The Pharma Innovation Journal 2022; 11(10): 1289-1293

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(10): 1289-1293

www.thepharmajournal.com
Received: 29-07-2022
Accepted: 05-09-2022

Pathapelly Raja Shekhar
Department of Silviculture and Agroforestry, FCRI, Mulugu, Telangana, India

Mhaiskar Priya Rajendra
Assistant Professor, Department of Forest Ecology and Climate Science, Forest College and Research Institute, Mulugu, Siddipet, Telangana, India

Milkuri Chiranjeeva Reddy
Department of Silviculture and Agroforestry, FCRI, Mulugu, Telangana, India

Reeja Sundaram
Department of Tree Breeding and Improvement, FCRI, Mulugu, Telangana, India

Sreedhar Bodiga
Department of Basic and Social Sciences, FCRI, Mulugu, Telangana, India

Ooha M
Department of Silviculture and Agroforestry, FCRI, Mulugu, Telangana, India

Ravula Rohith
Department of Silviculture and Agroforestry, FCRI, Mulugu, Telangana, India

Indu Kale
Department of Forestry, IGKV, Raipur, Chhattisgarh, India

Bhargavi CH
Department of Forestry, IGKV, Raipur, Chhattisgarh, India

Corresponding Author:
Mhaiskar Priya Rajendra
Assistant Professor, Department of Forest Ecology and Climate Science, Forest College and Research Institute, Mulugu, Siddipet, Telangana, India

Effect of pre-sowing treatments and growth hormones on germination and propagation of *Terminalia chebula* Retz

Pathapelly Raja Shekhar, Mhaiskar Priya Rajendra, Milkuri Chiranjeeva Reddy, Reeja Sundaram, Sreedhar Bodiga, Ooha M, Ravula Rohith, Indu Kale and Bhargavi CH

Abstract
Terminalia chebula is an important medicinal tree species in Asian countries. It is considered as the "King of Medicines "and is always listed at the top in Ayurvedic Materia Medica due to its extraordinary power of healing. However, Large scale planting program of the species is often difficult due to non-availability of quality planting material, which is impacted by low seed germination & longer germination period. The present Investigation was conducted in the nursery unit of the Department of Silviculture and Agroforestry, Forest College and Research Institute, Mulugu, Telangana during 2021-2022. The experiment was laid out in a completely randomized design with ten treatments and three replications. Ninety seeds of *Terminalia chebula* were used for each treatment and these seeds were sown on seedbed of 10m x 1m with potting media of soil, sand, and FYM in 2:1: 1. Among all the treatments, seeds of *Terminalia chebula* soaked in water treatment (room temperature) for 24 hours (T_3) was shown significantly superior performance with respect to germination percentage (78.88%) and Germination Energy (50.0%). However, maximum survival percentage (98.07%), Shorter Germination period (19 days), maximum root length (11.20 cm), shoot length (14.22 cm), Number of Leaves (7.81) and Collar diameter (1.93 cm), was observed in GA_3 500 ppm for 24 hours (T_9). While, Dry weight of Root (1.30 g) and Shoot (1.75 g) was influenced by GA_3 300 ppm (T_8) whereas shoot: root ratio was maximum (2.80) in 50% Conc. H_2SO_4 for 2 minutes (T4). Therefore, pre-sowing treatment of seeds soaked in water treatment (room temperature) for 24 hours was more effective in germination and GA_3 of 500 ppm for 24 hours was found to give better growth of quality seedlings of *Terminalia chebula* in the nursery.

