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Germination of *Aeschynomene Elaphroxylon* (Guill. & Per.)Taub seeds under different dormancy breaking treatments and its storability

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Abstract

The objectives of this study paper are 1) to evaluate the potential of different seed dormancy breaking treatments in improving the germination of Aeschynomene elaphroxylon 2) to assess the seed longevity behavior of A. elaphroxylon. To achieve the objectives, seeds of the species were collected and their germination with different seed pre-sowing treatments such as; cold water treatment for 12 and 24 hours; and hot water treatments for 5, 10 and 15 minutes were assessed in a greenhouse. For the evaluation of seed longevity, the seeds stored for one year in a cold room and then their germination was evaluated. One- way ANOVA and t-test were used for the data analysis. Mean separation was performed using Fisher's least significance difference (LSD) test with a significance level of p=0.05. The result indicated significance differences in the mean germination index and mean germination time of the different seed dormancy breaking treatments (P<0.05). There was also a significance difference in the mean germination index of A. elaphroxylon seeds sown soon after collection and seeds sown after storing it for a year period of time (P<0.05). Overall, the findings indicated that, hot water treatment resulted in relatively higher germination index than the other seed dormancy breaking treatments. It is also found that the seed of the species has poor viability as the storage time increases.

Keywords: *Aeschynomene elaphroxylon*, germination, longevity, seed dormancy, treatment.

Introduction

Aeschynomene elaphroxylon (Guill. & Per.) Taub. belongs in the Fabaceae family, in the genus of *Aeschynomene*. The species is a large shrub/ small tree that can grow up to 9 m high, and it has a spins in the stems, and thorns under the leaf base[1 2]. The species is widely grown in tropical Africa[3]. The species is adapted to fluctuating water levels and in Ethiopia, the species is distributed in Lake Ziway, Lake Abaya and other Lakes[4 5]. The species has unbranched roots, and the root grows superficially into the soil[2]. The bark of the species has containing nitrogen-fixing bacteria of the genus *Bradyrhizobium* and the species is potentially useful for enhancing soil fertility and it is used as green manure in crop cultivation[6,7]. The woods of *A. elaphroxylon* species have a lot of local importance and in Ethiopia, it is used for making seating chair (stools), boats and etc, and it is possible to observe women and men are selling stools along the roadsides, that is prepared from it[7].

Seed dormancy is a failure of a seed to germinate temporary in a favourable conditions[8]. Seed longevity is related with the viability of a seed after storing it for some time in a conducive storage[8]. Seed dormancy is caused by because of the presence of inhibitors for a germination, hard seed coat cover of the seed and other factors[9,10]. In order to enhance seed germination, breaking seed dormancy is important and for such purposes, different treatments such as plant growth regulators, chemicals, hot water, cold water and heat treatments have been recommended and used[11]. The effectiveness of the dormancy breaking methods are directly associated with the dormancy behavior of the species seed[11]. Persistency of dormancy is the time of the seed from harvest till its germination which is stored in an ambient storage, reached a germination of less than five percent[12]. Despite the other external factors (example, temperature, moisture etc) seed dormancy as an internal factor, affects seed germination very strongly[13]. Some plant seeds can have one or more types of dormancy that must be overcome before they will germinate, and such characteristics is especially common for woody ornamental and native perennial plants[14]. Evaluating different treatments such as hot water treatment, cold water treatment, scarification and etc. to break the seed dormancy problem of any species is required in order to enhance the germination[14]. Despite the economic and environmental importance of *A. elaphroxylon*, so far, study results on the propagation techniques, and seed longevity are not available. Overall, understanding the effect of seed storage on the germination of the species, with different seed dormancy breaking treatments is important for afforestation and conservation purposes of the species. The objectives of this research are 1) to evaluate the effect of different treatments on the germination of *A. elaphroxylon* seeds 2) to assess the seed longevity behavior of *A. elaphroxylon*. At the beginning of the study it was hypothesized that a) *A. elaphroxylon* does not have a seed dormancy problem b) the seeds of *A. elaphroxylon* can be stored for a longer year without losing its viability.

