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Effects of some dormancy breaking methods on germination of jute (*Corchorus olitorius* L.)

Bazı dormansi kırma metotlarının jütün (*Corchorus olitorius* L.) çimlenmesi üzerine etkileri

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ABSTRACT

Corchorus olitorius L. is an annual plant that grows in temperate and tropical regions. Although this species is cultivated in some countries, in temperate regions, it is observed that it causes problems as a weed in summer crops. Jute shows resistance to germination even in favorable conditions. This situation is an obstruction for studies with this species, and cultivation process for farmers. On the other hand, in weed management, it is important to know the methods for removing dormancy to reduce the seed bank in the soil. In this study, the effect of some preliminary treatments to reduce dormancy in *C. olitorius* seeds was investigated. For this purpose, seeds were exposed to mechanical scarification, soaking in pure water (2 and 6 hours), application of sulfuric acid (98%; 5, 10 and 15 minutes), gibberellic acid (200, 400 and 600 ppm) and microwave applications (30 and 60 second durations of dry, wet and afloat seeds). Pre-applied seeds were left to germinate in incubators set at 30 °C and germinated seeds were recorded for 10 days. As a result, the germination rate of the seeds in the control group remained at 4%. The highest germination rate (88%) was obtained from the mechanical abrasion of seed coat by sanding. This result suggests that inhibition of germination in this species is mainly due to the hard seed coat. Other applications except sanding were not much different from the control. Sanding is an easy and risk-free method for scientific research to be carried out with the related species, and the farmers can obtain maximum germination from the seeds of jute by this method.

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ÖZ

Corchorus olitorius L. ılıman ve tropik bölgelerde yetişen tek yıllık bir bitkidir. Bu türün ılıman iklime sahip bazı ülkelerde kültürü yapılsa da yazlık kültür bitkileri içerisinde yabancı ot olarak probleme neden olduğu gözlemlenmektedir. Jüt tohumları uygun koşullarda dahi çimlenmeye karsı bir direnç göstermektedir. Bu durum, bu türle yapılan çalışmalarda ve kültür bitkisi olarak üretiminde çiftçiler için zorluğa neden olmaktadır. Diğer taraftan, yabancı ot yönetimi açısından, topraktaki tohum bankasını azaltmak amacıyla dormansiyi ortadan kaldıran metotların bilinmesi önem arz etmektedir. Bu çalışmada *C. olitorius* tohumlarında görülen dormansinin kırılması için yapılan bazı ön uygulamaların etkisi araştırılmıştır. Bu amaçla, tohumlara, mekanik aşındırma, saf suda bekletme (2 ve 6 saat), sülfürik asit (% 98; 5, 10 ve 15 dakika), gibberellik asit (200, 400 and 600 ppm) ve mikrodalga (kuru, ıslak ve nemli tohumlara 30 ve 60 saniye) uygulamaları yapılmıştır. Ön uygulama yapılan tohumlar 30 °C'ye ayarlı inkübatörlerde çimlenmeye bırakılmış ve 10 gün boyunca çimlenen tohumlar kaydedilmiştir. Sonuç olarak, kontrol grubundaki tohumların çimlenme oranı %4 seviyesinde kalmıştır. En yüksek çimlenme oranı (% 88) tohum kabuğunun zımparalanarak mekanik olarak aşındırılması yönteminden elde edilmiştir. Bu sonuçlar, bu türdeki dormansinin nedeninin kalın tohum kabuğundan kaynaklandığını göstermektedir. Zımparalama dışındaki diğer uygulamalar kontrolden çok farklı bulunmamıştır. Zımparalama yöntemi, bu türle yürütülecek bilimsel araştırmalar için kolay ve risksiz bir yöntemdir. Ayrıca üreticiler bu yöntemle ektikleri tohumlardan maksimum düzeyde çimlenme elde edebileceklerdir.

