Journal of Global Ecology and Environment

Volume 20, Issue 2, Page 35-41, 2024; Article no.JOGEE.12244
ISSN: 2454-2644

Effect of Seed Presowing Treatments on Germination Parameters in *Albizia Procera*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/jogee/2024/v20i28784

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.ikprress.org/review-history/12244

Original Research Article

Received: 11/05/2024
Accepted: 15/07/2024
Published: 19/07/2024

ABSTRACT

Albizia procera is an important tree species and it belongs to the Fabaceae family. An experiment was conducted to determine the most effective pre-sowing treatments for maximizing germination. Ten pre-sowing treatments were tested, with data collected on daily basis to calculate the germination percentage (G%), germination rate index (GRI), mean daily germination (MDG), peak value (PV), germination value (GV), and mean germination time (MGT). Significant differences were

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Cite as: *Jaliya, R. M., S. S. Jha, B. S. Desai, R. S. Chauhan, V. B. Patel, and Y. A. Garde. 2024. "Effect of Seed Presowing Treatments on Germination Parameters in Albizia Procera". Journal of Global Ecology and Environment 20 (2):35-41. https://doi.org/10.56557/jogee/2024/v20i28784.*

observed between the seed pretreatments and control for all parameters. The highest germination percentage (90.00%), GRI (27.12%), MDG (2.81), PV (10.00), and GV (28.13) were achieved in seeds pretreated with 50 ppm GA_3 for 12 h (T9). Seeds treated with hot water at 70 °C for 5 min followed by soaking in tap water for 24 h also showed improved results. This study helps to identify the most effective pre-sowing treatments to improve germination rates and seedling establishment of *A. procera*, thereby enhancing the success of large-scale plantations in agroforestry and social forestry initiatives.

Keywords: Albizia procera; pretreatment; germination percentage; mean daily germination; peak value.

1. INTRODUCTION

"The genus *Albizia* consists of around 150 species, primarily trees and shrubs, native to tropical and subtropical regions of Asia and Africa" [1]. Approximately 16 species are native to the Indian subcontinent and are often cultivated as avenue and shade trees in tea and coffee plantations [2,3]. Some species of this genus, such as *A. julibrissin*, *A. lebbeck*, *A. gummifera*, *A. chinensis*, *A. adianthifolia*, and *A. procera*, are also significant in Ayurvedic medicine.

Albizia procera, known as "Safed siris," is a valuable multipurpose tree belonging to the Fabaceae family. It thrives in dry mixed deciduous tropical forests with 80–200 cm of rainfall and open sunlight. This species is widely distributed across more than 15 countries, including India, Myanmar, Southeast Asia, Papua New Guinea, Northern Australia, some African countries, Panama, and Puerto Rico [4]. It prefers fertile, deep, clayey loam soil with good drainage and can withstand extreme summer temperatures. Typically growing to 7-15 meters, it can reach up to 30 meters with a 9-meter bole, 35-60 cm in diameter. The bark is smooth and dark green or yellowish-green, with the inner bark turning from green to orange and finally pinkish or straw-colored [5]. The heartwood is light brown to light chocolate brown, moderately hard, durable, and termite-resistant [6]. The compound leaves have 2-5 pairs of sub-opposite pinnae with a 5.5-12 cm petiole, featuring a large, dark-colored gland near the base. The inflorescence consists of pedunculate clusters grouped in an axillary panicle up to 30 cm long.

Extensive adaptability and range of desirable traits makes *A. procera* an ideal candidate for large-scale plantation efforts in agroforestry and social forestry. However, the success of these plantations heavily depends on effective seed germination and seedling establishment. Suitable pre-sowing seed treatment can enhance seed germination hence it is critical for large-scale plantations in agroforestry and social forestry [7-9]. Seed treatment ensures higher, quick and uniform germination [10,11]. The positive effects of pre-sowing treatments on tropical forest tree species have been well documented in *Tamarindus indica* [12], *Acacia spp.* Aref *et al.* [13]. *Afzelia africana* [14], *Bauhinia thonningii* [15], *Melia dubia* [10], *Albizia lebbeck* [16], *Faidherbia albida* [17]. However, there is limited information on the effects of such treatments on *A. procera* despite it is observed that the *Albizia* species have poor germination success without pre-treatment [18]. The present study aims to determine the best pre-sowing treatment for higher germination in *A. procera*.

2. MATERIALS AND METHODS

2.1 Plant Materials

The present study was carried out during 2023-2024 in nursery at College of Forestry, Navsari Agricultural University, Navsari district of Gujarat, India. Matured dark brown pods were collected and dried in the open sun for about five days. Brownish Seeds were extracted manually from the pods. Uniform sized seeds were selected to reduce non-treatments variation and then subjected to different pre-sowing treatments as mentioned below and sown in polythene filled with the growing media of Soil: Sand: FYM (2:1:1).

