International Research Journal of Plant Science (ISSN: 2141-5447)
Vol. 14(6) pp. 01-9, December, 2023
DOI: http:/dx.doi.org/10.14303/irjps.2023.49
Available online @ https://www.interesjournals.org/plant-science.html

Research Article

Effect of pre-sowing treatments on germination and growth of *Terminalia tomentosa* Wight & Arn

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Abstract

Terminalia tomentosa Wight & Arn is known for treating multiple aliments, is one of the most popular timber species. However, hard seed coat and low germination are hindering its use in afforestation, reforestation and commercial plantation programs. Study was conducted to study the effect of different pre-sowing treatments on germination and growth of *Terminalia tomentosa* at Forest College and Research Institute, Mulugu, during 2021-2022. The experiment was laid out in completely randomized design with nine treatments and three replications. Presoaking treatment of seeds soaked in hot water for 24 hours (T4) has shown significantly superior performance with respect to germination percentage (71.11%), shorter germination period (12 days), survival percentage (93.75%) and growth attributes like root length (25.17cm), number of leaves (14.40), dry weight of root (13.3g) and dry weight of shoot (5g). It is because of the fact that hot water treatment gave earlier germination, which might be due to the stimulating effect of imbibitions on seed germination by affecting various factors, viz., seedcoat permeability for gases and water exchange and release of inhibitor whereas shoot: root ratio was maximum in T8 i.e. 50% concentrated H_2SO_4 for 5 minutes (0.72).

Keywords: Growth regulator, Hard seed coat, Hot water treatment, Planting material, Presowing treatments.

INTRODUCTION

Forest nurseries are critical to the success of afforestion/ reforestation programmes. Technical talents are required for generating high-quality seedlings, which include careful preparation for the selection of quality seeds, appropriate growing material, containers, nursery hygiene, and protection. The quick development of trees in an agroforestry plantation is critical because it offers the cultivator with the most potential benefits in a number of ways. *Terminalia tomentosa* Wight &Arn is a large deciduous tree of family Combretaceae, is one of the common tree stand widely distributed Indian timber species. The geographical distribution ranges from outer Himalayas, Punjab to Sikkim, Nepal, Myanmar and Sri Lanka (Kirtikar and Basu, 1989). It is extensively found in both moist and dry deciduous forests of Southern India (Gaur 1999; Naidu *et al.* 2018). Deep, rich alluvial soils are excellent for the tree's growth; sandy soil should be avoided. In terms of silviculture, it is regarded as appropriate for afforesting clayey soils.

T. tomentosa has long been recognized for its traditional medicinal efficacy in the treatment and management

Received: 30-Nov-2023, Manuscript No. IRJPS-23-123865; **Editor assigned:** 02-Dec-2023, Pre QC No. IRJPS-23-123865 (PQ); **Reviewed:** 15-Dec-2023, QC No. IRJPS-23-123865; **Revised:** 20-Dec-2023, Manuscript No. IRJPS-23-123865 (R); **Published:** 27-Dec-2023

Citation: Indu K., et al (2023). Effect of pre-sowing treatments on germination and growth of *Terminalia tomentosa* Wight & Arn. IRJPS 14:49

of a variety of ailments (Saklani, *et al*. 2021). Even in the presence of favorable environment seed germination becomes difficult (Zabala, 1990).

It is anticipated that seed treatments will ensure both successful seed germination and synchronized germination (Azad *et al.* 2011a, 2011b, 2012).The effect of pre-sowing treatments on seed germination of some tropical forest tree species was performed (Koirala *et al.*, 2000; Azad *et al.*, 2010a, 2010b; Billah, 2015; Patel, *et al.*, 2018). However, considerable work has not been done yet on propagation of the species on a large scale, despite of having many uses and less knowledge on the species (Saklani, S., *et al*. 2021). The species exhibits an exogenous dormancy and quiescence structure that precludes quick and uniform germination and production of quality planting stock and restricting in plantation activities due to destitute seed germination and delayed nursery establishment (Alamgir and Hossain 2005b; Falemara et. al., 2014).

