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## Effects of Artificial Pollination on Pistachio (*Pistacia vera* L.) Fruit Cropping

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**Abstract:** In this study artificial pollination has been studied in pistachio orchards. Six shoots that different pollinizers were applied in each tree; the experiment consisted of six treatments; natural pollination as control (covered with plastic mesh), honeybee plus natural pollination (kept uncovered) and four mixtures of pollen (2, 4, 6 and 8%) with soft wheat flour have been prepared for application. Results obtained showed that; artificial pollination of pistachio has both positive and some times negative effects on number of fruits per cluster. Two percent pollen mixture could be used as an effective treatment in pistachio orchards pollination. Artificial pollination not only increased number of fruits per cluster and total yield per cluster but also improved nut size and kernel dry weight in pistachio trees.

**Key words:** *Pistacia vera*, pollination, nut, kernel, honeybees

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### INTRODUCTION

Pistachio *Pistacia vera* L. is a deciduous wind-pollinated woody tree species member of the Anacardiaceae family. It is cultivated mainly in the Mediterranean regions of Europe, the Middle East and California (Vaknin *et al.*, 2001; Vaknin *et al.*, 2002). Its origin is still uncertain, but most experts agree that it probably originated in Central Asia (Herrera, 1997). Pistachio tree is dioecious; male and female flowers are born on different trees, for this reason, cross pollination is necessary (Acar *et al.*, 2001; Ak *et al.*, 1996; Iisfendiyaroglugluglu *et al.*, 2001). Pistachio flowers has no petals to attract insect pollinators, therefore, pollination and fertilization occurs by the transport of pollens from male to female trees by wind (Ak *et al.*, 1996). It is necessary to have enough male trees to insure adequate pollination and to get maximum nut production. Male and female trees are usually interplanted in the orchard with one male to eight or eleven females depending on the orchard (Herrera, 1997; Acar *et al.*, 2001; Ak *et al.*, 1996).

Female flowers do not have petals that could attract bees for insect pollination and pollen transfer depends entirely on the wind (Herrera, 1997). Artificial pollination appears temporary solution to the problem in orchards that under insufficient pollination conditions (Acar *et al.*, 2001). It is worth mentioning that the artificial pollination involves three major steps: (i) pollen collection; (ii) pollen storage; (iii) pollen deposition on receptive stigmas (Vaknin *et al.*, 2001, 2002).

Most of male trees bloom earlier than female pistachio trees and generally spread their pollen while the stigmas are not receptive in female trees (Ak *et al.*, 1996; Iisfendiyaroglugluglu *et al.*, 2001), therefore, artificial pollination gives good result and it should be used as a temporary solution when natural pollination is insufficient (Tasias and Valls, 1990).

Kuru (1995) used different blending materials (corn starch, rice flour, soft and hard wheat flour) in artificial pollination of pistachio and found that the successful results were obtained from the mixtures with 1% pollen concentrations.

Pollination is one of the most important factors in pistachio culture, it is mainly associated to the time difference between flowering of male and female trees, besides pollination may not be satisfactory

since male trees are not planted in suitable ratio and in appropriate direction in orchards, this situation results reduction of the production and great proportion of empty fruits (Iisfendiyarogluglu *et al.*, 2001). Pollen germination on the stigma was negatively correlated with yield (Vaknin *et al.*, 2002) and the large increases in pollen deposition on the stigma might, in some cases, decrease female reproductive success by causing interference between pollen grains at high densities (Young and Young, 1992).

This study has been conducted in pistachio orchards where the differences in maturity periods of the male and female flowers exist. Therefore, it was aimed to contribute artificial pollination with a practical way on yield of pistachio, since this method of application is suitable for improving pollination in wide pistachio areas on open pollinated trees as recommended by Acar *et al.* (2001).

## MATERIALS AND METHODS

This study was carried out on Ashori cultivar at pistachio orchards in Daba area; about 75 km to the south of Amman. Six pistachio trees (Cultivar Ashori), 12 years old, were selected randomly in the field at the 12th April and considered as blocks. In each tree six shoots were randomly selected, that different pollinizers can be applied with two inflorescence clusters represent each treatment, whereas the other clusters were removed from the selected shoots.

