



Biorationals and Chemical Treatments to Overcome the Dormancy in Tree spp.

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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: 10.9734/IJECC/2023/v13i31683

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://www.sdiarticle5.com/review-history/96872>

Review Article

Received: 15/12/2022

Accepted: 24/02/2023

Published: 01/03/2023

ABSTRACT

Dormancy in seeds is defined as the failure of seeds to germinate despite the presence of all necessary conditions for germination. It is caused by the impermeability of the hard seed coat or a lack of availability and activity of germination-essential enzymes. Seeds undergo a variety of physical and chemical pre-treatments to break their dormancy. It results into lower seed germination rate and poor growth. To overcome this drawback various treatments are given to the seeds before sowing this study reviews some of the pre-sowing practices and the effects they have on seed germination and growth. Scientists are quite concerned about seed dormancy; hence it is a research topic of interest to develop an effective solution. All viable seeds are capable of germinating if the proper pre-sowing treatment is used.

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Keywords: Dormancy; impermeability; pre-sowing treatment; poor growth and germination rate.

1. INTRODUCTION

Seed dormancy is a physiological phenomenon in plants caused by external or internal factors that prevents seeds from germinating even under ideal conditions. Hard seed coat, immature embryo, rudimentary embryo, and inhibitory materials can all cause seed dormancy [1]. Some species' seeds are unable to germinate because the embryo is constrained by its surrounding structures. Seed coat enhanced dormancy or physical dormancy is the name given to this phenomenon; embryos isolated from these seeds are not dormant. According to Wulandini and Widayani [2], *Melia azedarach* seeds are hard, and seed pre-treatments aim to break the physical barrier to improve water absorption and embryo expansion. In other species, a second type of dormancy known as morphophysiological dormancy is visible in seeds with underdeveloped embryos, but it also has a physiological component. As a result, these seeds require a dormancy-breaking treatment, such as a specific combination of warm and/or cold stratification [3]. Extensive cultivation in forestry and home garden plantation programmes is hampered by delayed nursery establishment and deprived seed germination [4-6].

Bonner [7] stated that germination is defined as "the resumption of active growth in an embryo which results in its emergence from the seed and development of those structures essential for plant development". The establishment of the seedling is the culmination of seed maturation [8].

Pre-sowing treatments are important for improving seed germination in nursery conditions. Pre-sowing treatments of seed are essential for establishing a nursery of a specific species in order to predict the maximum number of quality seedlings with the least amount of cost, time, and labour [9]. To break such dormancy in forest seeds, various pre-sowing seed treatments are used. Uniform seed germination with good vigour is required for the production of uniform planting stock, which is a prerequisite for any successful domestication and large-scale afforestation programme. Taking all of these factors into account, the current study was designed to investigate and title various methods of treatment to overcome dormancy in tree spp. for improved germination and growth.

1.1 What is Seed Dormancy?

All viable seeds have the ability to sprout when given optimal germination conditions. Even under the perfect circumstances for germination, some seeds do not germinate. This can be required by certain external circumstances or result from internal causes. The period during which the seeds' growth is stopped and they are believed to be in a resting or inactive state is referred to as seed dormancy [10].

1.2 Types of Seed Dormancy

Physical dormancy: The hard endocarp of the seed prevents water from passing through it. This happens when seeds are resistant to gas or liquid exchange. Legumes are a good example of physically inactive seeds because they have a low moisture content and cannot absorb water due to their seed coat. To allow for water absorption, the seed coat or other coverings may be chipped or cracked. Impermeability is typically produced by a mucilaginous cell layer or an external cell layer composed of macro-sclereid cells. A rigid endocarp is the third cause of seed coat impermeability. In the later stages of seed development, seed coverings that are impermeable to gases and water form.

Mechanical dormancy: This occurs when seed coats or other coverings are too hard to permit the embryo to enlarge during germination. Several species were once thought to use this method of dormancy, however endogenous substances were later found to be the cause of their hibernation. One of these endogenous truths is the physiological dormancy brought on by inadequate embryo development potential.

Chemical dormancy: This also includes the growth regulators present in the tissues surrounding the embryo. They can be removed from the tissues of the seed by washing, soaking, or deactivating them in different methods. Another substance that prevents seeds from germinating is eliminated by rainwater or snowmelt.