Several studies on seed dormancy have been conducted, but only a few have addressed the mechanism of seed coat softening (Okunlola et. al., 2011). One such solution for breaking dormancy may be pre-sowing treatments such as mechanical scarification (Catalan and Macchiavelli, 1991), hot water treatment (Kobmoo and Hellum,1984; Khasa,1992) or acid treatment (Kobmoo and Hellum, 1984) which increases germination percentages (Maguire 1962; Koirala *et al.* 2000; Alamgir and Hossain 2005b; Azad et al. 2010a and 2010b) and justify the purpose as it is high time to introduce the species on large scale afforestation, reforestation and other commercial plantation activities to avail the benefits. Therefore, the study attempts to determine the best possible pre-sowing treatment method that maximizes the germination percentages and seedling's growth performance at the nursery stages.

MATERIALS AND METHODS

Planting material and experimental site

The mature seeds of *T. tomentosa* were collected and the study was conducted in the field nursery at Forest College and Research Institute, Mulugu, Siddipet, Telangana. The experimental site is located at 17^{o}.728544 N to 78^{0}.63296 E. The region is dominated by red shallow gravelly soils, red clayey soils, deep calcareous and colluvial soils. The mean annual temperature ranges from 18^{0}C to 42^{0}C and the average rainfall of this area is 905.3 mm. The seeds were sown by dibbling method in the nursery beds of the size 10 m x 1 m with soil, sand and FYM as potting mixture in the ratio of 2:1:1 for the primary beds.

Seed treatments

Seeds of *T. tomentosa* were subjected to chemical pre sowing treatments ($GA_{3,}$ Conc. H_2SO_4) and soaking in hot water, cow dung slurry and control. The treatments are discussed in detail under application of treatments sub heading. Details of the seed treatments used in this study is given in Table 1.

Application of treatments

GA_3 treatment

The required quantity (0.5g) of GA_3 was dissolved in ethyl alcohol and then diluted with distilled water to make a stock solution of 500 ppm. Further dilutions were made according to requirements using distilled water, ninety seeds of each were treated with Gibberellic acid with varying concentrations i.e. 100 ppm, 200 ppm, 300 ppm and 500 ppm, then the treated seeds were dried under shade condition and later sown in primary bed to observe their germination response.

Hot water treatment

Ninety seeds of each were soaked in hot water for 12 hours and 24 hours. Then the seeds were dried in shed and sown in primary bed and observed for germination.

Conc.H_2SO_4 treatment

Ninety seeds of each were treated with concentrated H_2SO_4 for 2 minutes and 5 minutes. Then seeds removed from acid and washed under tap water. The treated seeds were later sown in primary bed and observed for germination.

Table 1: Details of seed treatments and description.

Treatments	Details of the treatment
T_1	Soaking in 100 ppm GA_3 for 24 hours
T_2	Soaking in 200 ppm GA_3 for 24 hours
T_3	Soaking in 500 pm GA_3 for 24 hours
T_4	Soaking in hot water for 24 hours
T_5	Soaking in hot water for 12 hours
T_6	Cow dung treatment for 24 hours
T_7	50% concentrated H_2SO_4 for 2 minutes
T_8	50% concentrated H_2SO_4 for 5 minutes
T_9	Control

Cow dung slurry treatment

Ninety seeds of each were soaked in cow dung slurry for 24 hours and then removed from slurry and kept in primary bed for germination.

Control

In this case, no treatment was given to the seeds. The untreated whole pods were directly sown in the primary bed and kept for observation.

Experimental design

The experiment was laid out using completely randomized design (CRD) with nine treatments and three replications each. 90 seeds were sown for each treatment. A total of 810 seeds for all the treatments of the species were used. The details are given in Table 2.

