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Effects of different treatments on the seed germination and emergence of potential ornamental crop *Chamaecytisus hirsutus* (L.)

Farklı Uygulamaların Potansiyel Süs Bitkisi *Chamaecytisus hirsutus* (L.) Link'un Tohum Çimlenmesi ve Çıkışı Üzerine Etkileri

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Abstract
Natural plants are highly resistant to adverse weather conditions, drought, and lack of water due to their characteristics. They have a high rate of adaptability to different conditions. Acting on the notion of climate change and limited water resources, issues such as using some of the Mediterranean plants and cultivating them as landscape plants so that they could be used for different purposes should be given more importance. The first studies on plants that are subject to trade as landscape plants include; defining the characteristics of the plant and collecting data regarding its vegetative development and production activities. The purpose of this study; determine the effects of different sowing times and treatments on the seed germination and emergence of one of the natural species of the Mediterranean flora, the *Chamaecytisus hirsutus*, for them to be practically seed propagated under producer conditions. To determine the effects of sowing times on germination, sowing has been conducted in October, November, February, and March. To increase germination rates, 14 different treatments have been implemented: immersion in water, stratification, scarification of the seed coat through hot water and sulphuric acid, cold (4 ^{o}C) storage, two different doses of the GA_3 treatment as well as a combination of these methods. From the treatments applied, the best results were obtained from; 10 section soak in boiling water, 10 section soak in boiling water + 24 hours soak in 250 ppm GA_3 solution, and 10 section soak in boiling water + 24 hours soak in 500 ppm GA_3 solution in November.

Keywords: *Chamaecytisus hirsutus*, cultivation, emergence, germination, ornamental plants.

Özet
Doğal bitkiler sahip oldukları özellikler nedeniyle kötü koşulara kuraklığa ve susuzluğa yüksek derecede toleranslı bitkilerdir. Farklı ortamlara adaptasyon kabiliyetleri yüksektir. Küresel iklim değişiklikleri ve kıt su kaynaklarının tasarruflu kullanımı düşüncesinden hareketle kurağa dayanıklı Akdeniz bitkilerinden bazılarının farklı amaçlı kullanımlar için, yeni süs bitkisi olarak kültüre alınması ve kullanımı öncelik verilmesi gereken konulardandır. Süs bitkisi olarak ticarete konu olacak bitkilerde ilk çalışmalar; bitkinin özelliklerinin tanımlanması, vejetatif gelişimiyle ilgili verilerin toplanması ve üretim çalışmalarıdır. Bu çalışma ile; Akdeniz bitki örtüsünün doğal türlerinden *Chamaecytisus hirsutus* türünün üretici koşullarında tohumla pratik çoğaltımı için, farklı tohum ekim zamanlarının ve uygulamaların tohum çimlenmesi ve çıkışına etkilerinin saptanması amaçlanmıştır. Ekim zamanının çimlenmeye etkilerini belirlemek amacıyla ekim, kasım, şubat ve mart aylarında ekimler yapılmıştır. Çimlenme oranlarını artırmak için; suda bekletme, katlama, sıcak su ve sülfirik asitle kabuk aşındırma, soğukta bekletme, iki farklı dozda GA_3 uygulaması ile bu uygulamaların kombinasyonlarından oluşan 14 farklı uygulama yapılmıştır. Yapılan uygulamalardan; kasım ayında, 10 sn kaynar suya daldırma, 10 sn kaynar suya daldırma + 250 ppm GA_3'te 24 saat bekletme ve 10 sn kaynar suya daldırma + 500 ppm GA_3'te 24 saat bekletme uygulamalarından en iyi sonuçlar alınmıştır.

Anahtar kelimeler: Chamaecytisus hirsutus, kültüre alma, çıkış, çimlenme Süs bitkileri

1. Introduction

In recent years, the demands for special qualified plant materials have increased in stabilization studies in environments where plants are challenging to live.

During planting process there are many advantages using plant materials that have adapted to ecologic conditions in the environment. Not only making the work conducted aesthetic and effective in terms of functionality but it also enables the area to integrate with its close surroundings to contribute towards a healthy and sustainable ecosystem (Yazgan et al., 2005; Zencirkıran, 2005).