2.2 Experimental Design and Pretreatment

Seeds were subjected to ten treatments as listed in Table 1. For each treatment, three replications consisting of hundred healthy and uniform seed each, were pretreated. The experiment was laid out in a Completely Randomized Block Design (CRBD). The ten treatments and procedures used in the experiment were as follows:

Table 1. Pre-sowing treatments which used in the experiment

Treatment	Treatment Group	Description
T1	Hot water treatment	Soaking in hot water 70 ºC (5 min) followed by soaking in tap water (12 h)
T2		Soaking in hot water 70 ºC (5 min) followed by Soaking in tap water (24 h)
T3		Soaking in hot water 70 ºC (5 min)
T4		Soaking in hot water 70 ºC (15 min)
T5	Chemical treatment	Soaking in 20% H_2SO_4 (6 h)
T6		Soaking in 40% H_2SO_4 (6 h)
T7		Soaking in 20% H_2SO_4 (12 h)
T8	Plant growth regulator treatment	Soaking in GA_3 (25 ppm) (12 h)
T9		Soaking in GA_3 (50 ppm) (12 h)
T10	Control	Control (Un-treatment)

2.2.1 Data recording and germination assessment

The effects of seed pre-treatment were assessed by daily counting of number of germinated seeds. A seed was considered to have germinated when the tip of radicle emerged free of the seed coat [19,20]. The parameter of seed germination measurements as follow:

2.3 Germination Per Cent (G%)

Seed germination percentage was calculated from final germination using following formula and is expressed in per cent.

> Germination percentage (%) = Total number of normal seeds germinated / Total number of seeds sown * 100

2.4 Germination Rate Index (GRI)

Germination rate index (GRI) expresses the rate of germination according to the total number of seeds that germinate in a time interval and it is calculated Maguire, [21] by the formula:

> GRI = G1/T1 + G2/T2 + G3/T3 +...Gn/Tn
>
> Where, G = germination percent and T=days

2.5 Mean Daily Germination (MDG)

Mean Daily Germination (MDG) was calculated using following formula Czabator, [22] given below and expressed in value with unit less [23].

> MDG = ΣG/ ΣTn
>
> Where, ΣG = Total number of germinated seeds, ΣTn = Total number of days of final count.

2.6 Peak Value (PV)

It was calculated using Czabator, 1962 formula, the maximum quotient derived from all of the cumulative full-seed germination percentages on any day divided by the number of days to reach this percentages and it was expressed in value with unit less [23].

> Peak value (PV) = Maximum germination percent (%) / Number of days taken to reach maximum germination

2.7 Germination Value (GV)

Germination value is an index combining speed and completeness of seed germination. Daily germination counts were made and GV was calculated as per [22].

> GV = PV X MDG

Where, PV = Peak value of germination, MDG = Mean daily germination

2.8 Data Analysis

Germination parameters values were subjected to analysis the variance (ANOVA). The significance of treatment difference was assessed using LSD at 95% confidence interval. All the analysis was performed in JMP pro 10 software [24,25].

3. RESULTS

3.1 Seed Germination

There were significant differences between seed pretreatments for Germination percentage (G %),

Table 2. Summary of different pretreatments methods effects of *A. procera*

Treatment	GP (%)	GRI	MDG	PV	GV	MGT
T_1	78.33±1.67^{abc}	22.28±2.85^{ab}	2.45±0.05^{abc}	9.50±0.61^{a}	23.19±0.96^{ab}	5.01±0.28^{a}
T_2	86.67±4.41^{ab}	21.33±2.28^{b}	2.71±0.14^{ab}	9.63±0.49^{a}	26.22±2.69^{a}	5.53±0.11^{abcd}
T_3	78.33±6.01^{abc}	14.90±1.33^{c}	2.45±0.19^{abc}	9.44±0.56^{a}	23.18±2.56^{ab}	5.76±0.07^{bcd}
T_4	78.33±3.33^{abc}	15.46±1.33^{c}	2.45±0.10^{abc}	8.43±0.56^{a}	20.73±2.25^{ab}	5.87±0.26^{cd}
T_5	71.67±4.41^{c}	15.13±1.75^{c}	2.24±0.14^{c}	5.01±0.52^{b}	11.17±1.09^{c}	6.12±0.16^{d}
T_6	71.67±4.41^{c}	15.13±1.75^{c}	2.24±0.14^{c}	5.01±0.52^{b}	11.17±1.09^{c}	6.12±0.16^{d}
T_7	76.67±6.01^{bc}	18.19±1.42^{bc}	2.40±0.19^{bc}	8.82±0.38^{a}	21.27±2.52^{ab}	5.30±0.06^{abc}
T_8	80.00±2.89^{abc}	17.06±1.74^{bc}	2.50±0.09^{abc}	8.88±2.27^{a}	22.05±5.28^{ab}	5.71±0.40^{bcd}
T_9	90.00±2.89^{a}	27.12±2.42^{a}	2.81±0.09^{a}	10.00±1.43^{a}	28.13±4.11^{a}	5.17±0.16^{ab}
T_{10}	73.33±6.01^{c}	14.71±0.67^{c}	2.29±0.19^{c}	7.79±0.75^{ab}	17.66±1.18^{bc}	5.74±0.37^{bcd}

**In each column, mean with same letter(s) are not significantly different at p < .05*

germination rate index (GRI), mean daily germination (MDG), peak value (PV), germination value (GV) and mean germination time (MGT). The mean value of germination parameters is given in Table 2.