Germination parameters

Germination parameters were recorded from the day of the commencement of germination. The parameters investigated in the present study are listed below

Germination percentage was calculated following Maguire (1962)

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Germination energy (GE) was calculated following Ruan *et al.(*2002)

$$\text{GE} = \frac{\text{Total number of seeds germinated when daily germination reaches its peak value}}{\text{Total number of seeds sown}} \times 100$$

Germination period

The germination period was calculated as the difference between initial and final emergence (number of days) recorded

Survival percentage was calculated following Sajana (2016)

$$\text{Survival (\%)} = \frac{\text{Total number of seedlings survived}}{\text{Total number of germinated seedlings}} \times 100$$

Growth parameters

Growth parameters like root length, shoot length, number of leaves, collar diameter were recorded at 45 days interval up to 90 days (12 weeks) and dry weight of root, shoot and shoot: root ratio after 90 days. Electronic digital vernier caliper was used to measure the collar diameter

Statistical analysis

One-way analysis of variance (ANOVA) – Completely Randomized Design was performed to test the differential effect of different pre-sowing treatments on germination and growth of the species (Panse and Sukatme, 1995).

RESULTS

Germination parameters

Germination parameters are summarized in Table-3, which were significantly influenced by different pre-sowing treatments performed. The maximum (71.11%) germination percentage was recorded in seeds soaked in hot water for 24 hours (T_4) followed by seeds soaked in (T_2) 200 ppm GA_3 for 24 hours (64.44%) and the lowest germination percentage (16.66%) was recorded in (T_7) 50% concentrated H_2SO_4 for 2 minutes. The maximum (93.75%) survival percentage was recorded in seeds soaked in hot water for 24 hours (T_4) followed by (T_2) soaked in 200 ppm GA_3 for 24 hours (87.93%) whereas the lowest survival percentage (73.33%) was recorded in seeds treated with 50% concentrated H_2SO_4 for 2 minutes (T_7). The maximum (43.33%) germination energy was recorded in seeds soaked in 100 ppm GA_3 for 24 hours (T_1) followed by (T_3) seed soaked in 500 ppm GA_3 for 24 hours (40%) and the lowest germination energy (13.33%) was recorded in (T_6) cow dung slurry treatment for 24 hours. The shorter germination period of 12 days was recorded for seeds soaked in hot water for 24 hours in T_4 followed by T_5 soaked in hot water for 12 hours for 14 days and the longer germination period of 24 days was recorded in 50% concentrated H_2SO_4 for 2 minutes in T_7. The comparison for germination percentage with germination energy, germination period and survival percentages are depicted in the Figures 1-3.

Growth attributes

The different pre-sowing treatments have significantly influenced the growth parameters of *T. tomentosa*. The root length of seedling was significantly maximum (25.17 cm) in T_4 for seeds soaked in hot water for 24 hours treatment at 90 DAS, followed by (23.33 cm) T_2 for seeds soaked in 200

Table 2: Seeds required for nine pre-sowing treatments and time duration for soaking.

Treatments	Number of seeds used	Time duration for soaking
GA_3	270	24 hours (different ppm's)
Hot water	180	24 hours and 12 hours
Cow dung slurry	90	24 hours
Acid scarification	180	2 minutes and 5 minutes
Control	90	No soaking

Table 3: Effect of different pre-sowing treatments on germination parameters of *Terminalia tomentosa.*

Treatment. No	Germination percentage	Germination energy (%)	Germination period (Days)	Survival percentage
T_1	52.22	43.33	18	82.97
T_2	64.44	25.55	22	87.93
T_3	46.66	40.00	13	85.71
T_4	71.11	24.44	12	93.75
T_5	27.77	36.66	14	84.00
T_6	24.44	13.33	23	81.81
T_7	16.66	14.44	24	73.33
T_8	30.00	16.66	20	74.07
T_9	46.00	30.00	21	83.33
SEm±	**0.73**	**1.21**	**1.85**	**2.18**
CD(@5%	**2.19**	**3.64**	**5.55**	**8.86**

T_1: soaking in 100 ppm GA_3 for 24 hours, **T_2**: soaking in 300 ppm GA_3 for 24 hours, **T_3:** soaking in 500 pm GA_3 for 24 hours, **T_4:** soaking in hot water for 24 hours, **T_5**: soaking in hot water for 12 hours, **T_6:** Cow dung slurry treatment for 24 hours, **T_7:** 50% concentrated H_2SO_4 for 2 minutes, **T_8:** 50% concentrated H_2SO_4 for 5 minutes, **T_9:** Control.