Keywords: Pre-sowing treatments, seed germination, seedling growth, *Terminalia chebula*

Introduction
Terminalia is a large genus of predominantly deciduous trees and a few climbers. The genus is named after the Latin phrase 'Terminus,' which relates to how near the leaves are to the stalk tips. It has more than 200 species, making it the most diverse in South East Asia (Fahmy *et al* 2015) [8]. *Terminalia chebula* belonging to Combretaceae family, is a common medicinal tree species used for a number of purposes in the Indian subcontinent. It is generally known as Chebulic myrobalan and also known as "Harad" in Hindi, "Allale" in Kannada, and "Karrakya" in Telugu (Sharma *et al*., 1995) [34]. *Terminalia chebula* is a medium- to large-sized tree native to Asia's tropical and subtropical regions, including China and Tibet (Kannan 2009) [15]. In Tibet, *Terminalia chebula* is called as 'The king of medicines' (Bag *et al*., 2013; Pellati *et al*., 2013) [2], can grow in a wide range of soil conditions, including clay and sandy soils. The trees can grow to be around 20 meters tall and survive in areas with annual precipitation ranging from 900 to 4000 mm and temperatures ranging from 15 to 47.5 degrees Celsius. It grows in deciduous woods in Himachal Pradesh, Tamil Nadu, Kerala, Karnataka, Uttar Pradesh, Andhra Pradesh and West Bengal in India. (Gowda *et al*., 2011) [10].
Terminalia chebula is a well-known traditional medicine used not just in India, but also throughout Asia and Africa (Baliga *et al*. 2012). It is one of the essential constituents of the ayurvedic drug "Triphala," along with *Terminalia bellerica* and *Emblica officinalis* (Naik *et al*., 2003) [22]. The ripe fruits of *Terminalia chebula* are purgative and are used in pharmaceuticals such as laxatives, stomachics, and tonics (Krishnan 1998) [16] and used to cure piles, dropsy, diarrhea, headaches, dyspepsia, and ascites (Chang and Lin. 2010) [5] and also used in conjunction with cholesterol-lowering medicines (Usha 2007) [39].

This plant is also utilized as a food source for animals (Kumar and Bhatt 2006) [17]. It contains nutrients such as vitamin C, protein, amino acids, and minerals (Mahesh *et al*., 2007) [20].

Despite of its various benefits, *Terminalia chebula* plants are threatened, which is one of the main reasons for their population decline across the world. *Terminalia chebula* seeds have a low germination rate in the field attributed to the prevalence of a hard mesocarp in the seed, a thick shell (endocarp), and poor kernel development (Troup 1921) [37]. The fruit of *Terminalia chebula*, which is technically a drupe with a hard endocarp, must germinate over an extended period of time in ideal soil conditions. Rats, squirrels, and rodents devour the fruits which are spread out in the natural population, leading to poor natural regeneration of *Terminalia chebula* (Singh *et al*., 2003) [35]. As a result, effective pre-sowing seed treatments can accelerate the germination. (Hossain *et al*., 2013) [14].

Pre-sowing treatment is a seed treatment that refers to the treating of seeds with any chemical, physical, or biological means before sowing in order to accelerate seed germination. (Umarani *et al*., 2004) [38]. Seed treatments are practiced to ensure faster and uniform germination of seeds. As a result, much research has been conducted to create effective seed treatments for removing dormancy and breaking the hard seed coat of various species in order to assure faster and more effective germination (Nasim *et al*., 1996) [23]. Therefore, the study has been conducted to improve the germination parameters and seedling growth performances at the nursery stages by giving varied treatments to the seeds to overcome the poor germination constraints in this commercially important tree species.

Material and Methods

Planting material and Experimental Details

The mature seeds of *Terminalia chebula* were collected from Khammam forest area, Telangana in September 2021. The study was conducted in the field Nursery of Department of Silviculture and Agroforestry, Forest College and Research Institute, Mulugu, Siddipet, Telangana during 2021-2022. The experimental site is located at 17°.728544 N latitude to 78°.63296 E longitude. The region is dominated by the red shallow gravelly soils, red clayey soils, deep calcareous and colluvial soils. The mean annual temperature ranges from 18 ºC to 42 °C and average rainfall of this area is 905 mm. The seeds are sown by dibbling method in the nursery beds of the size 10 m x 1m with soil, sand and FYM as potting mixture in the ratio of 2:1:1 for the primary beds. The experimental design was laid out using Completely Randomized Design (CRD) with nine treatments and three replications each. 90 seeds were sown for each treatment cumulatively 900 seeds for all the treatments of the species. And the results are interpreted using One-way analysis of variance (ANOVA) – Completely Randomized Design (Panse and Sukatme, 1995) [26]

