both years are evaluated generally, it is seen that they are at a level that poses a problem in terms of fertilization and fruit set. It has been observed that the obtained viability and germination rates vary both over the years and across varieties. Many studies have emphasized that the reasons for this include the periodicity tendencies of the trees, climatic factors, genetic factors, and cultural maintenance measures applied to the trees (Acarsoy et al., 2011; Gül, 2020; Gül et al., 2023a; Gül et al., 2023b; Gül et al., 2023c; Gül and Ertan, 2025; Lovane et al., 2022; Mete et al., 2015).

The effects of different pollinators on fruit set and the productivity index (R) values in the 'Tavşan Yüreği' olive variety are shown in Table 3. There is a significant difference ($P < 0.001$) between the applications, and the data follow a normal distribution.

Table 2. Pollen viability and germination ratio (%).

| Cultivars | Pollen viability ratio | | Pollen germination ratio | |
|---------------|------------------------|---------|--------------------------|---------|
| | 2023 | 2025 | 2023 | 2025 |
| Memecik | 48.97 bc | 47.12 c | 31.61 b | 38.99 c |
| Erkence | 56.92 a | 75.95 b | 25.01 c | 38.83 c |
| Uslu | 35.43 d | 78.66 b | 30.22 b | 46.93 b |
| Tavşan Yüreği | 55.08 ab | 85.27 a | 47.81 a | 30.09 d |
| Gemlik | 43.25 c | 89.63 a | 52.42 a | 77.33 a |
| CV, % | 1.00 | 1.00 | 1.00 | 1.00 |

Means were grouped according to Student's t test ($P < 0.001$).

Table 3. Fruit set rates depending on pollination combinations in 'Tavşan Yüreği' female parent.

| Application | Fruit set ratio (%) | | Number of fruits per inflorescence | | Productivity index (R) | |
|------------------|---------------------|--------|------------------------------------|---------|------------------------|------|
| | 2023 | 2025 | 2023 | 2025 | 2023 | 2025 |
| Memecik | 2.85 ab | 2.25 a | 0.321 b | 0.238 a | 0.68 | 0.68 |
| Gemlik | 2.17 b | 2.82 a | 0.258 b | 0.247 a | 0.55 | 0.82 |
| Uslu | 3.14 ab | 3.09 a | 0.368 ab | 0.297 a | 0.78 | 0.93 |
| Erkence | 1.09 c | 0.78 b | 0.125 c | 0.074 b | 0.06 | 0.23 |
| Open pollination | 3.74 a | 3.26 a | 0.469 a | 0.321 a | 1.00 | 1.00 |
| Self-pollination | 0.51 c | 0.35 b | 0.059 c | 0.031 b | 0.12 | 0.10 |
| CV, % | 16.00 | 14.00 | 7.00 | 14.00 | | |

The means were classified according to the original values by Student's t test, and the groups were classified according to the transformed values ($P < 0.001$). The data fit the normal distribution.

It is generally known that the fruit set rate in olives varies between 1-5%. However, in cases of self-incompatibility on a variety basis and the absence of a suitable pollinator variety in the orchard, this rate is observed to drop below 0.4%. Table 3 shows the effects of different pollinators on the fruit set ratio and productivity index @ values in the 'Tavşan Yüreği' olive variety.

When fruit set rates are examined, it is seen that in both years, 2023 and 2025, when the 'Uslu' olive variety was used as a pollinator for the 'Tavşan Yüreği' olive variety, the fruit set rates were 3.14% and 3.09%, respectively. Similarly, in the 'Gemlik' and 'Memecik' pollinator combinations, the fruit set rates were at the levels of 2.17-2.82% and 2.85-2.25%, respectively, which is sufficient.

When the 2023 Number of Fruits Per Inflorescence (NFPI) values, which formed the basis of the evaluation, were examined, open pollination and 'Uslu', which were in the first statistical group, and 'Gemlik' and 'Memecik', which were in the second statistical group, were found to be the applications with the highest fruit set ($P < 0.001$). According to 2023 data on the productivity index (R) values, 'Uslu', 'Gemlik', and 'Memecik' olive varieties were classified as good pollinators, while 'Erkence' olive variety was classified as a bad pollinator. Additionally, 'Tavşan Yüreği' olive variety was found to be self-incompatible.