SEm± - standard error mean; CD(@5%critical difference at 5% level of significance).

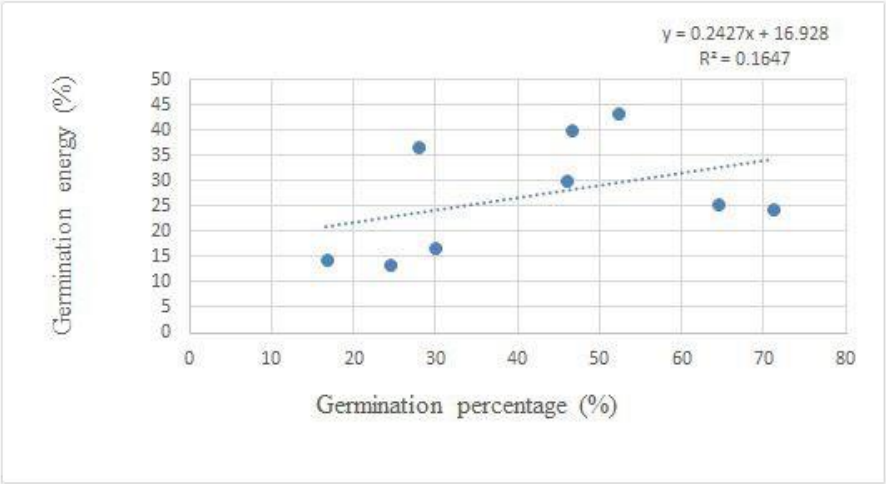

Figure 1. Relationship between germination energy and germination percentage.

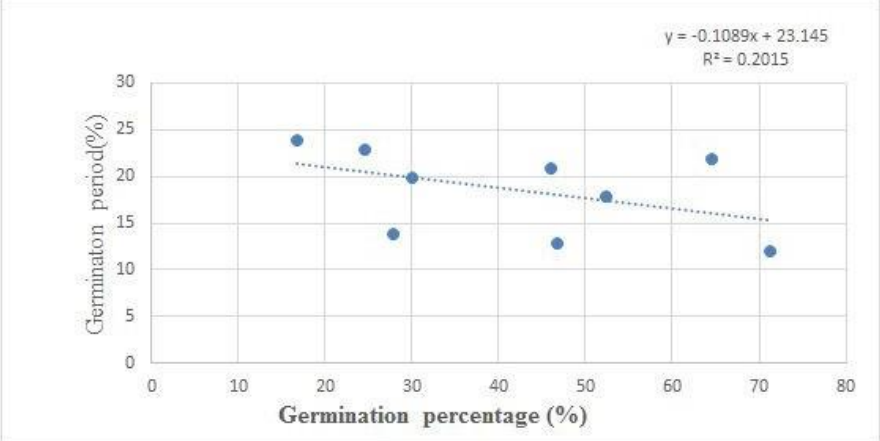

Figure 2. Relationship between germination period and germination percentage.

ppm GA_3 for 24 hours while the minimum (14.07cm) root length was observed in (T_6) cow dung slurry for 24 hours at 90 DAS. The maximum shoot length (15.75 cm) was observed in T_1 for seeds soaked in 100 ppm GA_3 for 24 hours at 90 DAS, followed by (14. 16 cm) in T_4 for seeds soaked in hot water for 24 hours and the minimum shoot length (7 cm) was observed in T_6 for seeds soaked in cow dung slurry treatment for 24 hours at 90 DAS. The collar diameter of seedling was significantly maximum of 1.76 cm in T_1 for seeds soaked in 100 ppm GA_3 for 24 hours treatment at 90 DAS, followed by 1.25 cm in T_4 for seeds soaked in hot water for 24 hours and minimum collar diameter of 0.75 cm was observed in T_6 for seeds soaked in cow dung treatment