Table 1: Pre-sowing treatment details of *Terminalia chebula*

T_1	water Treatment for 12 hours (Room Temperature)
T_2	water Treatment for 24 hours (Room Temperature)
T_3	water Treatment for 48 hours (Room Temperature)
T_4	50% H_2SO_4 for 2 minutes
T_5	50% H_2SO_4 for 5 minutes
T_6	50% H_2SO_4 for 10 minutes
T_7	100ppm GA_3 for 24 hours
T_8	300ppm GA_3 for 24 hours
T_9	500ppm GA_3 for 24 hours
T_{10}	Control

Germination attributes

Germination parameters are recorded from the day of commencement of germination. The parameters investigated in the present study are Germination Percentage (Maguire 1962) [19], Germination Energy (Ruan *et al*. 2002) [32], Germination Period and Survival Percentage (Sajana 2016) [33] (Table 1)

Growth attributes

Growth parameters like Root length, shoot length, Number of leaves, Collar diameter were recorded at 45 days interval up to 90 days and dry weight of root, dry weight of shoot and shoot: root ratio after 90 days. Digital caliper was used to measure the collar diameter (Table 2)

Results and discussion

Germination parameters of *Terminalia chebula*

Data presented in Table 2 showed that significant differences at the 5% level among different treatments applied. The observations showed that the maximum germination percentage (78.8%) was observed in seeds were soaked in water treatment (room temperature) for 48 hours (T_3) and the minimum germination percentage (33.3 %) was recorded in water treatment (room temperature) for 12 hours (T_1). Improvement in germination of seeds might be due to the stimulating effect of imbibition’s on seed germination caused by increased water absorbing capacity and killing pathogens (Cho and Lee 2018). The results are in accordance with the work done by Hossain *et al*., (2005) [13] found that seeds of *Terminalia chebula* showed maximum germination percentage (66.7%) when subjected to soaking in cold water for 48 hours and also Kumar (2016) [18] on *Terminalia bellirica* (Bahera).

However, the maximum germination energy (50%) was recorded in seeds soaked in water treatment (room temperature) for 48 hours (T_3) and the minimum germination energy (20%) was recorded in water treatment (room temperature) for 12 hours (T_1). The results are in agreement with those obtained by Hossain *et al*., (2005) [13] who stated that highest germination energy (58.9) in *Terminalia chebula* was observed when seeds were soaked in cold water for 48 hours.

The shorter germination period for (19 days) was noticed in seeds treated with GA_3 of 500 ppm for 24 hours (T_9) and the longer germination period (28 days) was observed in control (T_{10}). The maximum survival percentage (98.07%) was observed in seeds treated with GA_3 of 500 ppm for 24 hours (T_9) whereas the minimum survival percentage (76.66%) was recorded in seeds soaked in water treatment (room temperature) for 12 hours (T_1). This could be due to the weakening of the seed coat for gaseous and moisture exchange, as well as the availability of food material essential for early and better germination under this treatment. Early germination may have resulted in faster and stronger root development, which may have aided in the development of stem and leaves in these seedlings, resulting in a higher survival percentage. This obtained results goes in line with the findings of Manekar (2011) [21] discovered that *Emblica officinalis* seeds treated with GA_3 200 ppm for 24 hours have resulted in the highest (92.73%) seedling survival percentage and also Dilip *et al*., (2017) [7] in Rangpur Lime; Palepad *et al*., (2017) [25] in custard apple (*Annona squamosa*); Barche *et al*., (2010) [4] in papaya (*Carica papaya*).