To prevent open pollination, female trees were isolated by using paper bags before blooming (Iisfendiyarogluglu *et al.*, 2001). At the beginning of blooming male flowers were collected and the inflorescences were cut and spread over white paper at constant room temperature (25°C). Pollen shed overnight was cleaned and collected by passing it through a 100 µm mesh sieve. The pollen was then sealed in plastic bags and stored in 4°C in the refrigerator until the female blooming started.

Pollen germinability was tested *in vitro* which were performed at 25°C according to protocol described by Polito and Luza (1998) and Iisfendiyarogluglu *et al.* (2001) on a medium containing Agar (1%), Sucrose (15%) and Boric Acid (0.01%). Pollen grains with germinability more than 50% were used for the experiment.

The experiment consisted of six treatments; natural pollination as control (covered with plastic mesh), honeybee plus natural pollination (kept uncovered) and four mixtures of pollen (2, 4, 6 and 8%) with soft wheat flour have been prepared for application and covered with paper bags, according to procedures outlined by Kuru (1995) and Acar *et al.* (2001).

Treatments application time was done when the female flowers opened and stigma become receptive during the morning and at the afternoon hours of 15th, 16th and 17th April/2006. The applications of the pollen grains were done by using a drawing brush; four brushes were used (one/treatment). The pollen treated clusters were covered with paper bags until 26th April. Control treatment (wind pollination) was covered with plastic mesh to prevent honeybees from visiting it. On the other hand, the wind and honeybee treated clusters were left uncovered and sprayed with light sugar solution (1:1) as honeybee attractant.

Harvesting was done at 20th September/2006 when the hulls separates easily from the shell as recommended by Herrera (1997). Each two clusters (replicate) was collected in a paper bags for analysis.

### Measured Parameters

The parameters were taken into consideration to evaluate the efficiency of pistachio pollination were:

#### Number of Fruits per Cluster

The number of produced fruits per two clusters was counted and then the average readings were considered per one cluster.

#### **Total Production per Cluster**

The total freshly harvested fruits per two clusters were weighed (g) using a digital scale balance and then the average readings were considered per one cluster.

#### **Nut Size**

Ten harvested nuts per replicate were used to determine the nut size using water displacement method. The volume of displaced water was divided over the number of the used nuts (Kramer and Twigg, 1973), the average volume (mL) readings were considered per one nut.

#### **Nut Fresh Weight**

Ten harvested nuts per replicate were weighed and the average weight (g) of one nut was calculated.

#### **Nut Dry Weight**

The nut dry weight was determined by weighing ten freshly harvested nuts per replicate using a digital scale balance, then placed in an oven at 60°C for 48 h (Leskinen *et al.*, 2002), then average readings were considered per one nut.

#### **Kernel Fresh Weight**

Ten harvested kernels per replicate were weighed after removing their shells and hulls and the average weight of one kernel was calculated.

#### **Kernel Dry Weight**

Kernels were freshly weighed using a digital scale balance and then placed in an oven at 60°C for 48 h (Leskinen *et al.*, 2002), then average readings were considered per one kernel.

#### **Experimental Design and Statistical Analysis**

A Randomized Completely Block Design (RCBD), with six treatments per six replicates (trees) were used. All data obtained were statistically analyzed by variance, according to the procedure outlined by Steel and Torrie (1980). The differences between means of the different treatments were compared by the Least Significant Difference (LSD) test using SAS and differences with probability value at  $p = 0.05$  were considered significant.

### **RESULTS AND DISCUSSION**

#### **Number of Fruits per Cluster**

The treatments of artificial pollination (2, 4 and 6%) resulted in significantly higher number of fruits per cluster (Table 1); the highest number (69.5) was obtained by 4% pollen mixture treatment. Pollen mixture (8%) was resulted in a lower number of fruits per cluster in compare to 2 and 6% pollen mixture treatments, which may be due to the large increases in pollen deposition on the stigma that decreases female reproductive success by causing interferences between pollen grains on the stigma at high densities and this is similar to the previous suggestions by Young and Young (1992). The same results were found by Vaknin *et al.* (2002) who concluded that pollen germination on the stigma was negatively correlated with yield. Control treatment resulted in the lowest number of fruits per cluster (43.67), using of honeybees in addition to the natural pollination increased the number of fruits per cluster, but it still lower than that obtained by artificial pollination mixture treatments.

