Review Article

Biorationals and chemical treatments to overcome the dormancy in tree spp.

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.

Keywords: Dormancy, impermeability, pre-sowing treatment, poor growth andgermination rate.

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 (Mousavi et al., 2019). 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 Widyani (2007), 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 (Baskin & Baskin, 2004).Extensive cultivation in forestry and home garden plantation programmes is hampered by delayed nursery establishment and deprived seed germination (Alamgir and Hossain 2005b; Azad et al., 2006a & 2006b).

Bonner (1984) 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 (Kramer and Kozlowski, 1979).

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 (Das, 2015). 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.

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 (Soltani et al.2006).

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.

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) (Maherchandani 1975).

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 kinetics are the two most commonly used growth regulators (Telci et al. 2011).

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 spices and seeds by steeping them in concentrated H_2SO^4 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.

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. (2011) 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. (2011) 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. (2012) discovered that pre-sowing treatments such as cold water (40C for 24 hours), immersion in hot water (800C for 10 minutes and 1000C for 1 minute), and control affected seed germination rate in *Albizia procera*. Immersion in hot water (800°C for 10 minutes) has the highest germination success rate (82.07%), followed by immersion in cold water (79%). (1000C for 1 minutes). Missanjo et al. (2014) 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 lebbeck.*

Rasebeka*et al.* (2014) 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 (2015) conducted an experiment on pre-sowing treatments of *Aquilaria agallocha*and *Shorearobusta*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*wasobtained from soaking seeds in normal water for 72 hrs.

According to Hasnat et al. (2016), 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. (2017) investigated the effect of pre-treatment on *Pouteria campachiana* germination and early seedling growth. The study found that soaking *P.campachina* seeds in cold water did not improve germination, with a significant difference between soaked and unsoaked seeds.

Opoku et al. (2018) 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.

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

S. No.	Tree spp.	Description	Reference
1.	*Acacia holosericea*	Germination (%) increased significantly (69.3%) after 5 minutes of alternate dipping in hot and cold water, which was repeated three times.	Srinidhi *et al.* (2011)

2.	*Grevillea robust*	Highest seed germination of 33% in seeds soaked in cold water for 48 hrs.	Murugesh (2011)
3.	*Acacia auriculiformis*	Hot water treatment gives highest germination 83%	Azad *et al.* (2011)
4.	*Albizia procera*	Immersion in hot water (80^0C for 10 minutes) gives highest germination success 82.07% followed by 79% in immersion in hot water (100^0C for 1 minutes).	Azad *et al.* (2012)
5.	*Albizia lebbeck*	In large seeds, hot water resulted in 67.5% germination.	Missanjo*et al.* (2014)
6.	*Acacia tortilis*	Germination percentage was enhanced by 30 % on treating with hot water for 9 minutes	Rasebeka*et al.* (2014)
7.	*Aquilaria agallocha*	Best treatment on the seedswas soaking in hot water for 3 minutes and then kept in normal water for 24 hrs	Das (2015)
8.	*Shorearobusta*	Best result in seeds wasobtained from soaking seeds in normal water for 72 hrs.	Das (2015)
9.	*Canarium resiniferum*	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.* (2016)
10.	*Pouteria campachiana.*	Cold water was detrimental to seed germination, with a significant difference between soaked and unsoaked seeds.	Amoakoh*et al.* (2017)
11.	*Bauhinia rufescens*	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.* (2018)

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. (2010) conducted an experiment on the effect of pre-sowing treatment on *Melia azedarach* seeds and

found that the germination percentage was highest in the H_2SO_4 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. (2011) conducted an investigation on seed germination of *Prosopis koelziana* and *Prosopis juliflora*and found that scarification with H_2SO_4 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. (2012) investigated the effect of different pre-sowing treatments on germination of *Sphaerophysakotschyana* seeds and found that treating seeds with Conc. H_2SO_4 for 15 minutes resulted in a high germination percentage.

Rasebeka et al. (2014) showed effect of pre-sowing treatments (cold water, hot water and concentrated (H_2SO_4) 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. H_2SO_4 while the control, cold water and hot water treatment reduced their germination percentage (5%) significantly.

Zazai*et al.* (2018) 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 H_2SO_4 for 10 minutes.