When the values for Number of Fruits Per Inflorescence (NFPI) in 2025 were examined, just like in 2023, 'Uslu', 'Gemlik', 'Memecik' and open pollination applications were in the same statistical group, respectively, and were the applications that increased fruit set the most ($P < 0.001$). According to 2025 data on productivity index (R) values, 'Uslu', 'Gemlik', and 'Memecik' olive varieties are classified as good pollinators, while 'Erkence' olive variety is classified as a bad pollinator, and 'Tavşan Yüreği' olive variety is found to be in the self-incompatible category.

When climatic data for the 2023 olive park location is examined, it is seen that the daily maximum temperatures varied between 21.8 and 32.1°C during the flowering period. In terms of daily rainfall, there has been no significant precipitation except for the 69.2 mm rainfall on May 6th (Figure 2).

When examining the start and end dates of flowering in the Zeytinpark location in 2023, it is observed that it occurred between May 1st and May 20th (Figure 2). 'Uslu', 'Erkence', and 'Tavşan Yüreği' olive varieties entered the flowering period simultaneously on May 1st, while 'Gemlik' entered the flowering period one day later on May 2nd, and 'Memecik' entered it four days later on May 5th. In this location, the first pollination applications were carried out on May 2nd for 'Uslu' and 'Erkence' olive varieties, and on May 3rd for 'Gemlik' and 'Memecik' olive varieties, with a period of approximately 55 hours until the 69.2 mm rainfall on May 6th. In this sense, it is thought that the controlled pollination applications were effective. Histological studies have shown that following pollination, pollen grains descend into the ovules within 24-56 hours, resulting in fertilization (Arzani and Javady, 2000; Gencer, 2020; Kaplan, 2025; Kaplan et al., 2024; Selak et al., 2013).

In the subsequent period, after the rainfall, the second pollination application was carried out on May 8th for all combinations in this location, and there were no climatic problems until May 17th, since the isolations ended. The full flowering period was reached in all varieties by May 7th. Flowering end dates, like flowering start dates, occurred one day apart between May 17 and 22, depending on the variety (Figure 2).

When climatic data for the olive grove location in 2025 is examined, it is seen that daily maximum temperatures during the flowering period vary between 20.7-27.8°C. In terms of daily rainfall, there was no significant rainfall except for 16.6 mm on April 25th (Figure 3).

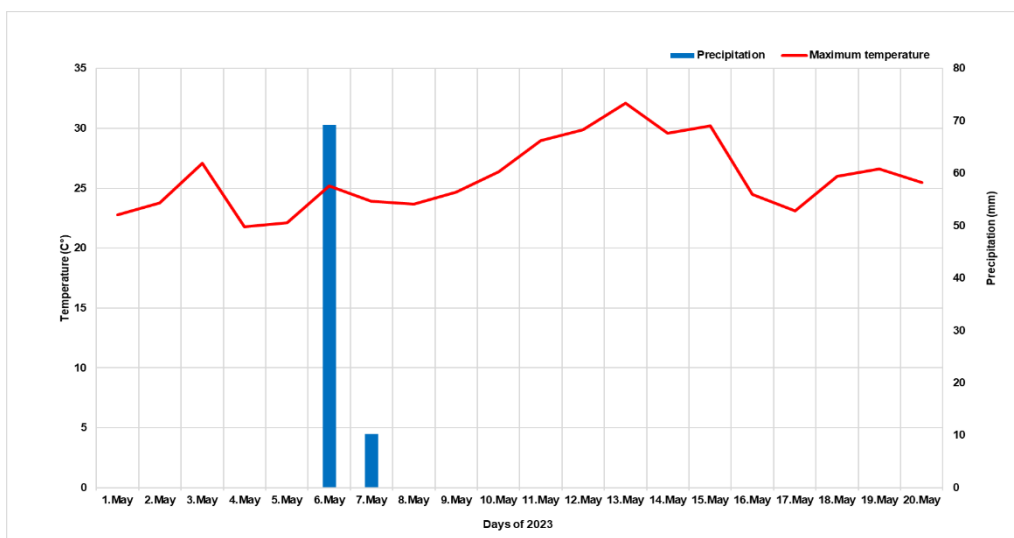


Figure 2. The daily maximum temperature and precipitation in the blooming period of 2023.