2. METHODS OF BREAKING SEED DORMANCY

Temperature treatments: When embryo factor is the cause of dormancy, the seed is incubated for 3 to 10 days on a substrate at a low temperature (0-5°C) so that it can achieve its ideal

temperature. Some seeds required a brief period of incubation (from a few hours to one to five days) at 40 to 50°C before germination at the right temperature. (When employing this strategy, ensure that the seed, for instance, paddy, has a moisture level of no more than 15%) Another effective strategy is to use hot water treatment to soften the seeds in beans. This method entails soaking the seeds in 80°C water for 1 to 5 minutes before placing them for germination (depending on the type of seed) [11].

Growth regulators and other chemical treatments: Germination inhibitors may result in endogenous dormancy. Low-dose growth regulators such as gibberellins, cytokinins, and ethylene may be used to break seed dormancy. Gibberellins and kinetins are the two most commonly used growth regulators [12].

Gibberellic Acid (GA3): A 500 ppm solution of GA3 made by dissolving 500 mg of GA3 in one litre of water can be used to moisten the germination substrate. When dormancy is weak, 200 ppm can suffice. If the problem is severe, a 1000 ppm solution may be used. When the concentration exceeds 800 ppm, a 0.01 M buffer in distilled water can be used.

Soaking: After soaking in water for 24–48 hours, seeds with tough seed coats may germinate more easily. Immediately after soaking, the seed needs to be planted for germination.

Acid scarification: It is possible to successfully digest some species and seeds by steeping them in concentrated H₂SO₄ until the seed covering develops pits. Although digestion could occur quickly or take longer than an hour, the seeds should be checked every few minutes. Seeds need to be properly rinsed in running water after digestion in order to germinate.

2.1 Effect of Normal and Hot Water Treatment

To address the issue of a decreased rate of germination in tree species, several researchers and scientists conducted experiments to test the effectiveness of soaking seeds in water prior to germination are depicted in Table 1. According to a study conducted by Srinidhi et al. [13] on *Acacia holosericea*, germination percentage increased significantly (69.3%) after alternate dipping in hot and cold water for 5 minutes and each repeated thrice. Murugesh (2011) found that seeds soaked in cold water for 48 hours had

the highest seed germination rate of 33% in *Grevillea robusta*. Azad et al. [14] investigated the effect of various pre-sowing treatments on germination in *Acacia auriculiformis* seeds, including cold water, hot water, scarification with sand paper, and concentrated H₂SO₄. The results showed that hot water treatment results in the highest germination rate (83%), followed by scarification with sand paper (78%), H₂SO₄ (75%), and cold water (52%).

Azad et al. [15] discovered that pre-sowing treatments such as cold water (40°C for 24 hours), immersion in hot water (80°C for 10 minutes and 100°C for 1 minute), and control affected seed germination rate in *Albizia procera*. Immersion in hot water (80°C for 10 minutes) has the highest germination success rate (82.07%), followed by immersion in cold water (79%). (100°C for 1 minutes). Missanjo et al. [16] discovered that treatment with hot water was effective in large seeds, producing 67.5% germination, in a study on the effect of seed size and pre-sowing on the germination of *Albizia lebbek*.

Rasebeka et al. [17] reported that germination percentage was enhanced by 30 % on treating with hot water for 9 minutes in *Acacia tortilis* compared to other pre-sowing treatments (cold water, hot water and concentrated sulphuric acid).

Das [9] conducted an experiment on pre-sowing treatments of *Aquilaria agallocha* and *Shorea robusta* seeds and subjected to different pre-sowing seed treatments, i.e. control, normal water, hot water (for different times), 80% concentrated sulphuric acid for 20 minutes and so on. Results showed that the best treatment on the seeds of *A. agallocha* was soaking in hot water for 3 minutes and then kept in normal water for 24 hrs whereas, best result in seeds of *S. robusta* was obtained from soaking seeds in normal water for 72 hrs.

According to Hasnat et al. [18], soaking seed in cold water for 24 hours increases germination percentage (33%), germination energy (16.7%), plant percentage (33%), and germination value (0.4) in *Canarium resiniferum*.

Amoakoh et al. [19] investigated the effect of pre-treatment on *Pouteria campachiana* germination and early seedling growth. The study found that soaking *P. campachiana* seeds in cold water did not improve germination, with a significant difference between soaked and unsoaked seeds.