Table 2: Effect of chemical treatments on germination and growth

S. No.	Tree spp.	Description	Reference
1.	*Melia azedarach*	Germination percentage was found to be maximum in H_2SO_4 treatment (74%)	Azad *et al.* (2010)
2.	*Prosopis koelziana*and *Prosopis juliflora*	Scarification with H_2SO_4proved to be the most effective treatment for breaking seed dormancy and inducing seed germination.	Zare*et al.* (2011)
3.	*Sphaerophysakotschyana*	Good germination percentage on treating seeds with Conc. H_2SO_4 for 15 minutes.	Yildiztugay*et al.* (2012)
4.	*Acacia* species	Increase in germination percentage of *A. erioloba*(87%) and *A.*	Rasebeka*et al.* (2014)

		nigrescens(30%) on treating with Conc. H_2SO_4	
5.	*Terminalia arjuna*	Maximum germination percentage in large fruit size treated with concentrated H_2SO_4 for 10 minutes.	Zazai*et al.* (2018)

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) (Moktan et al., 1993).Kiran et al. (2001) found that seeds of *Gevotiarotteriformis* treated with 1000 and 2000 ppm GA_3 germinated better than control seeds.

Gunashekaran et al. (2001) found that seeds of *Myristica fragrans* treated with 1000 ppm GA_3 germinated at 85%, which was significantly higher than the control.

Musilamani and Dharmalingam (2002) discovered that treating seeds of *Grevillea robusta* with 25ppm GA_3 for 24 hours resulted in higher germination (43%). Similarly, Gowda and Vasudeva (2004) found that applying GA_3at 50 ppm after mechanical seed coat removal improved germination in *Nothopodytesnimmoniana* (92%). Mukherjee (2008) demonstrated that when *Swertia chirayita* seeds were treated with 400ppm GA_3, germination increased to 63.7%, compared to 37% in the control.

Giri and Tamta (2012) conducted an experiment on *Hedychium spicatum* seeds and treated with lower concentration of GA_3 and reported maximum germination under laboratory condition was 61.1%.

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

S. No.	Tree spp.	Description	Reference
1.	*Albizzia odoratissima*	When compared to the control, 100 ppm GA_3resulted in better germination (33.3%), the shortest number of days for germination (17.9), and the greatest plant height (13 cm).	Moktan*et al.*, 1993
2.	*Gevotiarotteriformis*	Higher germination in seeds	Kiran *et al.* (2001)

		treated with 1000 and 2000 ppm GA_3 compared to negligible germination in control.	
3.	*Myristica fragrans*	Higher germination percentage 85 % in seeds treated with 1000 ppm GA_3 which was significantly higher than control.	Gunashekaran*et al.* (2001)
4.	*Grevillea robusta*	Higher germination in seeds on treating with 25ppm GA_3 for 24 hours (43%).	Musilamani and Dharmalingam (2002)
5.	*Nothopodytesnimmoniana*	Germination was improved by applying GA_3 at 50 ppm after mechanical seed coat removal (92%).	Gowda and Vasudeva (2004)
6.	*Swertia chirayita*	Germination of seeds increase upto 63.7% when treated with 400ppm GA_3 and was 37% in control.	Mukherjee (2008)
7.	*Hedychium spicatum*	Seeds treated with lower concentration of GA_3 reported maximum germination under laboratory condition 61.1%.	Giri and Tamta (2012)

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 (2005) 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 (2007) 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. (2011) 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 (2009) reported a similar type of outcome.

Krishna et al. (2011) 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 (2011) studied the effect of different pre-sowing treatments on *Hydnocaruspentandra* seeds and discovered that alternate wetting and drying in cow dung slurry for fifteen days resulted in higher germination (72.7%). Anand et al. (2012) 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. (2019) investigated the effect of pre-sowing treatments on Pterocarpus santalinus germination (*Raktachandana) P. santalinus* seeds were treated with KNO_3, HCL, H_2SO_4, GA_3, 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. (2021) 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.

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

S. No.	Tree spp.	Description	Reference
1.	*Garcinia indica*	Cowdung slurry for three days resulted in 61.3% germination, while the control resulted in 51.3% germination.	Gouda (2005)
2.	*Terminalia chebula*	Maximum germination in seeds treated with	Lokesh

		cow dung for 30 days (63.3%) compared to control (16.7%).	(2007)
3.	*Melia dubia*	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 forcow dung slurry for seven days.	Krishna *et al.* (2011)
4.	*Hydnocaruspentandra*	Germination was higher (72.7%) after fifteen days of alternate wetting and drying in cow dung slurry.	Manasi (2011)
5.	*Melia dubia*	Germination was greatest in seeds that had been soaked in cow dung slurry for seven days (34.3%).	Anand *et al.* (2012)
6.	*Pterocarpus santalinus*(Raktachandana)	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*etal.* (2019)
7.	*Melia azedarach*	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 + Glomus mosseae.	Khaiper*et al.* (2021)

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. H_2SO_4, 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.