Within the cultivation of foliage plants, except for the development of varieties, requirements to identify new species that have not yet been produced, and promoting has gained more importance across the world and for sub-tropical climates such as Turkey. Especially in the development of outdoor plants, taking advantage of flora with the same characteristics should be obligatory (Köse, 1998; Kostak, 1998).

Natural plants have systems that adapt perfectly to the circumstances. They need a long term to evolve according to the biotic and abiotic conditions belongs to the region. Due to this characteristic, natural plants are significant and economic alternatives in landscaping as well as protection and stabilization projects. When used in landscaping work, they create a healthier ecosystem because of their conformity to the natural environment and the surrounding flora. In addition, they enable a more economical planting due to they use less water, have low facility and maintenance costs, and are more durable (Sarıbaş, 1998; Barış, 2002).

Temperature increase, one of the main effects of global warming, is an inevitable reality of today, and whose effects we are starting to experience rapidly will increase the demand for plants of the Mediterranean flora resistant to drought. Due to this reason, the use, production, and cultivation of Mediterranean plants come into prominence (Anonymous, 2003).

In accordance with the principles of enabling use of sustainable natural species and transforming value-added natural resources, this study aims to determine the seed propagation method, which is the practical propagation method under producer conditions, on the *Chamaecytisus hirsutus* (L.) Link species that are naturally found in the flora of Turkey. For this purpose, the effects of planting at different times and pretreatments on seed germination and emergencies were determined.

2. Material and Method

2.1. Material

The materials of this study were composed of; the *Chamaecytisus hirsutus* (L.) Link species are a part of the Leguminosae (Fabaceae) family and are found naturally in 100-2000 m altitudes of the Mediterranean climate zone. It is a 20-100 cm high plant, looks like a bit of scattered bush that is slowly developing vertically and has yellow flowers (Davis, 1984; Kaynak, 1997). The seeds used in the trials have been collected from the natural population in the provinces of Bursa and Yalova.

2.2. Method

The seeds collected in July were left in climate conditions that were not under control. October and November in autumn and February and March in spring were chosen for sowing times. To increase the emergence rates of the seeds used in these four different times, the below-mentioned 14 treatments were implemented.

1) Scarification for 30 minutes with H_2SO_4
2) Scarification for 45 minutes with H_2SO_4
3) Scarification for 60 minutes with H_2SO_4
4) Scarification for 45 minutes with H_2SO_4 + 24 hours soak in 250 ppm GA_3 solution
5) Scarification for 30 minutes with H_2SO_4 + 24 hours soak in 500 ppm GA_3 solution
6) 8-week stratification (4 °C) in moist perlite
7) 8-week cold (4 °C) storage
8) 10 section soak in boiling water
9) 10 section soak in boiling water + 24 hours soak in 250 ppm GA_3 solution
10) 10 section soak in boiling water + 24 hours soak in 500 ppm GA_3 solution
11) 24 hours soak in 250 ppm GA_3 solution
12) 24 hours soak in 500 ppm GA_3 solution
13) 24 hours soak in warm (at room temperature) water
14) Control (Leaving it in seed storage)

The seeds were placed in paper packages and then in +4 °C cold storage. The cold wet stratification was done by using moist perlites in plastic boxes and leaving them for 8-weeks in 4 °C storage. The treatment of soaking in water for 24 hours was applied by immersing seeds in room-temperature water. The process of soaking it in boiling water was implemented by placing the seeds in cloth bags and soaking them in 100 °C boiling water for 10 seconds and taking them back out. During the sulphuric acid treatments, 95% concentrated sulfuric acid was used. At the end of the process, the seeds were left to rest in a solution for 30 minutes, prepared by adding 50 grams of sodium bicarbonate to 1 liter of water (Hartman et al., 1990; Eser et al., 2005).

After the treatments, the seeds were sowed to viols filled with perlites + peats (1+3). The trials were conducted under greenhouse conditions with a greenhouse canopy drawn over it without climate control. The trials were ended at the end of May, and seeds that germinated and emerged from the date of the sowing until May were evaluated.