Materials and methods

Seed collection: Seeds of *A. elaphroxylon*, along its pod were collected in Ziway Lake, located 164 km away from Addis Abeba, the capital city of Ethiopia. The seeds were carefully removed from the pod, and allowed to dry under shade. The dried seeds were sealed in a plastic jar and kept in a cold room for two months period until the experiment was started. After two months of storage, part of the seed was taken out from the storage for the purpose of seed dormancy breaking test with different treatments. The remaining seeds were kept in a cold room (for one year period) for the purpose of seed longevity study experiment.

Germination experiment: The seed germination study was carried out in a greenhouse. The germination experiment was performed using plastic boxes filled with sand, in which the sand was used as a germination media. Randomized Complete Block Design (RCBD) was used in the germination study. The treatments used for the seed dormancy breaking experiment were; i. Hot water treatment (soaking in hot water for 5, 10 and 15 minutes) ii. Cold water treatment for 12 and 24 hours iii. Control (untreated seed). For each treatment, there were four replications and for each replication 100 seeds were used. For the seed longevity study, the seeds that were stored in a cold room for a year period of time were taken out and their seed germination with the different seed dormancy breaking treatments was evaluated after one year of storage. The seeds in the experimental study were watered daily, in the morning time.

Data collection and analysis: The germination of the species seeds was attended for two months period of time in the greenhouse. The data of germination were collected daily using a data collection sheet. One way- analysis of variance (ANOVA) and t-test used for the analysis and Sigma Plot 13 (Systat Software, Inc., San Jose, CA, USA) program was used. Means were separated using Fisher's least significance difference (LSD) test, with a significant level of p=0.05. .The final germination percent, mean germination time and germination index for the different germination treatments applied on the seeds were analysed using the following formulas:

Final germination percent (GP) was calculated using the formula (1):

GP = total number of seeds germinated/total number of sown seeds x 100 (1)

Mean germination time (MGT) was calculated using the formula (2):

$$MGT= \sum(T_1n_1 + T_2n_2 +\ldots+ Tknk)/\sum(n_1 + n_2 +\ldots+nk) \quad (2)$$

where n= number of new germinated seed, T= time from the beginning of the experiment, Germination Index (GI) was calculated using the formula (3):

$$GI= \sum(T_1n_1 + T_2n_2 +\ldots+ Tknk) \quad (3)$$

where - n= number of new germinated seed, T= time from the beginning of the experiment.

Results and discussion

The result on the germination of *A. elaphroxylon* with different treatments is presented in Table 1. The ANOVA result revealed significance differences on the mean germination of the different treatments applied to break seed dormancy (Table 1, p=0.002).The significant differences were between the controlled (untreated seed) and the other seed dormancy breaking treatments (cold water for 12 and 24 hours; and hot water for 5, 10, and 15 minutes) (Table-1, p=0.002). The statistical result revealed no significant differences, on the mean germination of seeds treated with cold water (for 12 and 24 hours); and among the hot water seed treatments (for 5 minutes, 10 minutes, and 15 minutes) at a significance level of 0.05 (Table-1). The result revealed significant differences mean germination index of the seeds of the species (Table-1, p=0.002), and the significant differences were between the control and all other seed pre-sowing treatments. The analysed result revealed statistically no significant differences among applied treatments of cold water for 12 hours, cold water for 24 hours, hot water for 5 minutes, hot water for 10 minutes, and hot water for 15 minutes. There was a significance difference in the mean germination time for the seed dormancy breaking treatments on cold water treatment for 12 hours and hot water treatment for 15 minutes.