Reference:

Alamgir, M. and Hossain, M. K. (2005b). Effect of pre-sowing treatments on germination and initials seedling development of *Albizia saman* in the nursery. *Journal of Forestry Research,* 16(3): 200–204.

Amoakoh, O. A., Nortey, D. D. N., Sagoe, F., Amoako, P. K. and Jallah, C. K. (2017). Effect of pre-sowing treatments on the germination and early growth performance of *Pouteria campachiana. Forest Science and Technology,* 13(2): 183-188.

Anand, B., Devagiri, G. M., Maruti gurav, Vasudev, H.S. and Khaple, A. K. (2012). Effects of pre-sowing seed treatments on germination and seedling growth performance of *Melia dubia*Cav: An important multipurpose tree. *International Journal of Life Sciences,* 3: 59-63.

Azad, M. S., Al-musa, Z. M. and Matin, A. M. (2010). Effect of pre-sowing treatments on seed germination of *Melia azedarach. Journal of Forestry Research,* 21(2): 193-196.

Azad, M. S., Biswas, R. K. and Matin, M. A. (2012). Seed germination of *Albizia procera* (Roxb.) Benth, in Bangladesh: a basis for seed source variation and pre-sowing treatment effect. *Forestry Studies in China,* 14(2):124-130.

Azad, M. S., Islam, M. W., Matin, M. A. and Bari, M. A. (2006a). Effect of pre-sowing treatment on seed germination of *Albizia lebbeck* (L.) Benth. *South Asian Journal of Agricos,* 1(2):32-34.

Azad, M. S., Manik, M. R., Hasan, M. S. and Matin, M. A. (2011). Effect of different pre-sowing treatments on seed germination percentage of *Acacia auriculiformis. Journal of Forestry Research,* 22(2): 183-188.

Azad, M. S., Matin, M. A., Islam, M. W. and Musa, Z. A. (2006b). Effect of pre-sowing treatment on seed germination of Lohakath*(XyliakerriiCraib& Hutch.*). *Khulna University Studies*, 7(2): 33-36.

Baskin, C. C. and Baskin, J. M. (2004). Determining dormancy-breaking and germination requirements from the fewest seeds. *Ex-situ Plant Conservation: Supporting Species Survival in the Wild*, 162-179.

Bonner, F. T. (1984). Glossary of seed germination terms for tree seed workers. Gen. Tech. Rep. SO49. New Orleans : USDA Forest Service, *Southern Forest Experiment Station*. p. 4.

Das, N. (2015). The effect of different pre-sowing treatments on the germination of *Aquilaria agallocha*and *Shorearobusta*seeds in the nursery. *The Indian Forester,* 141(3): 285-292.

Giri, D. and Tamta, S. (2012). Effect of pre-sowing treatments on seed germination in *Hedychium spicatum*: An important vulnerable medicinal plant of Indian Himalayan region. *Scientific Research and Essays*, 7(19): 1835-1839.

Gouda, M. (2005). Standardization of nursery techniques in *Garcinia indica* Choisy. M.Sc (For.) Thesis, Submitted to *University of Agriculture and Science, Dharwad (India).*

Gunashekaran, M., Prasad, D. and Krishnaswamy, V. (2001). Effect of chemical treatment on germination of nutmeg *(Myristica fragrans*) seeds. *Journal of Spices and Aromatic Crops,* 10(1) : 57-58.

Hasnat, G. N. T., Hossain, M. K., Bhuiyan, M. K., Alam, M. S. and Hossain, M. A. (2016). Effect of pre sowing treatments on seed germination and initial seedling growth performance of *Canar ium resiniferum*: A native threatened tree of Bangladesh. *Journal of Tropical Forestry and Environment,* 6(1): 11-19.

Khaiper, M., Dhanda, S. K., Ahlawat, K. S., Chugh, R. S., Jangra, M. and Verma, P. (2021). Effect of pre-sowing treatments on drupe germination of *Melia azedarach* at nursery stage. Agricultural Mechanization in Asia, Africa and Latin America, 52:4569- 4577.

Kiran, D. S. S., Rao, P. S., Venkaiaha, M. and Saibabu, A. (2001). Effect of GA_3 on germination of *Gevotia rotteriformis* seeds. *Indian Forester,* 127(8) : 944-946.

Kramer, P. J. and Kozlowski, T. T. (1979). Physiology of woody plants. *New York Academic Press,* p. 811.

Krishna, A., Lebba, J. J. and Shivanna, H. (2011). Studies on seed biology, seed moisture content and pre-sowing treatments in *Melia dubia*Cav. *My Forest,* 47(4): 315-323.