The trials were laid out as split plots based on a randomized complete block design with two factors and three repetitions—each repetition contains 100 seeds. The trials were repeated, and the evaluations were made on average for two years in the 2008-2009 and 2009-2010 periods. The arc-sinus transformation was implemented on the % values that

were obtained. The analyses were conducted on the JUMP (The Statistical Discovery Software) statistical program package. In contrast, the groupings were performed under the LSD (LS Means Differences Student's test) method of multiple comparisons at the 95% confidence threshold level (α=0,05) (Kalaycı, 2005; Acar and Gizlenci, 2006).

3. Findings

The statistical analysis results of the data obtained from seed germination studies of *C. hirsutus* are given in Table 1. As a result of the analysis of variance, the time and treatment interaction was significant. In this study, according to the two-year average of the results obtained from the sowings conducted at four periods after 14 treatment methods, 12.50% to 59.00% germination and emergence were obtained from the *C. hirsutus* seeds. From the evaluations implemented for sowings in November, 10 section soak in boiling water, 10 section soak in boiling water + 24 hours soak in 250 ppm GA_3 solution and 10 section soak in boiling water + 24 hours soak in 500 ppm GA_3 solution are the best group with 59.00%, 54.83% and 54.33% emergence, respectively.

As can see Table 1, treatments 8, 9, and 10 were the first three treatments that resulted in above 35% of emergencies. Besides, boiling water treatment has been in the first place. The difference between these treatments and the others can be seen more clearly during the sowing in November.

As an average of all periods, 24.54% germination rate and emergence have been obtained from the control treatment. The 30 minutes H_2SO_4, 45 minutes H_2SO_4, 60 minutes H_2SO_4, 45 minutes H_2SO_4, + 250 ppm GA_3, 30 minutes H_2SO_4 + 500 ppm GA_3, 8-week stratification (4 °C) in moist perlite, 10 section soak in boiling water, 10 section soak in boiling water + 24 hours soak in 250 ppm GA_3 solution and 10 section soak in boiling water + 24 hours soak in 500 ppm GA_3 solution treatments have had positive effects on the germination of *C. hirsutus* seeds and have also resulted in germination as well as emergence on the control treatment. 8-week cold (4 °C) storage, 24 hours soak in 250 ppm GA_3 solution, 24 hours soak in 500 ppm GA_3 solution, and 24 hours soak in warm (at room temperature) water treatments have not had positive effects on germination and have not resulted in germination or emergence under the control treatment (Table 1).

Table 1. The average seed emergence (%) and statistical groups obtained from the *C.hirsutus* at different times and with different treatments.

Order no	Treatment	Time (seed sowing time)				Average (Treatment) **
		October	November	February	March	
1	Scarification for 30 minutes with H_2SO_4	24.83 q-w***	34.00 e-l	38.00 b-g	24.00 q-w	**30.21**
2	Scarification for 45 minutes with H_2SO_4	32.33 e-o	36.33 c-ı	30.67 f-q	23.50 r-w	**30.71**
3	Scarification for 60 minutes with H_2SO_4	26.67 m-v	35.17 d-k	37.17 b-g	28.00 k-t	**31.75**
4	Scarification for 45 minutes with H_2SO_4 + 250 ppm GA_3 solution for 24 hours	40.17 b-e	29.00 h-s	36.17 c-ı	21.17 t-y	**31.63**
5	Scarification for 30 minutes with H_2SO_4 + 500 ppm GA_3 solution for 24 hours	18.83 w-A	37.33 b-g	32.00 f-p	27.67 l-u	**28.96**
6	Cold storage at 4 ºC for 8 weeks in moist perlite	35.83 c-.j	42.83 b-d	25.83 n-v	28.50 j-s	**33.25**
7	Cold storage at 4 ºC for 8 weeks	28.83 ı-s	32.83 e-n	20.83 u-y	15.33 y-B	**24.46**
8	Soaking in boiled water for 10 section	44.17 b	**59.00 a**	36.50 b-h	28.00 k-t	**41.92**
9	Soaking in boiled water for 10 section + 250 ppm GA_3 solution for 24 hours	38.17 b-f	**54.83 a**	30.33 g-r	25.33 o-w	**37.17**
10	Soaking in boiled water 10 section + 500 ppm GA_3 solution for 24 hours	43.17 bc	**54.33 a**	42.67 b-d	22.33 s-x	**40.63**
11	250 ppm GA_3 solution for 24 hours	21.50 t-y	25.67 n-v	23.83 q-w	12.50 B	**20.88**
12	500 ppm GA_3 solution for 24 hours	25.50 o-w	33.33 e-m	20.67 v-z	14.00 AB	**23.38**
13	Warm water for 24 hours	22.17 s-x	27.83 k-t	25.83 n-v	14.83 z-B	**22.67**
14	Control	23.50 r-w	33.33 e-m	24.83 p-w	16.50 x-B	**24.54**
	Average (time)*	**30.40**	**38.27**	**30.38**	**21.55**	