The ANOVA result on the GP, MGT, and GI of the seeds stored for one year, and then evaluated for their germination using different treatments is presented in Table-1. The analysis results revealed a significant differences in the GP of the seed of *A. elaphroxylon* that were assessed with different treatments for their germination after storage for one year time (p=0.031, Table 1). These significant differences were between cold water treatment for 12 and 24 hours. The ANOVA result showed no significant differences in GP among the hot water treatments for 5, 10 and 15 minutes (Table-1). The result on the MGT of *A. elaphroxylon* presented in Table-1, revealed no significant differences among the treatments to enhance the seed germination of *A. elaphroxylon* (Table-1, P=0.402). The GI result showed a significant differences among the different treatments (P<0.05, Table-1); and these were significant difference on the GI the cold water treatment for 12 and the 24 hours (P<0.05, Table-1). There were also statistical significant differences among the hot water treatments for 5, 10 and 15 minutes. GI of the seed treatments between cold water treatment for 12 hours and the control showed no significant differences. Overall, the ANOVA result revealed a significant differences on the germination of the seeds sown soon after collection and seeds sown after storing it for a year period of time (Figure-1, p<0.05).

Table-1: Analysis of variance results on the impact of different treatments on the seed germination parameters for *A. elaphroxylon* species. Means with similar letters are not significantly different (p = 0.05).

Seed dormancy breaking treatment	Mean germination % of fresh seeds (GP)	Mean Germination % of stored seeds (GP)	Mean germination time of fresh seeds (MGT)	Mean germination time of stored seeds (MGT)	Germination index of fresh seeds (GI)	Germination index for stored seeds (GI)
Cold water for 12 hours	28 (2.5) ^{A}	4.5 (1.04) ^{B}	6.4 (0.4) ^{A}	10.8 (3.4) ^{A}	195.3 (6.8) ^{A}	39 (8.8) ^{A}
Cold water for 24 hours	28 (1) ^{A}	9.3 (2.9) $^{A\,C}$	7.0 (0.2) $^{A\,D}$	8.5 (1.7) ^{A}	230.3 (8.6) ^{A}	98 (5.5) ^{B}
Hot water for 5 minutes	33.5 (2.3) ^{A}	10.8 (0.9) $^{A\,C}$	8.2 (0.5) $^{B\,C}$	9.4 (2.4) ^{A}	228 (16.0) ^{A}	89 (8.3) ^{B}
Hot water for 10 minutes	29.5 (2.9) ^{A}	11.8 (1.6) $^{A\,C}$	7.1(0.3) $^{A\,C\,D}$	9.8 (2.2) ^{A}	222.3(20.4) ^{A}	98.5 (9.7) ^{B}
Hot water for 15 minutes	32.5 (3) ^{A}	9.5 (0.6) $^{A\,C}$	8.4 (0.4) ^{B}	8.8 (0.6) ^{A}	238.3(34.6) ^{A}	79.5 (5.8) ^{B}
Untreated seed (control)	15.3 (3.5) ^{B}	6.8 (0.5) $^{B\,C}$	7.7 (0.4) $^{B\,D}$	11.6 (2) ^{A}	112 (30.4) ^{B}	53 (4.5) ^{A}
P	0.002	0.031	0.011	0.402	0.002	<0.001