Table 1. Effect of normal and hot water on germination and growth

S. No.	Tree spp.	Description	Reference
1.	<i>Acacia holosericea</i>	Germination (%) increased significantly (69.3%) after 5 minutes of alternate dipping in hot and cold water, which was repeated three times.	Srinidhi et al. [13]
2.	<i>Grevillea robusta</i>	Highest seed germination of 33% in seeds soaked in cold water for 48 hrs.	Murugesh [21]
3.	<i>Acacia auriculiformis</i>	Hot water treatment gives highest germination 83%	Azad et al. [14]
4.	<i>Albizia procera</i>	Immersion in hot water (80°C for 10 minutes) gives highest germination success 82.07% followed by 79% in immersion in hot water (100°C for 1 minutes).	Azad et al. [15]
5.	<i>Albizia lebbeck</i>	In large seeds, hot water resulted in 67.5% germination.	Missanjo et al. [16]
6.	<i>Acacia tortilis</i>	Germination percentage was enhanced by 30 % on treating with hot water for 9 minutes	Rasebeka et al. [17]
7.	<i>Aquilaria agallocha</i>	Best treatment on the seeds was soaking in hot water for 3 minutes and then kept in normal water for 24 hrs	Das [9]
8.	<i>Shorea robusta</i>	Best result in seeds was obtained from soaking seeds in normal water for 72 hrs.	Das [9]
9.	<i>Canarium resiniferum</i>	Soaking seeds in cold water for 24 hours increases germination percentage (33%), germination energy (16.7%), plant percentage (33%), and germination value (0.4).	Hasnat et al. [16]
10.	<i>Pouteria campachiana</i> .	Cold water was detrimental to seed germination, with a significant difference between soaked and unsoaked seeds.	Amoakoh et al. [19]
11.	<i>Bauhinia rufescens</i>	At 49 days after soaking, hot water at 65 0C for 60 minutes produces the highest mean germination rate, tallest plant height, and most leaves per plant.	Opoku et al. [20]

Opoku et al. [20] performed an experiment in which *Bauhinia rufescens* seeds were soaked in hot water at 65 0C for 60 minutes, yielding the highest mean germination rate, tallest plant height, and most leaves per plant at 49 days after soaking.

2.2 Effect of Chemical Treatment

In order to address the problem of the hard seed coat, which prevents seed germination, numerous studies have been conducted. This can be resolved by chemically treating the seeds before planting. Table 2 displays some of these. Azad et al. [22] conducted an experiment on the effect of pre-sowing treatment on *Melia azedarach* seeds and found that the germination percentage was highest in the H₂SO₄ treatment (74%), followed by the hot water treatment (69%) and revealed that pre-sowing treatments significantly increased germination compared to the control.

Zare et al. [23] conducted an investigation on seed germination of *Prosopis koelziana* and *Prosopis juliflora* and found that scarification with H₂SO₄ for 10 and 15 minutes, sandy paper, hot water for 5 and 10 minutes, potassium nitrate 0.1%, GA3 was the most effective treatment for breaking seed dormancy and in seed germination induction.

Yildiztugay et al. [24] investigated the effect of different pre-sowing treatments on germination of *Sphaerophysa kotschyana* seeds and found that treating seeds with Conc. H₂SO₄ for 15 minutes resulted in a high germination percentage.

Rasebeka et al. [17] showed effect of pre-sowing treatments (cold water, hot water and concentrated (H₂SO₄) on germination of *Acacia* species (*A. tortilis*, *A. erioloba*, and *A. nigrescens*) and reported increase in germination percentage of *A. erioloba* (87%) and *A. nigrescens* (30%) on treating with Conc. H₂SO₄ while the control, cold water and hot water

treatment reduced their germination percentage (5%) significantly.

Zazai et al. [25] conducted an experiment on effect of pre-sowing seed treatments and different fruit size on the germination percentage of *Terminalia arjuna* and reported maximum germination percentage in large fruit size treated with concentrated H₂SO₄ for 10 minutes.

2.3 Effect of Growth Regulators on Germination

Table 3 shows the effects of gibberellic acid and its concentration on the germination and growth of various tree species. In comparison to the control, seeds of *Albizzia odoratissima* treated with 100 ppm GA₃ had better germination (33.3%), a shorter germination period (17.9), and a higher plant height (13 cm) [26]. Kiran et al. [27] found that seeds of *Gevotia rotteriformis* treated with 1000 and 2000 ppm GA₃ germinated better than control seeds.