Table 1: Effect of different pre-sowing treatments on Germination parameters of *Terminalia chebula*

Treatment Details	GP (%)	SP (%)	GE (%)	G.PE (days)
T_1	33.33	76.66	20.00	25
T_2	48.88	84.09	33.33	23
T_3	78.88	85.91	50.01	21
T_4	53.33	87.50	34.44	20
T_5	61.11	81.81	38.88	22
T_6	56.66	82.35	37.77	23
T_7	65.55	83.05	41.11	24
T_8	70.00	93.96	46.66	20
T_9	57.77	98.07	43.33	19
T_{10}	51.11	82.60	31.11	28
S.Em±	0.541	0.293	1.378	1.906
CD (@5%)	1.608	N/S	4.095	5.663

*GP - Germination percentage * GE - Germination energy
* G.PE - Germination period * SP- Survival percentage
* SEm± - Standard error mean * CD (@5%) – Critical difference at 5 % level of significance * N/S= Non –Significant

Growth parameters of *Terminalia chebula* seedlings

Overall results showed significant differences at the 5% level among different treatments applied. Data in table 3 reveals about the influence of different pre-sowing treatments on growth parameters of *Terminalia chebula* seedlings. The maximum Root length (7.70cm), shoot length (11.7cm), Number of Leaves (7.30) and Collar diameter (1.76 cm) after 45 days of sowing was obtained in GA_3 of 500 ppm for 24 hours (T_9) and on contrary minimum Root length (5.80cm), Number of Leaves (4.80) and Collar diameter (0.76 cm) was noticed in control, while shoot length (9.10cm) was found in water treatment (room temperature) for 12 hours (T_1).

The Root length, Shoot length, Number of Leaves, Collar diameter showed significantly with increasing in the number of days and the same trend was followed after 90 days of sowing with maximum Root length (11.20cm), shoot length (14.22cm), Number of Leaves (7.81) and Collar diameter (1.93 cm) was observed in GA_3 of 500 ppm for 24 hours (T_9) conversely minimum Root length (8.40cm), Number of Leaves (5.20) and Collar diameter (0.97cm) was found in control while shoot length (10.00cm) was found in water treatment (room temperature) for 12 hours (T_1).

Comparison between root length, shoot length, collar diameter, number of leaves of 45 days with 90 days were represented under figure 1-4. Whereas the results of the study showed that Growth attributes are preferably influenced by GA_3 treatment which is very well in line with the work conducted by Thounaojam and Dhaduk (2020) [36] on *Buchanania lanzan* seeds where highest root length (9 cm) was obtained when seeds were treated with GA_3 @900 mg/l for 24 hrs. The importance of GA_3 in root initiation and development is evident, and the needed concentration of GA_3 may have promoted cell elongation, cell division, and cell multiplication in cambium tissues (Ratan and Reddy 2004) [31]. Similar results were reported by Polaiah (2020) [29] maximum shoot length (22.42cm) in sandalwood (*Santalum album L.*); Vijayakumar and Selvaraju (2013) [40] in *Cassia auriculate;* Rai *et al*., (2018) [30] in khirni (*Manilkara hexandra*). Maximum number of leaves was reported by Pawar *et al*., (2010) [28] in *jatropha* at 90 days of sowing when seeds were treated with GA_3 at 300 ppm for 8 hrs. while, maximum collar diameter (5.34 mm) was reported by Patel *et al*., (2018) [27] in *Santalum album* when seeds treated with 500 ppm GA_3 for 24 hours and also supported by Hemalatha and chandari (2021) [12] in the *Santalum album.*

Table 3: Effect of different pre-sowing treatments on Growth parameters of *Terminalia chebula* seedlings