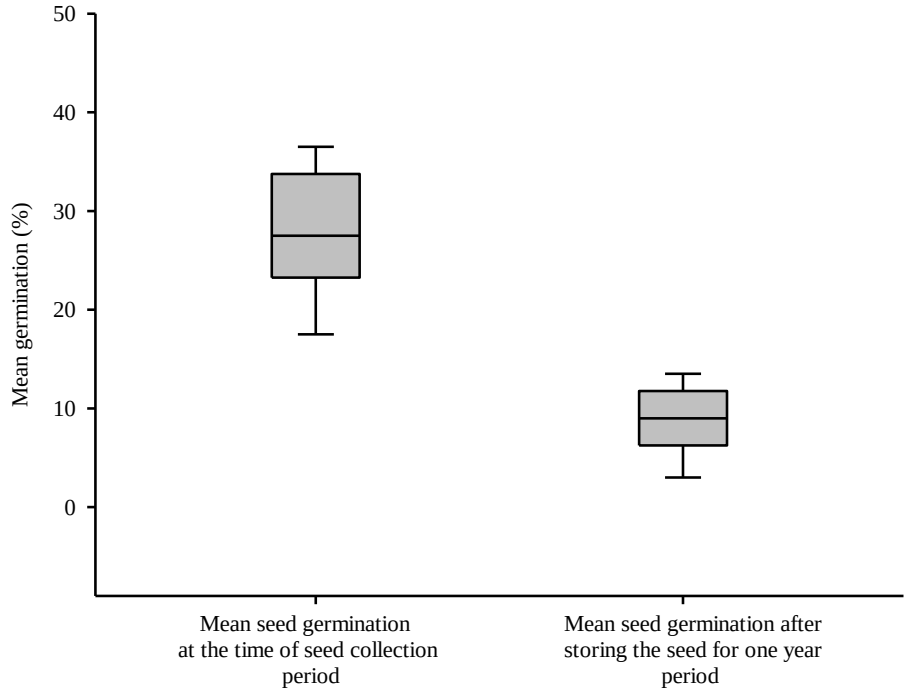

Figure-1: ANOVA results on the mean germination of *A. elaphroxylon* using different seed dormancy breaking treatments studied soon after collection and after storing it for a year period of time.

Discussion: Though the degree of occurrence varies, seed dormancy is a normal phenomena and it occurs in species[15]. The current study result also showed that *A. elaphroxylon* seed has a dormancy problem. Accordingly, applying seed dormancy breaking treatments could be necessary to enhance its germination. The findings revealed that *A. elaphroxylon* seeds has a dormancy problem and the treated seeds achieved a better GI as compared with the control. Although the statistical analysis result showed no significance differences among the different seed dormancy breaking treatments that were applied on the seeds to enhance their germinations, hot water treatment for fifteen minutes resulted in relatively higher germination index than the other treatments. This result does not coincide with the findings of Amusa[16] who indicated that seeds of

Afzeliaafricana that were treated with hot water, resulted in poor germination as compared with the cold water pre-treatment and the control. This could show that the dormancy breaking treatments required by different species varies. The result further indicated that freshly collected seeds and seeds stored for one year in a cold room and treated in a hot water for 15 minutes and 10 minutes resulted in a germination index of 238.3 and 98.5, correspondingly, which could further show that variations for the dormancy seed treatments for a similar species.

The longevity test result revealed that, the seeds of *A.elaphroxylon* stored for a year period of time, and evaluated for their germination with different seed dormancy breaking treatments, resulted in lower germination index relative to the freshly collected and tested seeds (Table-1, Figure-1). This could show that the germination of the species declines as the storage time increases. Nguyen et al. [8] indicated that there was a negative relationship between seed dormancy and longevity on some species. Seed storability is the total seed life span [17]. The present study shows that the studied species cannot be stored for a longer period of time. Therefore, if we want to raise the seedlings of *A.elaphroxylon* we have to collect the seed and sow it as soon as possible to have higher number of germinated seeds.

Overall, the findings indicated, the seeds of *A. elaphroxylon* have a dormancy problem and in order to enhance its germination treating the seed with hot water for 10 – 15 minutes could enhance the germination of the seed. The seed longevity study results also indicated that within one year period of storage time, the viability of the seed of the species, was highly reduced, which further showed that the species has short longevity. This could show that in afforestation or plantation establishment of *A. elaphroxylon* using freshly collected seeds in the nursery could result in a higher number of seedlings. Finally, it is recommended that the potential of the species for vegetative propagation through cuttings has to be studied and evaluated.

Conclusion

To break seed dormancy of *A. elaphroxylon*, treating the seed of *A. elaphroxylon* with a hot water for 10-15 minutes could enhance the germination of the species. The species has the problem of losing its viability as storage time increases and therefore, it is recommended to use freshly collected seeds to have higher germination percent.

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Figure-2: A photo that shows the germination of *A.elaphroxylon* in a greenhouse.

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