1. Introduction

Dormancy is a period that growth, development and metabolic activities in plant`s formations such as buds, tubers, rhizomes and seeds, are temporarily stopped. Dormancy is a form of resistance to unfavorable conditions and especially in bad seasons (Akman and Darici 1998). Seed dormancy is basically divided into two groups. The first of these is called real or primary dormancy in which the seeds do not germinate due to the physiological and morphological characteristics, such seeds can not germinate even if they have suitable environmental conditions for germination. The second one is temporary or secondary dormancy which is completely related to the environmental conditions where the seed in. Thus, when appropriate environmental conditions (temperature, humidity, oxygen, light, etc.) occur, the seed germinates (Bewley and Black 1982). The seed remains dormant state plays an insurance role in terms of continuity of species, in the environmental conditions that are not suitable for surviving of the seedling. This feature that is not very common and desirable for crop species is of great importance in terms of weeds. As it is known, highly dormancy is seen in most of the weed seeds and via this feature, they continue to exist and become a problem for many years in areas where they propagate their seeds. In weed management, it is important to know the methods to remove the dormancy to reduce the seed bank in the soil. On the other hand, in most of the researches on seed biology and plant development, dormancy in the seeds of the plant being studied is one of the factors that makes it difficult to work. In all the studies conducted, dormancy was observed in the seeds of jute (*Corchorus olitorius* L.) (Velempini et al. 2003; Helaly et al. 2008; Maina et al. 2011; Ibrahim et al. 2013). For this reason, in our study, some preliminary treatments against jute seeds showing germination stagnation in optimum conditions were investigated on dormancy breaking. *C. olitorius* is an annual, herbaceous plant from Tiliaceae family. It grows erect, usually strongly branched. Leaves are alternate, simple and petiolate. Flowers are hermaphrodite, usually 5-merous, shortly stalked and petals are yellow. Fruit is a cylindrical capsule with a short beak. Seeds are angular, 2-3 mm long, irregularly ribbed, dark grey or black (Figure 1 and 2). The plant naturally grows in tropical and temperate zone of the world, including North and South America and Australia, but mainly in Africa and Asia. The plant is cultivated and consumed as food especially in most of the African countries and the Middle East. Also, it is known that the plant is used for medicinal purposes and as a source of fiber (Tulio et al. 2002). On the other hand, in many countries where jute grows naturally, it is an important weed for many summer crops. According to Holm et al. (1997), this species is a weed in 50 countries and in 28 crops. For instance in Turkey, this species is observed as weed in summer crops like sesame, citrus and olive groves in the southern provinces such as Antalya, Adana and Hatay of the Mediterranean Region of Turkey (Incekara 1979; Uremis 2005; Kitis 2009; Cagirgan et al. 2014).

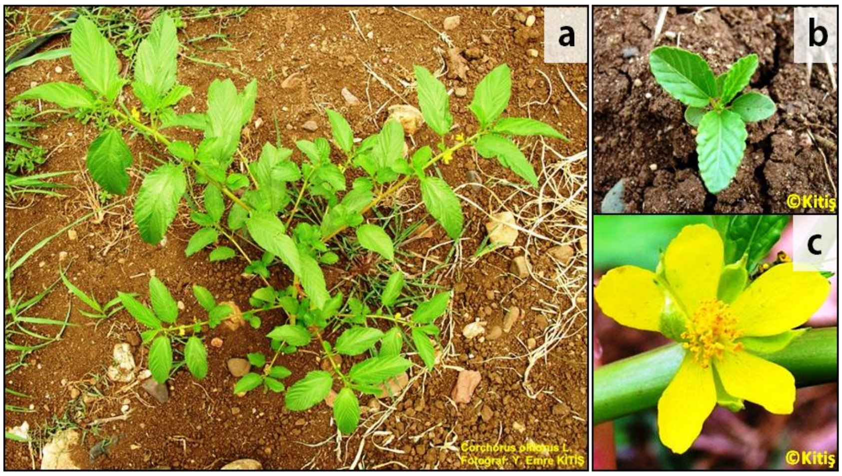

Figure 1. Jute (*Corchorus olitorius* L.) (a) mature plant, (b) seedling, (c) flower.