*Time significant ά= 0,05 cv 0,09
**Treatment significant * The values expressed by the same letters in the
***Time x Treatment significant line/column of the same topic are not different

Germination rate and emergence of seed 30.40% was obtained in October, 38.27% in November, 30.38% in February and 21.55% in March as an average of all treatments (Figure 1). The highest germination and emergence average was obtained in the treatments in November. The lowest percentage of germination and emergence were taken from the treatments in March as values in the time of treatments.

When the results are evaluated as application averages, it is seen that germination between 20.88% (250 ppm GA_3 solution 24 hours) and 41.92% (Boiled water 10 sc.) is obtained. In Figure 2, it is seen that applications exposed to hot water for 10 seconds stand out compared to other applications. Exposure seeds in hot water for 10 seconds could be figured out the simpliest and best application.

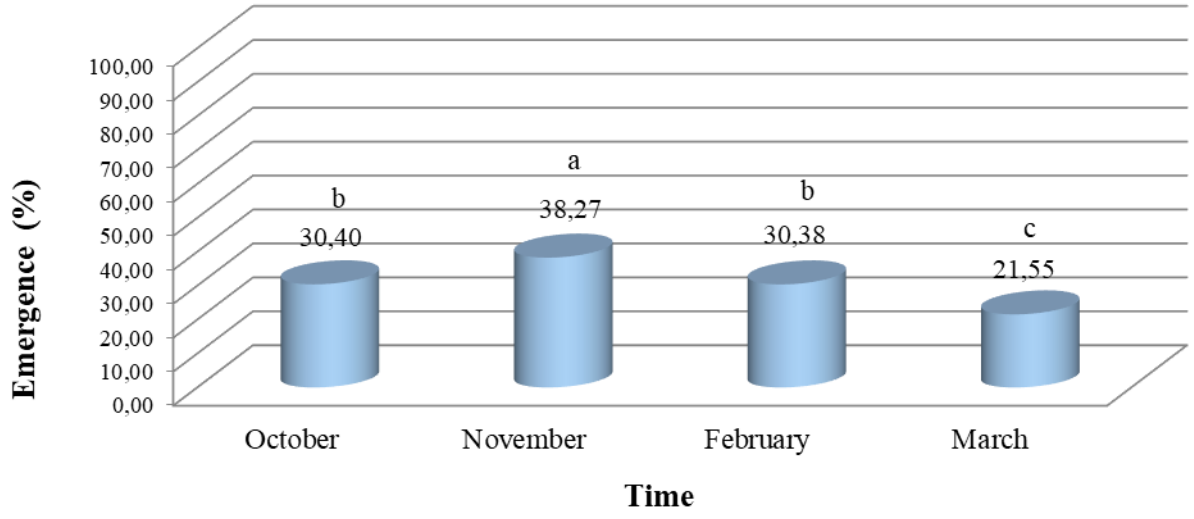

Figure 1. The average seed emergence has taken from different times (%).

