

Effects of dormancy-breaking treatments on seed germination of *Pistacia* species

Pistacia türlerinin tohum çimlenmesi üzerine dinlenme azaltıcı uygulamaların etkileri

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To cite this article:

Yasar, H. & Acar, I. (2019). Effects of dormancy - breaking treatments on seed germination of *Pistacia* species. Harran Tarım ve Gıda Bilimleri Dergisi, 23(2): 206-210. DOI: 10.29050/harranziraat.445109

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Received Date:

18.07.2018

Accepted Date:

14.03.2019

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ABSTRACT

This study was carried out to determine the effects of different dormancy-breaking treatments including stratification, sulfuric acid scarification, dehulling and gibberellic acid (GA₃), on seed germination of different *Pistacia* species e.g. *Pistacia vera* cv. Kırmızı, *Pistacia vera* cv. Siirt, *P. khinjuk-A*, *P. khinjuk-B*, *P. atlantica*, *P. terebinthus* and *P. mutica* using as rootstock for pistachio trees. Seed dormancy-breaking treatments were shelled (control), shelled + GA₃, dehulled, dehulled + GA₃, Sulfuric acid scarification and sulfuric acid scarification + GA₃ applications in the experiment. The seeds of *Pistacia* species were stratified at 4 °C for 50 days after the dormancy-breaking treatments. Stratified seeds were sown in the seedling viols filled with peat in the greenhouse to determine the germination percentage. The highest germination rate was obtained from sulfuric acid scarification in *P. khinjuk-A* (96.7%), and followed by dehulled application of *P. vera* cv. Kırmızı and *P. mutica* species with 94.6% and 93.2%, respectively. On the other hand, the lowest seed germination was observed for shelled + GA₃ application of *P. mutica* with 6.7%. When the seed germination rates of *Pistacia* sp. were examined, the highest germination occurred in *P. vera* cv. Kırmızı, and followed by *P. khinjuk-B*. The lowest germination rate was observed on *P. atlantica*.

Key Words: *Pistacia* sp., Stratification, Scarification, GA₃, Seed germination

Öz

Bu çalışma, katlama, sülfürik asitle aşındırma, kavlatma ve GA₃ uygulamalarını içeren farklı tohum dinlenmesini azaltıcı uygulamaların, antepfıstığına anaç olarak kullanılan *Pistacia* türlerinin (*Pistacia vera*-Kırmızı ve Siirt çeşitleri, *P. khinjuk-A*, *P. khinjuk-B*, *P. atlantica*, *P. terebinthus* ve *P. mutica*) tohum çimlenmesi üzerine etkilerini belirlemek amacıyla yürütülmüştür. Çalışmada kullanılan tohum dinlenmesini azaltıcı uygulamalar; kabuklu (kontrol), kabuklu + GA₃, kavlak, kavlak + GA₃, sülfürik asitle aşındırma ve sülfürik asitle aşındırma + GA₃'tür. Denemede kullanılan *Pistacia* türlerinin tohumları, tohum dinlenmesini azaltıcı uygulamalardan sonra +4 °C'de 50 gün katlamaya alınmıştır. Katlamadan çıkarılan tohumlar, serada içerisine torf doldurulmuş viyollere ekilmiştir.

En yüksek çimlenme oranı, *P. khinjuk-A*'da sülfürik asitle aşındırma uygulamasından elde edilmiş (%96.7) ve bunu *P. vera*-Kırmızı ile *P. mutica*'da kavlatma uygulaması izlemiştir (%94.6 ve %93.2). En düşük tohum çimlenmesi ise *P. mutica*'nın kabuklu + GA₃ uygulamasında (%6.7) görülmüştür. *Pistacia* türlerinin tohum çimlenmesi tür bazında incelendiğinde, en yüksek çimlenme *P. vera*-Kırmızı çeşidinde görülmüş ve bunu *P. khinjuk-B* takip etmiştir. En düşük çimlenme oranı ise *P. atlantica*'da belirlenmiştir.