Gunashekar et al. [28] found that seeds of *Myristica fragrans* treated with 1000 ppm GA₃ germinated at 85%, which was significantly higher than the control.

Musilamani and Dharmalingam [29] discovered that treating seeds of *Grevillea robusta* with 25ppm GA₃ for 24 hours resulted in higher germination (43%). Similarly, Gowda and Vasudeva (2004) found that applying GA₃ at 50 ppm after mechanical seed coat removal improved germination in *Nothopodytes nimmoniana* (92%). Mukherjee [30] demonstrated that when *Swertia chirayita* seeds were treated with 400ppm GA₃, germination

increased to 63.7%, compared to 37% in the control.

Giri and Tamta [31] conducted an experiment on *Hedychium spicatum* seeds and treated with lower concentration of GA₃ and reported maximum germination under laboratory condition was 61.1%.

2.4 Cow Dung Slurry Treatment

Some tree species' seeds have been found to germinate better after soaking for a few days in cow dung slurry (Table 4). Gouda [32] demonstrated that treating seeds of *Garcinia indica* with cowdung slurry for three days resulted in 61.3% germination, whereas the control resulted in 51.3% germination. Lokesh [33] conducted an experiment on *Terminalia chebula* seeds and found that seeds treated with cow dung for 30 days had the highest germination (63.3%) compared to control (16.7%).

Krishna et al. [34] treated *Melia dubia* seeds with cow dung slurry for seven days and found that it significantly improved germination and seedling growth. Germination of seeds began 32 days after sowing and lasted up to 66 days. The highest germination percentage (34.3%) was observed after seven days of soaking seeds in cow dung slurry (T4). T4 had the highest germination value (2.2) and germination energy (25) as well. Shoot length, root length, collar diameter, and leaf number all increased for T4 and T7, respectively. As a result, T4 pre-sowing treatment was more effective in the nursery for germination and the production of quality seedlings of *Melia dubia*. Parthiban [35] reported a similar type of outcome.

Table 2. Effect of chemical treatments on germination and growth

S. No.	Tree spp.	Description	Reference
1.	<i>Melia azedarach</i>	Germination percentage was found to be maximum in H ₂ SO ₄ treatment (74%)	Azad et al. [22]
2.	<i>Prosopis koelziana</i> and <i>Prosopis juliflora</i>	Scarification with H ₂ SO ₄ proved to be the most effective treatment for breaking seed dormancy and inducing seed germination.	Zare et al. [23]
3.	<i>Sphaerophysa kotschyana</i>	Good germination percentage on treating seeds with Conc. H ₂ SO ₄ for 15 minutes.	Yildiztugay et al. [24]
4.	<i>Acacia</i> species	Increase in germination percentage of <i>A. erioloba</i> (87%) and <i>A. nigrescens</i> (30%) on treating with Conc. H ₂ SO ₄	Raseeka et al. [17]
5.	<i>Terminalia arjuna</i>	Maximum germination percentage in large fruit size treated with concentrated H ₂ SO ₄ for 10 minutes.	Zazai et al. [25]

Table 3. Effect of Gibberellic acid treatment on germination and growth

S. No.	Tree spp.	Description	Reference
1.	<i>Albizzia odoratissima</i>	When compared to the control, 100 ppm GA ₃ resulted in better germination (33.3%), the shortest number of days for germination (17.9), and the greatest plant height (13 cm).	Moktan et al. [26]
2.	<i>Gevotia rotteriformis</i>	Higher germination in seeds treated with 1000 and 2000 ppm GA ₃ compared to negligible germination in control.	Kiran et al. [27]
3.	<i>Myristica fragrans</i>	Higher germination percentage 85 % in seeds treated with 1000 ppm GA ₃ which was significantly higher than control.	Gunasekaran et al. [28]
4.	<i>Grevillea robusta</i>	Higher germination in seeds on treating with 25ppm GA ₃ for 24 hours (43%).	Musilamani and Dharmalingam [29]
5.	<i>Nothopodytes nimmoniana</i>	Germination was improved by applying GA ₃ at 50 ppm after mechanical seed coat removal (92%).	Gowda and Vasudeva (2004)
6.	<i>Swertia chirayita</i>	Germination of seeds increase upto 63.7% when treated with 400ppm GA ₃ and was 37% in control.	Mukherjee [30]
7.	<i>Hedychium spicatum</i>	Seeds treated with lower concentration of GA ₃ reported maximum germination under laboratory condition 61.1%.	Giri and Tamta [31]