Treatment details	Root length (cm)		Shoot length (cm)		Collar diameter (cm)		No. of leaves		S: R Ratio (gm)	Dry weight of shoot (gm)	Dry weight of root (gm)
	45D	90D	45D	90D	45D	90D	45D	90D			
T_1	6.80	9.43	9.10	10.00	1.48	1.76	5.00	6.01	1.26	1.01	0.78
T_2	6.20	9.46	9.22	10.99	1.58	1.83	4.80	6.40	1.65	1.19	0.82
T_3	6.81	10.40	9.40	11.20	1.06	1.27	5.10	6.91	2.16	1.43	1.09
T_4	5.93	9.21	9.61	10.60	1.05	1.19	5.61	6.80	2.80	1.52	0.94
T_5	5.91	9.01	10.4	10.60	0.81	0.99	6.22	6.81	2.20	1.30	0.85
T_6	7.50	11.00	11.5	12.77	1.24	1.32	6.20	7.50	2.06	1.29	0.92
T_7	6.51	9.73	11.2	12.66	0.70	1.16	5.31	6.71	1.76	1.09	0.75
T_8	6.82	9.83	11.5	13.22	1.21	1.43	5.83	7.32	2.51	1.75	1.30
T_9	7.70	11.20	11.7	14.22	1.76	1.93	7.30	7.81	2.13	1.02	1.22
T_{10}	5.80	8.40	9.32	11.44	0.76	0.97	4.51	5.20	1.30	0.98	0.68
SEm±	0.229	0.404	0.592	0.368	0.167	0.495	0.286	0.446	0.675	0.155	0.091
CD@5%	0.679	1.200	1.760	1.094	0.192	0.572	0.849	1.325	N/S	0.459	0.270

For biomass (shoot and root) data was taken at 90 days after sowing. Significantly highest dry weight of root (1.30g) was observed in seeds treated with 300pm GA_3 for 24 hours (T_8). While, minimum dry weight of root (0.68g) was observed in control (T_{10}). Similar results were also reported by Pawar *et al*., (2010) [28] found that the dry weight of root in *Jatropha* seedlings was maximum (4.3 g) at 90 days of sowing when seeds were treated with GA_3 at 300 ppm for 8 hrs and also Ratan and Reddy (2004) [31] in custard apple (*Annona squamosa*).

Highest dry weight of Shoot (1.75g) was observed in seeds treated with 300ppm GA_3 for 24 hours (T_8). While, minimum Dry weight of shoot (0.98g) was observed in (T_{10}) control. This obtained result goes in line with those findings by Pawar *et al*., (2010) [28] reported that the dry weight of shoot *jatropha* seedlings was maximum (14.3 g) at 90 days of sowing when seeds were treated with GA_3 at 300 ppm for 8 hrs and also Rai *et al*., (2018) [30] in khirni (*Manilkara hexandra*).

Highest Shoot to Root ratio (2.80) was recorded in 50% conc. H_2SO_4 for 5 mins (T_4) treatment and it was superior over all other treatments performed conversely minimum Shoot to Root ratio (1.26) was recorded in (T_1) water treatment (room temperature) for 12 hours. These findings are in agreement with the findings of Fallah *et al*., (2014) [9] reported the highest ratio of shoot to root (1.23) was influenced by conc. H_2SO_4 treatment which fall in harmony with the present experiment.