Figure 2. Fruit and seeds of jute (*Corchorus olitorius* L.).

2. Materials and Methods

The main material of the study was the seeds of jute (*Corchorus olitorius* L.) collected from the Antalya Province located in Mediterranean Region of Turkey in February 2017 (Fig. 2). The thousand-grain weight of the harvested seeds was determined to be 1.74 ± 0.03 g. The seeds were stored about one month at room temperature in laboratory conditions. The other main materials were pliers, sandpaper, microwave oven, gibberellic acid (GA3), sulfuric acid (H_2SO_4), petri dishes, filter paper, drying papers, germination cabinets and pure water were used for the applications to the seeds. All treatments were carried on the Weed Science Laboratory of Plant Protection Department of Akdeniz University in Antalya, Turkey in 2017.

Five different applications were applied for breaking dormancy of *C. olitorius* seeds, including mechanical, chemical and microwave applications and soaking methods.

2.1. Mechanical scarification methods

Two different methods were applied for this purpose. In the first application, jute seeds with a thick seed coat were cracked by applying pressure with pliers. In the second application, the jute seeds were spread on a flat floor in a plastic tub and sanded with zero-number sandpaper for five minutes.

2.2. Microwave applications

In this method, three different applications have been carried out within itself. In the first application, completely dry seeds were applied microwave at 800 watts power and 2.45 GHz frequency, for 30 and 60 seconds (s) (dry application). In the second application, the seeds were kept in the petri dishes containing 10 ml of distilled water for 24 hours at room temperature and then all the seeds were transferred to dry petri dishes and then microwave was applied at the same power, frequency and durations (30 s and 60 s) (preconditioned application). In the third application, microwave was applied at the same power, frequency and durations to the seeds which kept 24 hours in petri dishes include 10 ml distilled waters without drain (wet application).

2.3. Chemical applications

In the other test group, a plant growth hormone gibberellic acid (GA3) was applied to the seeds at doses of 200 ppm, 400 ppm and 600 ppm. For this, 10 ml of each petri dish was added from the GA3 solutions prepared at different concentrations.

For another chemical application of sulfuric acid (H_2SO_4), 98% pure Merck brand sulfuric acid was diluted at 20% with distilled water and jute seeds were immersed in the solution for 5, 10 and 15 minutes. Immediately after the application, the seeds were washed three times with pure water for five minutes, then placed in distilled water for 15 minutes and then transferred to petri dishes.

2.4. Soaking

The last preliminary application was keeping the seeds in pure water in particular durations. For this purpose, two test groups were constituted, and jute seeds were kept in pure water for 2 hours in the first group and 6 hours for the second group. All the seeds were kept in dark condition and at the temperature of 30 °C. At the end of the specified period the seeds were taken with a strainer and placed in petri dishes.

In all applications, disposable plastic petri dishes of 9 cm in diameter were used. A double-layer filter paper was placed at the bottom of each petri dish and 25 *C. olitorius* seeds which were the same shape and size were placed in each petri dish. Ten ml pure water was added to all petri dishes except the petri dishes in microwave wet application. Then, all petri dishes were placed inside transparent nylon bags and their mouths were closed. In all applications, petri dishes were placed in germination cabinets set at 30 °C, the optimum germination temperature of *C. olitorius*. Observations were made on the 1st, 3rd, 5th, 7th and 10th days after the application and the seeds with radicle size of 0.5 cm were accepted germinated and was taken out from petri dishes. The number of seeds germinated at each observation was recorded and the results were evaluated according to the total number of seeds germinated at the end of the 10th day. The experiments were established for each application in three replicates in a randomized complete plot design.

2.5. Statistic analyze

The data were analyzed using R statistical software (Version 1.0.143 ©2009-2016 RStudio, Inc.). The data collected on all parameters were subjected to analysis of variance (ANOVA). Multiple comparisons of values of the averages were determined with the Duncan Test at the rate of 95% confidence.