#### **Total Yield per Cluster**

Total yield per cluster was improved by artificial pollination mixture treatments, since all treatments of artificial pollination resulted in significantly higher total yield per cluster, in compare to

**Table 1: Effects of artificial pollination on fruit number per cluster, total production and nut size of pistachio trees\***

Pollination treatments	No. of fruits per cluster	Total yield per cluster (g)	Nut size (mL)
Control (natural pollination)	43.67d**	63.18c	2.102b
Honeybee plus natural pollination	57.17c	94.10b	2.067b
2% pollen mixture	69.33a	114.25a	2.103b
4% pollen mixture	69.50a	123.27a	2.550a
6% pollen mixture	66.33ab	113.00a	2.550a
8% pollen mixture	62.50bc	117.45a	2.300ab

\*Values are the mean of six replicates; \*\*Means within each column having different letter(s) are significantly different according to LSD at 5% level

**Table 2: Effects of artificial pollination on nut and kernel fresh and dry weight of pistachio trees\***

Pollination treatments	Nut weight		Kernel weight	
	Fresh (g)	Dry(g)	Fresh(g)	Dry(g)
Control (natural pollination)	1.653a**	0.787a	0.587a	0.373b
Honeybee plus natural pollination	1.854a	0.933a	0.619a	0.434ab
2% pollen mixture	1.676a	0.836a	0.593a	0.417ab
4% pollen mixture	1.921a	0.985a	0.653a	0.462a
6% pollen mixture	2.027a	0.934a	0.665a	0.453a
8% pollen mixture	1.851a	0.849a	0.601a	0.427ab

\*Values are the mean of six replicates; \*\*Means within each column having different letter(s) are significantly different according to LSD at 5% level

the control or natural pollination plus honeybee treatments (Table 1). The highest yield (123.27 g) was obtained by the 4% pollen mixture treatment, whereas the lowest one (63.18 g) was obtained by the control treatment. Furthermore the use of honeybees in addition to natural pollination increased the total yield per cluster in compare to control treatment, but this increase is still lower than that obtained by artificial pollination treatments (Table 1).

### **Nut Size**

The biggest nut size (2.55 mL) was obtained by the 4 or 6% pollen mixture treatments, which were not significantly different to 8% pollen mixture treatment (Table 1). On the other hand the smallest nut size (2.102 mL) was obtained by the control treatment, which was not statistically different with the natural plus honeybee, 2 and 8% pollen mixture treatments.

### **Nut and Kernel Weights**

No statistical differences were observed between all pollinated treatments of pistachio trees in respect to nut fresh and dry weight and to kernel fresh weight (Table 2), even though the highest nut fresh weight (2.027 g), nut dry weight (0.985 g) and kernel fresh weight (0.665 g) was obtained by the 6, 4 and 6% pollen mixture treatments, respectively, while the lowest nut fresh weight (1.653 g) was obtained by the control treatment.

On the other hand, the use of honeybees and or artificial pollination treatments improved kernel dry weight in compare to the control treatment which produced the lowest kernel dry weight (0.373 g), while the highest kernel dry weight (0.462 g) was obtained by the 4% pollen mixture treatment which does not show any significant differences with all other treatments, except the control treatment.

## **CONCLUSIONS**

Artificial pollination is an effective method in pistachio trees, which can be used, to replace natural pollination and ensure high yields with high nut quality. Artificial pollination of pistachio has both positive and some times negative effects on number of fruits per cluster and the 2% pollen mixture could be used as an effective treatment in pistachio orchards pollination.

Artificial pollination; improved number of fruits per cluster, total yield per cluster, nut size and kernel dry weight in pistachio trees, on the other hand, fruit set and yield can be increased with regular soil fertilization, irrigation, pruning, etc.

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