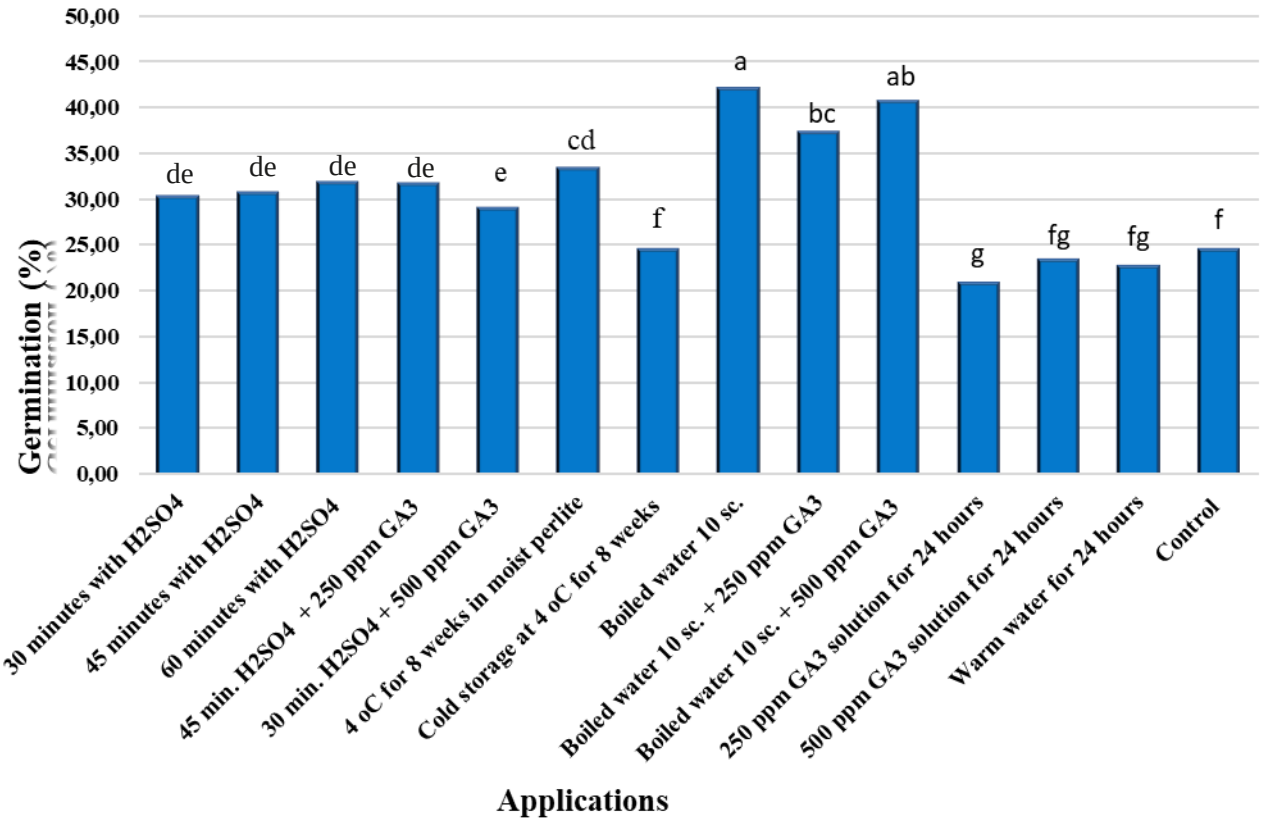

Figure 2. The average seed emergence has taken from different treatments (%).

4. Discussion and Conclusion

While the emergence in October and November increased, it decreased in February and March. It can be seen that the germination period is insufficient for seeds sowed in spring. On the other hand, seeds sowed in autumn find more convenient periods and conditions for germination and emergence.

The results obtained from seed germination and emergence trials are parallel to literature and results reported in Chinea et al. (2006), Tilki (2004), Tansi (2006), Patane and Gresta (2006) and Travlos et al. (2007). In Chinea et al. (2006)'s study about seeds of *Chamaecytisus palmensis* species, the best seed germination was obtained from 80 °C hot water application with 54% germination. Tilki (2004) reported that treatment of hot water, cold water, and acid would increase germination to overcome dormancy caused by a seed coat. In Tansi (2006) studied that folding and hot water treatments were implemented to overcome dormancy in the seeds of eighteen forest trees. The best germination of the seeds of four species belonging to the family of legumes from 18 species (*Robinia pseudoacacia*, *Albizzia julibrissin*, *Gleditsia triacanthos*, and *Diospyros lotus*) has been achieved through the hot water treatment. It has been concluded that these species have dormancy due to their seed coat.