Anahtar Kelimeler: *Pistacia* türleri, Katlama, Asitle aşındırma, GA₃, Tohum çimlenmesi

Introduction

Pistacia genus is a member of the *Anacardiaceae* family and consists of at least eleven species (Zohary, 1952). Turkey has a large population of *Pistacia* species and several pistachio cultivars since Turkey is the genetic center of pistachio. Seven species, *P. vera*, *P. terebinthus*, *P. khinjuk*, *P. atlantica*, *P. mutica*, *P. palaestina* and *P. lentiscus*, are present and distributed in different regions of Turkey (Atlı et al., 2001). The main pistachio rootstock used in Turkey is *P. vera*, and it is followed by *P. khinjuk*, *P. terebinthus* and *P. atlantica* (Acar et al., 2017).

It was determined that *P. atlantica* and *P. khinjuk* rootstocks were better than *P. vera* rootstock in terms of tree vigour and crown formation of budded cultivars in dry conditions (Ulusaraç, 1992). Among the *Pistacia* species used as rootstocks for pistachio, it was determined that *P. khinjuk* is the best beneficiary of the soil nitrogen. Graft compatibility is well with pistachio cultivars, and no swelling or growth differences at the budding area (Atlı et al., 2001). There are two types of *P. khinjuk* in nature having large fruits (A) and small fruits (B) (Ak, 1988).

Pistachio trees have significant potential for arid and semi-arid areas having suitable climatical conditions in the world. Pistachio cultivars are extremely difficult to propagate clonally on their own roots, and therefore rootstocks offer a simple method for propagate the pistachio cultivars (Acar et al., 2017).

Rootstocks can influence scion vigour, cropping, fruit quality, climatic adaptability, and susceptibility to pests and diseases. Until the mid-19th Century, almost all of deciduous fruit tree rootstocks were raised from seed of fruits collected from indigenous wild populations. Usually, the seedling rootstocks and the fruiting clones grafted on them were of the same botanical genus and species (Webster, 1995). There are many researches dealing with stratification, acid scarification and GA₃ application on seed germination of different *Pistacia* species. Because the seeds of *Pistacia*

species are surrounded by a hard sclerotic endocarp that makes it difficult to germinate, the germination rate in these species is low (İsfendiyaroglu and Ozeker, 2001). Various chemical solutions are used to stimulate seed germination. Gibberellic acid (GA) is one of the growth regulators which can be used to partially or fully replace the required period of cold moist stratification in a number of plant species (Baskin and Baskin, 1998). Scarification and cold stratification were found to improve the seed germination in *Pistacia* sp. (Ak et al., 1995). Seed scarification favours significantly the germination process, therefore it involved the fast inhibition of the tegument of seeds and the entry of water in the reserves that allows the fast exit of the root and the starting of the metabolic reactions of the embryo and the cotyledons (Ahoton et al., 2009; Chebouti-Meziou et al., 2014).

The objective of this study was to determine the effect of dormancy-breaking treatments on seed germination of *Pistacia* sp. using as rootstock for pistachio trees.

Materials and Methods

Plant material

This experiment was carried out in greenhouse of Harran University, Faculty of Agriculture, Department of Horticulture located in the Şanlıurfa province of Turkey.

Dried seeds of different *Pistacia* species e.g. *Pistacia vera* cv. Kırmızı, *Pistacia vera* cv. Siirt, *P. khinjuk*-A, *P. khinjuk*-B, *P. atlantica*, *P. terebinthus* and *P. mutica* were used in the experiment. The seeds were used to determine the seed germination in respect to dormancy-breaking treatments in the research.

Treatments

Six different dormancy-breaking treatments and cold stratification were applied to seeds. Treatments were a) shelled (control), b) shelled + GA₃ application, c) dehulled, d) dehulled + GA₃ application, e) Sulfuric acid scarification and f) Sulfuric acid scarification + GA₃ applications.