Lokesh, S. L. (2007). Standardization of nursery techniques in *Terminalia chebula Retz* : An important medicinal tree. M. Sc. (For.) Thesis, *University of Agricultural Sciences, Dharwad (India).*

Maherchandani, N. (1975). Effects of gamma radiation the dormant seeds of *Avenafatua.* Radiation Botany,15:439-443.

Manasi, R. N. (2011). Standardization of nursery techniques in *Hydnocarpus pentandra* (buch-ham), M. Sc. (For.) Thesis, *University of Agricultural Sciences, Dharwad (India).*

Missanjo, E., Chioza, A. and Kulapani, C. (2014). Effects of different pretreatments to the seed on seedling emergence and growth of *Acacia polyacantha*. *International Journal of Forestry Research,* 14:1-5.

Moktan, M. R., Gopikumar, K. and Anoop, E .V. (1993). Effect of growth regulators on seed germination and seedling vigour in two selected tree legumes. *My Forest,* 29(1): 1-5.

Mousavi, L., Wan Ishak, W. R. and Mousavi, M. (2019). Evaluation of physicochemical methods for dormancy breakage and germination of datura stramonium seeds. Journal of Chemical Health Risks, 9(3): 217-224.

Mukherjee, D. (2008). Germination improvement in *Swertia chirayita*: An endangered medicinal herb. *Journal of Medical Aroma Plant Science,* 30: 136-138.

Murugesh, S. (2011) . Effect of seed pre-treatment on germination and seedling attributes of *Grevillea robusta (Silver oak), My Forest,* 47(1): 53-62.

Musilamani, P. and Dharmalingam, C. (2002). Enhancement of germination and seedling growth in Silver oak (*Grevillea robusta) seeds. Indian Journal of Forestry,* 25(1): 30-33.

Opoku, J. A., Amissah, J. N., Essilfie, M. E. and Norman, J. C. (2018). Effect of pre-sowing treatments on seed germination and seedling growth of Silver Butterfly Tree (*Bauhinia rufescens*). *Current Agriculture Research Journal,* 6(3): 344-354.

Parthiban, K. T., Bharathi, A. K., Seenivasan, R., Kamala, K. and Rao, M. G. (2009). Integrating *Melia dubia*in agroforestry farms as alternate pulpwood species. *Asia-pacific agro forestry newsletter* No.34.

Rasebeka, L., Mathowa, T. and Mojeremane, W. (2014). Effect of seed pre-sowing treatment on germination of three *Acacia species indigenous to Botswana*. *International Journal of Plant Soil Science,* 3(1): 62-70.

Soltani, F., Kashi, A. andArghavani, M. (2006). Effect of magnetic field on *Asparagus officinalis L.* seed

germination and seedling growth. Seed Science and Technology, 34:349-353.

Srinidhi, H. V., Gill, R. I. S. and Sidhu, D. S. (2011). Effects of pre-sowing treatments on seed germination of *Acacia holosericea*. *Journal of Crop Improvement*, 21(2) : 226-228.

Telci, C., Yıldız, M., Pelit, S., Önol, B., Erkılıç, E.G. andKendir H (2011). The effect of surface-disinfection process on dormancy-breaking, seed germination, and seedling growth of *Lathyrus chrysanthusBoiss.* Under in vitro conditions. Propagation of Ornamental Plants, 11:10-11.

Thanuja, P. C., Nadukeri, S. and Kolakar, S. S. (2019). Effect of pre-sowing seed treatments on seed germination and seedling growth in Rakta Chandana (*Pterocarpus santalinus L.*): An Endangered medicinal plant. *Indian Journal of Current Science*, 7(3): 1577-1580.

Wulandini, R. and Widyani, N. (2007). *Melia azedarach* L. Seed Leaflet. *Forest & Landscape, Denmark*, 117.

Yildiztugay, E. and Kucukoduk, M. (2012). Dormancy breaking and germination requirements for seeds of *SphaerophysakotschyanaBoiss. Journal of Global Biosciences*, 1: 20-27.

Zare, S., Tavilli, A. and Darini, M. J. (2011). Effects of different treatments on seed germination and breaking seed dormancy of *Prosopis koelziana*and *Prosopis juliflora*. *Journal of Forestry Research*, 22(1): 35−38.

Zazai, K. G., Raina, N. S. and Sehgal, S. (2018). Effect of pre-sowing Treatments and fruit size on germination of *Terminalia arjuna*. *International Journal on Current Microbiology. Applied Science*, 7(9): 1926-1933.