3. Results and Discussion

Just 4% of the *C. olitorius* seeds in the control group were germinated (Figure 3). This suggests that jute seeds have dormancy in optimum germination conditions. Tolorunse et al. (2015) reported that seeds of this species show high degree dormancy and, in their study, seeds of *C. olitorius* in the control group were germinated just 4%.

Germination occurred in 4.0% and 5.3% respectively in two and six-hour immersion of seeds in water as preliminary applications for breaking dormancy (Figure 3). In the six-hour immersion in water process, a little more seed was germinated than two-hour immersion, but there were no statistical differences between these two applications and also control. Velempini et al. (2003)'s result are supporting our results. In their study, the germination rate of the *C. olitorius* seeds kept in the water at room temperature was below 5%. Similarly, soaking the *C. olitorus* seeds during 24 h at room temperature were not found different from the control group and the germination rate was very low in another study (Maina et al. 2011).

In the application of 20% sulfuric acid (H_2SO_4), there was no significant increase in the germination of *C. olitorius* seeds. The seeds immersed in sulfuric acid for 5, 10 and 15 minutes, germinated at the rate of 4%, 5.3% and 0% respectively (Figure 3). In the application of sulfuric acid for 15 minutes, there was not been observed any germination. In the study of Velempini et al. (2003), the germination rate of *C. olitorius* seeds immersed in concentrated sulfuric acid at different durations (5, 10, 15, 20 and 30 minutes) varied depending on the duration of acid exposure. For example, in 5 and 10 minutes

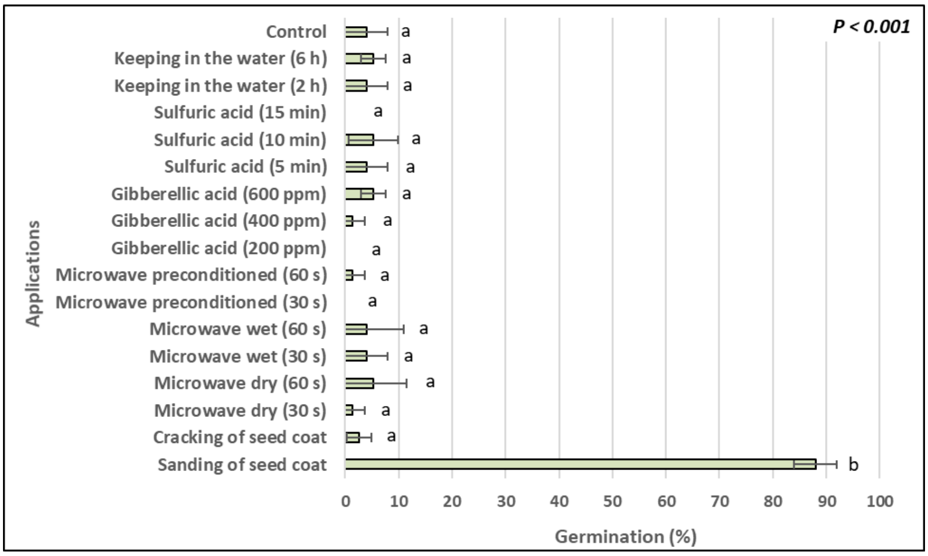

Figure 3. The effect of some dormancy breaking applications on germination of *C. olitorius* seeds. The applications with the same letter are not significantly different at $P \geq 0.05$ using the Duncan's Multiple Range test.

of application the germination rate is close to 20%, but in 15 minutes this rate dropped to almost 0%. These findings are very close to our results. Helaly et al. (2008) conducted a study of dormancy breaking in *C. olitorius* seeds, the best results were obtained in the application of sulfuric acid at 90% concentration for 30 minutes at a germination rate of 84%. In another study investigating the effect of different applications on germination of *Corchorus tridens* seeds which is another species of *Corchorus* genera, the application which most promotes the germination of seeds is sulfuric acid application in 98% concentration for 10 minutes. But in this application, it was stated that the germination capacity of seeds exposed to sulfuric acid over 10 minutes decreased significantly (Emongor et al. 2004). As can be seen, there are different conclusions and interpretations regarding the application of sulfuric acid.