Treatments were;

- Shelled (control): Seeds soaked for 24 hours in the water and then stratified at 4 °C for 50 days.
- Shelled + GA₃: Seeds soaked in the 500 ppm GA₃ for 24 hours and then stratified at 4 °C for 50 days.
- Dehulled: Seeds soaked for 24 hours in the water and then removed soft shells. Dehulled seeds were stratified at 4 °C for 50 days.
- Dehulled + GA₃: Seeds soaked for 24 hours in the water and then removed soft shells. Dehulled seeds soaked in the 500 ppm GA₃ for 24 hours and then stratified at 4 °C for 50 days.
- Sulfuric acid scarification: Seeds were immersed in sulfuric acid during 30 min for *Pistacia terebinthus*, 60 min for *P. atlantica* and 90 min for *P. khinjuk* and *P. mutica*. Then seeds were washed and soaked for 24 hours in the water (Crane and Forde, 1974; Ak, 1988; Baninasab and Rahemi, 2001). Scarified seeds were stratified at 4 °C for 50 days. Since the endocarp is cracked in the *P. vera* cultivars, the sulfuric acid was damaging the embryo. For this reason, sulfuric acid scarification was not applied to seeds of *P. vera* cvs. Kırmızı and Siirt.
- Sulfuric acid scarification + GA₃: Seeds were immersed in sulfuric acid during 30, 60 and 90 mins in respect of species, and then washed and soaked for 24 hours in the water. Scarified seeds soaked in the 500 ppm GA₃ for 24 hours and then stratified at 4 °C for 50 days (Crane and Forde, 1974; Ak, 1988; Baninasab and Rahemi, 2001).

Stratified seeds were sown in the seedling

viols filled with peat in the greenhouse to determine the germination percentages. After 21 days from seed sowing, the plants emerging from germinated seeds were counted and seed germination rates (%) were determined.

Statistical analysis

The experimental design was completely randomized design with 3 replications, and 25 seeds were used for each dormancy-breaking treatment in each replication of each *Pistacia* sp. genotypes. Data were analysed using Minitab 17 software (PA, USA, Minitab Inc.). Means were separated by Duncan's Multiple Range Test at $p \leq 0.05$.

Results and Discussion

The results obtained from the present study confirmed that dormancy-breaking treatments had an important effect on seed germination of *Pistacia* genotypes (Table 1). It was known that the exogenous application of various stimulants and inhibitors can affect the plant growth regulators levels and rates in the seeds and thus increase the germination rates (Baninasab and Rahemi, 2001; Mehanna et al., 1985). The highest germination rate was obtained from sulfuric acid scarification in *P. khinjuk-A* as 96.7%, and followed by dehulled + GA₃ application of *P. terebinthus* with 95.6% and dehulled application of *P. vera* cv. Kırmızı with 94.4%. The lowest seed germination was observed for shelled + GA₃ application of *P. mutica* with 6.7%.

Table 1. Effects of dormancy-breaking treatments on seed germination of *Pistacia* species.

Çizelge 1. *Pistacia* türlerinin tohum çimlenmesi üzerine dinlenme azaltıcı uygulamaların etkileri.

Treatments Uygulamalar	<i>Pistacia atlantica</i>	<i>Pistacia khinjuk-A</i>	<i>Pistacia khinjuk-B</i>	<i>Pistacia mutica</i>	<i>Pistacia terebinthus</i>	<i>Pistacia vera- Kırmızı</i>	<i>Pistacia vera-Siirt</i>
Shelled Kabuklu	14.4 d	33.3 e	53.3 d	10.0 d	20.0 c	55.4 c	50.8 c
Shelled+GA ₃ Kabuklu+GA ₃	15.6 d	25.5 f	46.7 e	6.7 d	17.4 c	81.5 b	45.4 c
Dehulled Kavlak	83.4 a	93.3 b	83.3 b	93.2 a	72.2 b	94.6 a	75.4 a
Dehulled+GA ₃ Kavlak+GA ₃	55.6 bc	74.4 d	74.4 c	68.9 c	95.6 a	89.0 a	60.8 b
Scarification Asitle aşındırma	53.3 c	96.7 a	90.0 a	83.3 b	70.0 b	--	--
Scarification+GA ₃ Asitle aşınd.+GA ₃	57.8 b	86.7 c	85.6 b	82.2 b	74.0 b	--	--

The letters following the numbers indicate different groups determined by Tukey test ($p \leq 0.05$)

When the seed germination rates of *Pistacia* sp. were examined, the highest germination occurred in *P. vera* cv. Kırmızı, and followed by *P.*

khinjuk-B. The lowest germination rate was observed on *P. atlantica* (Figure 1).