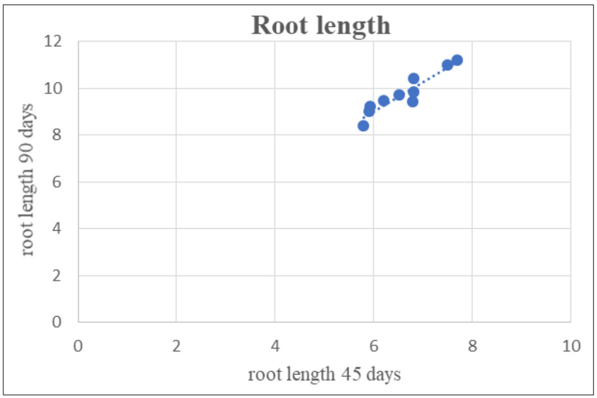

Fig 1: Correlating Root length of 45 days with 90 days

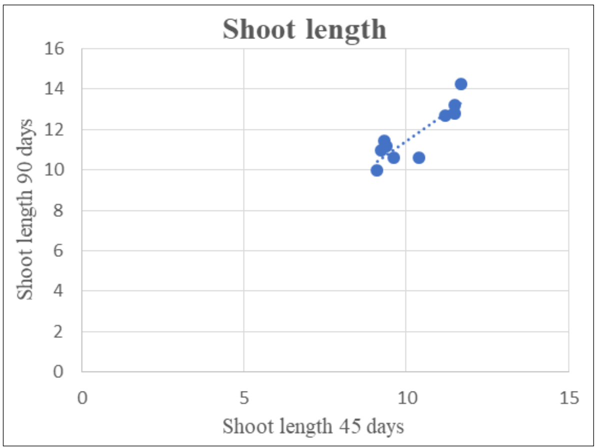

Fig 2: Correlating shoot length of 45 days with 90 days

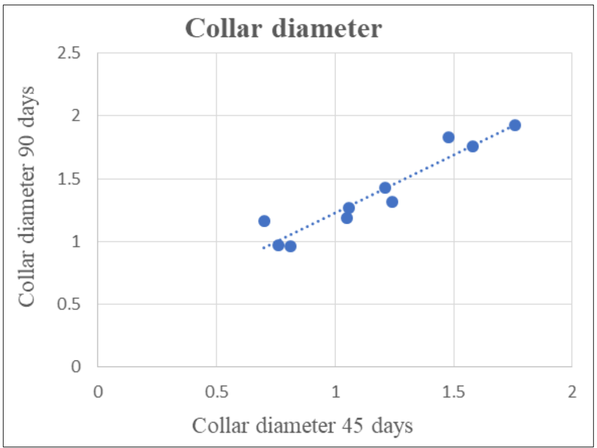

Fig 3: Correlating collar diameter of 45 days with 90 days

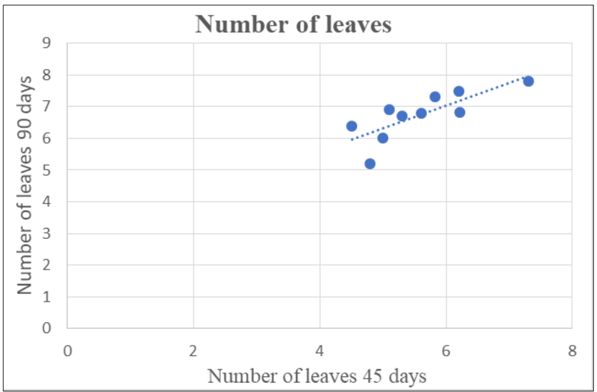

Fig 4: Correlating no. of leaves of 45 days with 90 days

Conclusion

Terminalia chebula seeds have a limited germination capacity, lack of natural regeneration in the field due to the presence of a hard endocarp in the seed, a thick shell (endocarp), and poor kernel formation. Pre-sowing treatment is essential to enhance the germination percentage of such species having low germination either to break the dormancy or to break the hard seed coat. Among all the treatments applied, seeds of *Terminalia chebula* treated with water treatment (room temperature) for 24 hours and GA_3 of 500 ppm for 24 hours was found to give higher seed germination and better growth of *Terminalia chebula* seedlings respectively. Considering the practicability of the nursery raising technique for the species, the best treatment option obtained in this study was seeds soaked in water treatment (room temperature) for 48 hours and GA_3 of 500 ppm for 24 hours which could be useful for large scale plantation programs.