The highest germination percent (90.00%), germination rate index (27.12%), mean daily germination (2.81), peak value (10.00) and germination value (28.13) was observed in T_9 *i.e.* seeds pretreated with 50 ppm GA_3 for 12 h followed by treatment T_2 (Soaking in hot water (70 ºC) for 5 min followed by soaking in tap water for 24 h), where these parameter values were observed as 86.67%; 21.33%; 2.71; 9.63; and 26.22, respectively. The lowest germination percentage (71.67 %) peak value (5.01) and germination value (11.17) was recorded T_5 and T_6 (seeds were pretreated with H_2SO_4). Mean germination time was lowest in treatment T_1 (5.01) *i.e.* Soaking in hot water 70 ºC (5 min) followed by soaking in tap water for 12 h. Treatment T_9 (seeds treated with 50 ppm GA_3 for 12 h) was at par (5.17) with T_1. The maximum mean germination time observed in treatment T_5 and T_6 (6.12).

4. DISCUSSION

The present investigation showed that the pretreatment of seed was highly effective in enhancing seed germination in *A. procera* as compare to untreated seed. Seed dormancy affect the use of dormant species in nurseries for the production of seedlings, it is known that seed dormancy varies from species to species, so the type of pretreatments should be given in accordance with the forest tree species. Several authors Azad et al. [18], Aref et al. [13], Amusa, [14], Mwase and Mvula, [15], Anand et al. [10], Azad et al. [26], Missanjo et al. [16], Fredrick et al. [17], Kheloufi et al. [27] have discussed "different methods of pre-sowing treatments for seed germination in order to break dormancy and enhance the rate of germination and speed up the germination process".

"The finding of this present study shows that seed germination of *A. procera* under pretreatment methods significantly affected various germination parameters. Among the pretreatments, seeds pretreated with GA_3 (50 ppm) for 12 h had maximum germination followed by Soaking in hot water 70 ºC (5 min) followed by Soaking in tap water (24 h). Role of hormones to relive dormancy of forest tree seeds are well established" [28,29]. "Exogenous applications of GA_3 have been widely used to break physiological dormancy of hard seed coat species" [30]. In case of *A. procera* the GA_3 treatment was effective to increase germination. Dhupper [31] seed germination and growth rate in *Albizzia lebbeck* increased to maximum when treated with 750ppm GA3 for 24 hours. González-López and Casquero, [32] conducted a germination trial on *Gentiana lutea* using different seed pretreatment to increase germination percentage and they observed that the best pre-germinative doses of GA_3 for breaking seed dormancy in *G. lutea* were 100, 500, and 1000 ppm. Similarly, Ikinci [33] found 56.67%germination rate in seeds soaked in water for 96 hours in Argan however, it increased in parallel with the increase in GA3 dose.

"A. procera seeds are known to exhibit physical dormancy due to their hard, impermeable seed coat, which hinders water absorption. Pre-sowing treatments have been shown to enhance germination rates for such seeds" [34]. Catalán and Macchiavelli [35] and Schmidt [25] reported that physical dormancy can be effectively managed through methods like seed scarification using clipping, nicking, abrasion paper, needles,

knives, or hot wire burners *etc.* However, these techniques can be time-consuming compared to hot water treatments, which have also proven to be effective Kobmoo and Hellum, [36], Khasa, [37], Airi et al., [38]. The study results indicated that hot water treatment significantly improved seed germination in *A. procera*, corroborating the findings of Azad et al. [12] for this species [39-42]. Azad et al*.,* [12] reported "the highest germination success in the treatment of immersion in hot water (80°C) for 10 min, followed by 79.00% in immersion in hot water (100°C) for 1 min in *A. procera"* [43-45].

5. CONCLUSION

To establish nurseries that produce the maximum number of quality seedlings with minimal cost, time, and labour, effective seed pretreatments are essential. This study on pre-sowing treatments demonstrates practical potential. Among the treatments, soaking *A. procera* seeds in 50 ppm GA_3 for 12 hours proved most effective, yielding higher germination percentages and rates compared to the control and other treatments. Additionally, soaking seeds in hot water followed by normal water for 24 hours was found to be equally effective, offering a cost-efficient alternative. The improved seed treatment methods identified can be applied to large-scale seedling production of *A. procera*.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.ikprress.org/review-history/12244