One of the applications to break the dormancy was microwave application in different durations and conditions. However, no significant increase in the germination of *C. olitorius* seeds was observed in any microwave applications (Figure 3). It has been reported that there is no study of microwave application in order to break the dormancy in *C. olitorius* seeds, but it has been reported that the germination of *Stylosanthes seabrana* Maass & 't Mannetje species seeds increased about 40% of 60 seconds 980 W microwave application (Anand et al. 2011). The mode of action of the microwave application differs from conventional heat treatment, but the opening of micro-slits for water and gas entry in the seed coat is come true by the heat too. Especially for species with hard seed coats, the effect of microwave application with different powers and durations can be investigated in order to break the seed dormancy.

The application of gibberellic acid (GA_3), a plant growth hormone, did not increase the germination of *C. olitorius* seeds. Even at doses of 200 and 400 ppm, the germination rate remained below the control. However, only a germination of 5.3% occurred at a dose of 600 ppm (Figure 3). While there is no literature on the application of GA_3 to *C. olitorius* seeds, it has been reported that gibberellic acid at 50, 100 and 150 ppm doses applied to seeds of *C. tridens* which is another species of *Corchorus*, has no effect on germination (Emongor et al. 2004). GA_3, as a germination stimulant of many plant species, has not shown any effect on *C. olitorius* seeds. The possible cause is thought to be due to the impermeability of this type of seed coat and the inability of gibberellic acid to penetrate the seed coat and into the seed, as in the case of water retention (high osmotic pressure) application.

Another application to break dormancy of *C. olitorius* seeds was the mechanical abrasion. For this purpose, the seeds that cracked with a plier, germinated only 2.7%, while the seeds that sanded with sandpaper germinated at 88% (Figure 3). At the same time, this application has been the best-ending application among all other applications. This is the clearest evidence that dormancy seen in the seeds of *C. olitorius* is related to the impermeability of the seed coat. Following the sanding application, water and gas inflow and outflow became possible with the slimming of the seed coat and the seeds germinated at a great rate of like 88%. In the case of breakage of the seed coat with the help of a plier, the germination rate has been very low, probably because the seed embryo was damaged. The method of abrading the seed coats with sandpaper has given good results in many other plant species with hard seeds (Abubakar et al. 2004; Edgar and Roberto 2004; Bulbul and Uygur 2007; Yazlik and Uremis 2015; Sin et al. 2018).

In order to break dormancy in jute seeds, some other applications have been done besides the methods used in this study. The most prominent application among them is a hot water application. The fact that hot water application is an easy and inexpensive method has caused to be tried in many other studies (Velempini et al. 2003; Emongor et al. 2004; Helaly et al. 2008; Maina et al. 2011; Tolorunse et al. 2015). However, although Velempini et al. (2003) concluded that hot water (80-100 °C) reduces dormancy, it has been shown that duration has a very critical role. If the application time is slightly exceeded, seed viability dramatically decreases, and the germination rate comes close to zero. Similarly, in another study, when the duration of exposure to hot water is increasing, vitality of the seeds is getting decrease (Tuncer and Ummuhan 2017).

4. Conclusion

As a result, in the elimination of dormancy in *C. olitorius* seeds, mechanically abrasion of the seed coats with sandpaper in the tried methods gave the best result. However, although the literature mentions the effect of hot water application, it is stated that seeds can easily lose their vitality in case of poor regulation of water temperature. In this case, it can easily be said that sanding is an easy and risk-free method for scientific research to be carried out with the related species, and the farmers can obtain maximum germination from the seeds of jute by this method. On the other hand, in the field where the jute is a problem as a weed, reduced tillage or no-tillage can be a solution in terms of management of this species. Because, in conventional tillage, soil particles act as sandpaper in moving and then more amount of jute seeds find an opportunity for germination.

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