References

1. Anwesa B, Subir BK, Rabi CR. Therapeutic potential of *Terminalia chebula* Retz. (Combretaceae): the ayurvedic wonder. Asian Pacific Journal of Tropical Biomedicine; c2013. p. 244-252.
2. Bag A, Bhattacharyya SK, Chattopadhyay RR. The development of *Terminalia chebula* Retz. (Combretaceae) in clinical research. Asian Pacific journal of tropical biomedicine. 2013;3(3):244-252.
3. Bajaniya VG, Karetha KM, Varmora DL, Chotaliya BM, Parmar LS. Influence of pre-soaking treatment on seed germination, rooting and survival of khirni (*Manilkara hexandra*Roxb) seedling cv. *Local.* Int. J Pure App. Biosci. 2019;6(1):1629-1633.
4. Barche SK, Singh K, Singh DB. Response of seed treatment on germination, growth, survivability and economics of different cultivars of papaya (*Carica papaya* L.). Acta Hort. 2010;851:279-281.
5. Chang CL, Lin CS. Development of antioxidant activity and pattern recognition of *Terminalia chebula* Retzius extracts and its fermented products. *弘光學報*. 2010;(61):115-129.
6. Cho JS, Lee CH. Effect of germination and water absorption on scarification and stratification of kousa dogwood seed. Hort., Environ. Biotech. 2018;59(3):335-344.
7. Dilip WS, Singh D, Moharana D, Rout S, Patra SS. Effect of gibberellic acid (GA) different concentrations at different time intervals on seed germination and seedling growth of Rangpur lime. 2017;4(2):157-165.
8. Fahmy NM, Al-Sayed E, Singab AN. Genus *Terminalia*: A phytochemical and biological review. J Med Aromat Plants. 2015;4(5):1-21.
9. Fallah IA, Salehi SA, Shahdadneghad M. Effect of H_2SO_4 on seed germination and viability of *Canna indica* L. ornamental plant. Int. J Adv. Biol.Biom. Res. 2014;2(1):223-229.
10. Gowda HC, Vasudeva R, Raghu HB, George PM. Standardization of pre-germination seed treatment for *Embelia tsjeriam*-cottam. My forest. 2011;39(4):337-339.
11. Haider MR, Alam MS, Shutrodha AR. Effect of pre-sowing treatment on seed germination and seedlings growth of *Sapindus mukorossi* Gaertn. -an important medicinal plant in Bangladesh. Journal of Bioscience and