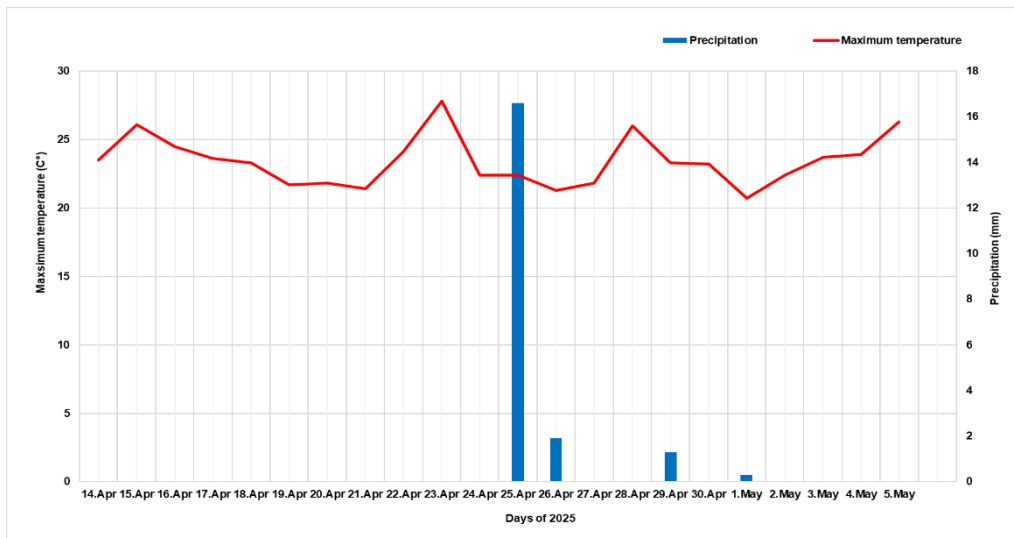


Figure 3. The daily maximum temperature and precipitation in the blooming period of 2025.

In the Zeytinpark location, the time elapsed from the first pollination applications to the rainfall on April 25th was 6 days (144 hours) for 'Erkence', 5 days (120 hours) for 'Uslu', 4 days (96 hours) for 'Gemlik' and self-pollination, and 3 days (72 hours) for 'Memecik'. These periods are considered sufficient for fertilization and fruit set. Histological studies indicate that pollen grains descend into the ovules within 24-56 hours following pollination, resulting in fertilization (Arzani and Javady 2000; Gencer, 2020; Kaplan, 2025; Kaplan et al. 2024; Selak et al., 2013).

However, the flowering period is a dynamic process one lasting approximately 20 days. To ensure pollination and fruit set in this study, a second and third controlled application was carried out. The second pollination application was performed immediately after rainfall on April 26-27, and the third pollination application was carried out on April 30 for all combinations. In the study, to protect against rain, pollen grains isolated in bags were stored in protected warehouses and used in applications following rainfall. In the three pollination applications, directly isolated pollen grains were used in controlled pollination applications. In all applications, the insulation was meticulously checked to prevent bag rupture due to wind speed, and the bags were continuously shaken to ensure pollination. Therefore, there were no problems in terms of climatic data in this location. The fruit set values per cluster obtained in the subsequent process already confirm this situation (Table 3).

4. Conclusion

According to the results, 'Tavşan Yüreği' olive variety has been determined to be in the self-incompatible category in terms of pollination biology. Therefore, the 'Uslu' olive variety, which produces the highest fruit set values in both years, is primarily recommended as the main pollinator for

the 'Tavşan Yüreği' olive variety. The 'Gemlik' and 'Memecik' olive varieties, which have good adaptation ability, high yield and are widely cultivated in the Mediterranean region, could be recommended as secondary pollinators for the 'Tavşan Yüreği' olive variety. At the same time, the flowering onset periods of the 'Uslu' and 'Gemlik' varieties coincide with the 'Tavşan Yüreği' olive variety and that they are varieties that produce abundant pollen constitutes an additional advantage in terms of pollination biology. For these reasons, it is considered that in newly established orchards with 'Tavşan Yüreği' olive variety; 'Uslu', 'Gemlik', and 'Memecik' varieties should definitely be included as pollinator varieties at a rate of 10%.

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