Patane and Gresta (2006), in their study on *Astragalus hamosus*, achieved 91.7% germination through soaking in 80 °C water for 10 minutes to overcome the problem of dormancy caused by a hard seed coat. Travlos et al. (2007) state that soaking and immersion in water are very effective methods in increasing germination and emergence rates in hard-seed coat *Leguminosae* plants.

Sample groups for the worst germination and emergence observed are treatments of 250 ppm GA_3 solution for 24-hour, Warm water for 24-hour, 500 ppm GA_3 solution for 24-hour, Cold storage at 4 oC for 8-weeks in March and control treatment (Table 1 and Figure 1, Figure 2). Travlos et al. (2007) reported that the GA_3 treatment after the seed coat is softened through other treatments gave better results than direct GA_3 treatment; however, the GA_3 treatment is less effective when compared to other treatments.

Rehman (2000), in the study on the germination of *Koelreuteria paniculata* seeds, has not achieved any results on GA_3 treatments without mechanic abrasion. The best results have been taken from three different GA_3 doses applied to seeds ith mechanic scarification + 30-day cold wet stratification. 60 and 90-day cold-wet stratification have adversely affected the germination in *Koelreuteria paniculata* seeds. Travlos et al. (2007) and Rehman (2000) stated that there is any statistically positive effects on germination and emergence between the control group and sample groups of GA_3+cold+24-hour water treatment.

As the average of all periods, better results were taken from the sulphuric acid treatment compared to the control. Even though it has not been in the first group of treatments, the sulphuric acid treatments had positively affected the germination and emergence of *C. hirsutus* seeds. In the Chinea et al. (2006) study, the positive effects of sulphuric acid on the germination of *Chamaecytisus palmensis* seeds were underlined.

According to Travlos et al. (2007), sulfuric acid applications could cause different levels of damage in terms of seed coat thickness and application time. It may lead to different results from various studies. Patane and Gresta (2006) achieved 100% germination in three days through 60-minute sulphuric acid treatments on *Astragalus hamosus*. The highest level of germination (34.9%) for *M. orbicularis* was reached through immersion for 60-minute in a 70% concentration. In this study, the results achieved through the sulphuric acid treatment were not good as much as Patane and Gresta (2006) on *A. hamosus*, but closer to results taken from *M. orbicularis* were obtained.

In the cold-wet stratification treatment through all periods, better emergencies were achieved compared to keeping in cold and immersion in water. Similar results were also achieved in the Zencirkıran et al. (2010) study on the germination of *Cercis siliquastrum* seeds. Zencirkıran et al. (2010) stated that the 4 and 8-week cold-wet stratification treatments increase germination.

Seeds with storage at 4 °C without a seed coat softening treatment, immersion in water for 24-hours, 250 and 500 ppm GA_3 treatments have lower germination and emergence rate than those of control group However, seed coat softening treatments or combination of treatments give better results than the control. It shows that the germination dormancy of the *C. hirsutus* species is caused by the hardness of the seed coat. Also, short-term seed coat softening treatments such as immersion in water for 24 hours are insufficient to overcome the germination dormancy obstacle.

According to these results, the germination dormancy in *C. hirsutus* seeds is not based on cold treatment or embryo rest. The germination percentage can be increased through treatments that alleviate the hard seed coat problem.

Abdalla and Mc Kelvie (1980) stated that both the chilling and GA_3 treatments increased the germination of fresh seeds in all species, in stored seeds, while GA_3 increased the germination of 21 species, chilling increased the germination in 16 species.

As can be seen from the results, the treatments implemented to overcome the obstacle of dormancy in the germination of seeds differ between fresh seeds and stored seeds. They may vary according to the storage time.

C. hirsutus species can be germinated at a 59% rate in November, without using extra materials and chemicals, by the simple and practical method of soaking it in boiling water for 10 seconds.

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