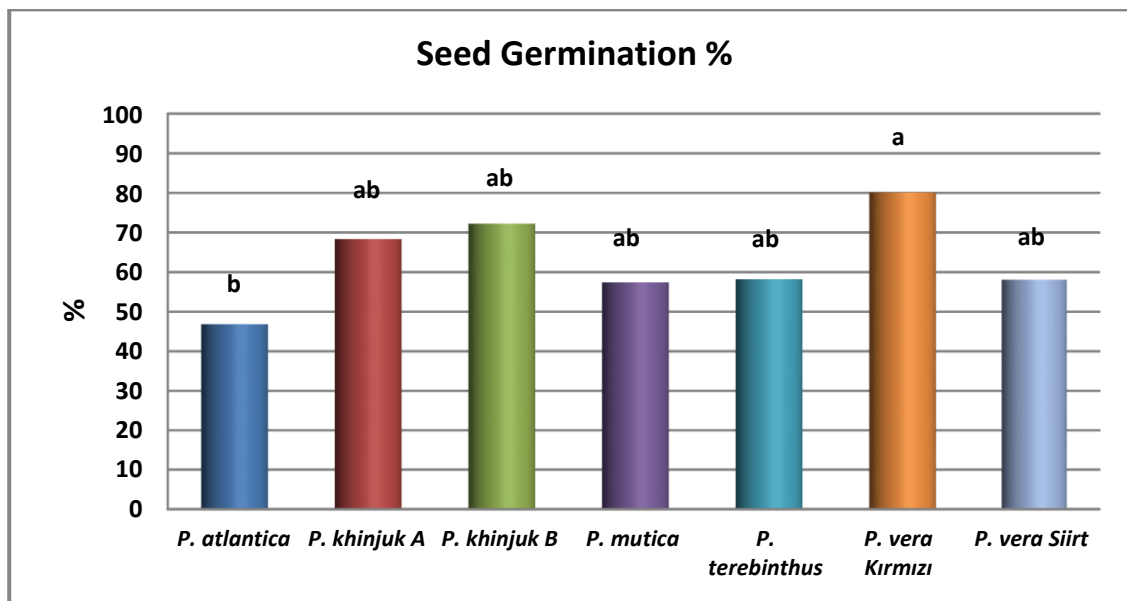


Figure 1. Seed germination rates of *Pistacia* species (%). The letters over the columns indicate different groups determined by Tukey test ($p \leq 0.05$).

Şekil 1. *Pistacia* türlerinin tohum çimlenme oranları (%). Sütunların üzerindeki harfler Tukey testi ile belirlenen farklı grupları göstermektedir ($p \leq 0.05$).

Kafkas and Kaşka (1997) were obtained the highest seed germination from the stratification and the lowest germination from the directly sown treatment in *P. khinjuk* types. It was stated that there were not significant differences between the scarified and scarified + prechilled seeds of *P. lentiscus* (Piotto, 1995). Besides, seeds soaking with 1000 ppm GA₃ for 24 hours did not increase the germination percentages in *P. atlantica* and *P. vera* (Ak et al., 1995). On the other hand, Ak (1990), mentioned that the increases in stratification periods were found positively correlated with the germination percentages of *P. vera* and *P. khinjuk* seeds. Pipinis et al. (2014) reported that, in non-stratified seeds of *Cotinus coggygia*, acid-scarified+GA₃ treatment improved germination significantly, whereas in stratified seeds, no significant differences were observed in the germination percentages of GA₃ treated and untreated seeds. Furthermore, the concentration of GA₃ was not found to affect germination. Abu-Qaoud (2005) obtained the highest germination rate from *P. palaestina* acid scarified+cold

stratified seeds as 60%, on the other hand the germination rate of scarified seeds and scarified+GA₃ applied seeds were 13.3% and 34% respectively in *P. lentiscus*.

As a conclusion, dormancy-breaking applications have been found to be effective on seed germination of *Pistacia* sp. It was determined that GA₃ applications negatively affected seed germination as known to the contrary.

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