Agriculture Research. 2016;6(02):570-577.
12. Hemalatha M, Chaudhari SB. Effect of pre-sowing treatments on seed germination and its parameters in sandalwood (*Santalum album* L.). Journal of Pharmacognosy and Phytochemistry. 2021;10(1):92-95.
13. Hossain MA, Arefin MK, Khan BM, Rahman MA. Effects of seed treatments on germination and seedling growth attributes of Horitaki (*Terminalia chebula* Retz.) in the nursery. Research Journal of Agriculture and Biological Sciences. 2005;1(2):135-141.
14. Hossain MA, Uddin MS, Rahman MM, Shukor NA. Enhancing seed germination and seedling growth attributes of a medicinal tree species *Terminalia chebula* through depulping of fruits and soaking the seeds in water. J Food Agric Environ. 2013;11(3-4):2573-8.
15. Kannan P, Ramadevi SR, Hopper W. Antibacterial activity of *Terminalia chebula* fruit extract. African Journal of Microbiology Research. 2009;3(4):180-184.
16. Krishnan BM, Kulashekaran M. Studies on seed germination in wild ber (*Zizyphus rotundifolia*). S. Ind. Hort. 1989;82(3):153-154.
17. Kumar M, Bhatt VP. Plant biodiversity and conservation of forests in foot hills of Garhwal Himalaya. Journal of Ecology and Application. 2006;11(2):43-59.
18. Kumar V. Effect of pre-sowing seed treatment on germination and seedling growth of *Terminalia bellirica* (Gaertn.) Roxb. Indian Journal of Ecology. 2016;43(1):233-238.
19. Maguire JD. Speed of germination-aid in selection and evaluation for seedling emergence and vigor. Crop Sci. 1962;2:176-7.
20. Mahesh R, Ramesh T, Nagulendran KR, Velavan S, Begum VH. Effect of *Terminalia chebula* on monoamine oxidase and antioxidant enzyme activities in aged rat brain. Pharmacognosy Magazine. 2007;3(12):240.
21. Manekar RS, Sable PB, Rane MM. Influenced of different plant growth regulators on seed germination and subsequent seedling growth ofaonla. Green farming. 2011;2(4):477-478.
22. Naik GH, Priyadarsini KI, Naik DB, Gangabhagirathi R, Mohan H. Studies on the aqueous extract of *Terminalia chebula* as a potent antioxidant and a probable radioprotector. Phytomedicine, 2004;11(6):530-538
23. Nasim FUH, Shahzadi TF, Ashraf MOHAMMAD. A cold shock during imbibition improves germination of *Acacia nilotica* seeds. Pakistan Journal of Botany. 1996;28:183-190
24. Nema S, Jain PK, Nema BK, Nema MK. Effect of GA_3, Sucrose and date of sowing on seed germination and seedling growth in Ber. Indian J. Hort. 1994;51(2):154-156.
25. Palepad KB, Bharad SG, Bansode GS. Effect of seed treatments on germination, seedling vigour and growth rate of custard apple (*Annona squamosa*). Journal of Pharmacognosy and Phytochemistry. 2017;6(5):20-23.
26. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Statistical methods for agricultural workers; c1954. p. 361 p.
27. Patel HS, Tandel MB, Prajapati VM, Amlani MH, Prajapati DH. Effect of different pre-sowing treatments on germination of Red sanders (*Pterocarpus santalinus* L. f.) in Poly house condition. IJCS. 2018;6(4):162-165.
28. Pawar VB, Gore RV, Patil VK, Narsude PB. Effect of Gibberellic acid on seed germination and growth of *Jatropha curcas* L. Asian Journal of Horticulture. 2010;5(2):311-313.
29. Polaiah AC, Parthvee RD, Manjesh GN, Thondaiman V, Shivakumara KT. Effect of presowing seed treatments on seed germination and seedling growth of sandalwood (*Santalum album* L.). 2020.
30. Rai R, Malay S, Srivastava R, Uniyal S. Improving seed germination and seedling traits by presowing treatments in khirni (*Manilkara hexandra*). Bulletin of Environment, Pharmacology and Life Sciences. 2018;7(4):77-81.
31. Ratan PB, Reddy YN. Influenced of gibberellic acid on custard apple (*Annona squamosa* L.) seed germination and subsequent seedling growth, j. Res. ANGRAU. 2004b;32(2):93-95.
32. Ruan S. Effects of seed priming on germination and health of rice (*Oryza sativa* L.) seeds. Seed Science and Technol. 2002;30:451-8.
33. Sajana S. Studies on effect of plant growth regulators on seed germination and seedling growth of marking nut (*Semecarpus anacardium* L.). Doctoral dissertation, submitted to Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani; c2016.
34. Sharma M, Tripathi P, Singh VP, Tripathi YB. Hepatoprotective and toxicological evaluation of hepatomed, an ayurvedic drug. Indian Journal of Experimental Biology. 1995;33(1):34-37.
35. Singh DRR, Dhir KK, Vij SP, Nayyar H, Singh Kamaljit. Study of genetic improvement technique of *Terminalia chebula* Retz. - An important multipurpose tree species of India. Indian Forester. 2003;129(2):154-168.
36. Thounaojam AS, Dhaduk HL. Enhancement of seed germination in Chironji (*Buchanania lanzan* Spreng) through physical and chemical treatments. Journal of Pharmacognosy and Phytochemistry. 2020;9(1):1354-1359.
37. Troup RS. Siliviculture of Indian trees. Vol. II, Oxford University Press, London, 1921, 511-514.
38. Umarani R, Vanangamudi K. Introduction to Tree seed technology. International Book Distributors. New Delhi, India; c2004. p. 1-199.
39. Usha C, Satyanarayanan R, Velmurugan A. Use of an aqueous extract of *Terminalia chebula* as an anticaries agent: A clinical study. Indian J Dent Res. 2007;18(4):152-56.
40. Vijayakumar A, Selvaraju P. Standardization of seed dormancy breaking treatment in Senna (*Cassia auriculata*). Journal of plant breeding and crop science. 2013;5(11):220-223.