Table 4. Effect of cow dung slurry treatment on germination and growth

S. No.	Tree spp.	Description	Reference
1.	<i>Garcinia indica</i>	Cowdung slurry for three days resulted in 61.3% germination, while the control resulted in 51.3% germination.	Gouda [32]
2.	<i>Terminalia chebula</i>	Maximum germination in seeds treated with cow dung for 30 days (63.3%) compared to control (16.7%).	Lokesh [33]
3.	<i>Melia dubia</i>	The highest germination percentage (34.3%) was observed after seven days of soaking seeds in cow dung slurry. It also had the highest germination value (2.2) and germination energy (25). Shoot length, root length, collar diameter and leaf number followed the same trend of higher value for cow dung slurry for seven days.	Krishna et al. [34]
4.	<i>Hydnocarus pentandra</i>	Germination was higher (72.7%) after fifteen days of alternate wetting and drying in cow dung slurry.	Manasi [36]
5.	<i>Melia dubia</i>	Germination was greatest in seeds that had been soaked in cow dung slurry for seven days (34.3%).	Anand et al. [37]
6.	<i>Pterocarpus santalinus</i> (Rakta chandana)	When seeds were soaked in cow dung slurry for 48 hours, they showed higher germination percentage (47.50), seedling length (32.45 cm), collar girth (3.24 mm), and seedling dry weight (6.75 g), while the control showed poor germination and growth.	Thanuja et al. [38]
7.	<i>Melia azedarach</i>	The germination percentage (75.87) and other parameters such as mean daily germination, germination value, and germination speed were highest in the 6 day treatment with cow dung slurry + <i>Glomus mosseae</i> .	Khaiper et al. [39]

Krishna et al. [34] conducted an experiment on seed germination of *Melia dubia* and found that cow dung treatment for 5 days was the most effective, followed by the mini sachet method

(33.3%). Similarly, seeds treated with cow dung performed better in seedling quality parameters such as seedling length and vigour index. Manasi [36] studied the effect of different pre-sowing

treatments on *Hydnocarus pentandra* seeds and discovered that alternate wetting and drying in cow dung slurry for fifteen days resulted in higher germination (72.7%). Anand et al. [37] investigated the germination of *Melia dubia* seeds with various pre-sowing treatments and discovered that seeds soaked in cow dung slurry for seven days had the highest germination (34.3%), followed by seeds treated with 100 ppm Gibberellic acid for 24 hours.

Thanuja et al. [38] investigated the effect of pre-sowing treatments on *Pterocarpus santalinus* germination (*Rakta chandana*) *P. santalinus* seeds were treated with KNO₃, HCL, H₂SO₄, GA₃, NAA, Cytokinin, cow urine, cow dung slurry, and hot water and showed higher germination percentage (47.50), seedling length (32.45 cm), collar girth (3.24 mm), and seedling dry weight (6.75 g) when seeds were soaked in cow dung slurry for 48 hours, while controls showed poor germination and growth.

In an experiment on *Melia azedarach*, Khaiper et al. [39] treated seeds with various pre-sowing treatments before sowing them into soils inoculated with arbuscular mycorrhiza fungi i.e. *Glomus mosseae*. They found that the seeds showed the highest seed germination percentage when treated with cow dung slurry for 6 days within the soil inoculated with *Glomus mosseae* as compared to control.

3. CONCLUSION

Seed dormancy is a practical issue with significant economic implications. Plant growers are frequently looking for seed that germinates quickly after being collected. It has a significant negative impact on the plantation programme and restricts the production of many different tree species. Despite the fact that seed sprouting and the production of healthy seedlings are required for plant output, some plant species exhibit both physical and internal dormancy, making high-frequency healthy seedling growth difficult. The purpose of this chapter is to provide a general overview of the numerous pre-sowing treatments for seeds for several species of trees, including regular water soaking, conc. H₂SO₄, gibberellic acid, and cow dung slurry. This article discusses seeds that are significant to scientists and seed farmers during the handling procedure. Actually, scientists are quite concerned about seed dormancy, thus these factors acts as an alternative to use in future for research. If given the proper germination conditions, all viable seeds have the potential to sprout.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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