for 24 hours at 90 DAS. Higher number of leaves as 14.40 was recorded in T_4 treatment for seeds soaked in hot water for 24 hours followed by 11.33 in T_8 for seeds soaked in 50% concentrated H_2SO_4 for 5 minutes treatment and the number of leaves in cow dung treated seeds for 24 hours (T_6) recorded least (7.80). Highest dry weight of root was 13.3 g for the seeds soaked in hot water for 24 hours (T4) followed by (T_5) hot water treatment for 12 hours (11.3) while, minimum dry weight of 4.1 g root was recorded in T6 for cow dung slurry treatment. Highest dry weight of shoot as 5 g was recorded for seeds soaked in T_4 treatment of hot water for 24 hours followed by 4.1 g in T_8 concentrated H_2SO_4 for 5 minutes treatment and minimum dry weight of

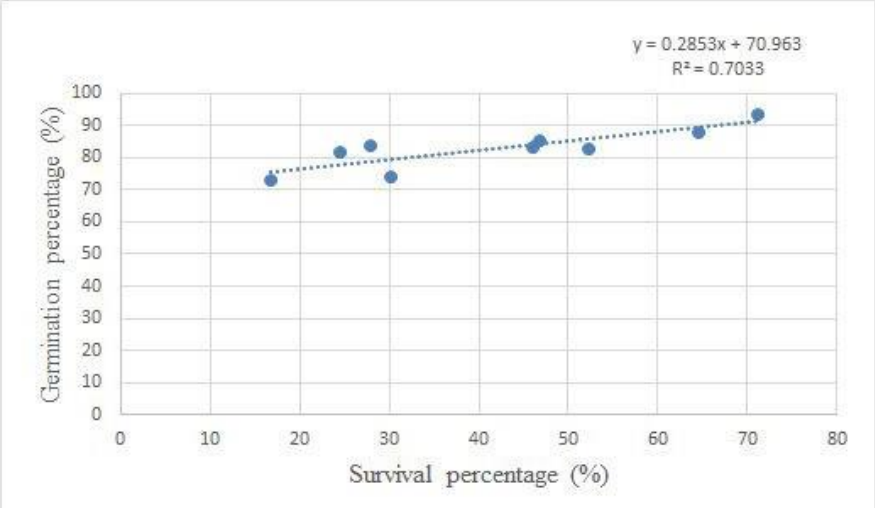

Figure 3. Relationship between survival percentage and germination percentage

Table 4: Effect of different pre-sowing treatments on growth parameters of *Terminalia tomentosa.*

Treatment details	Root length (cm)		Shoot length (cm)		Collar diameter (cm)		No. of leaves		S:R ratio	Root dry weight (g)	Shoot dry weight (g)
	45D	90D	45D	90D	45D	90D	45D	90D			
T1	14.07	19.03	15.00	15.75	1.63	1.76	6.83	9.03	0.54	7.0	2.9
T2	16.10	23.33	11.33	12.83	0.96	1.03	7.33	9.27	0.44	4.3	1.3
T3	11.58	15.83	11.00	12.00	0.95	1.01	7.57	11.10	0.22	6.3	1.0
T4	16.63	25.17	12.50	14.16	1.20	1.25	13.17	14.40	0.41	13.3	5.0
T5	12.90	18.43	11.41	13.91	0.80	0.83	7.17	11.27	0.26	11.3	2.4
T6	8.50	14.07	6.41	7.00	0.53	0.75	6.40	7.80	0.41	4.1	1.1
T7	13.17	15.25	12.50	13.33	1.03	1.11	8.67	11.00	0.41	8.8	2.5
T8	13.00	15.67	9.58	10.16	0.63	0.76	9.50	11.33	0.72	6.2	4.1
T9	15.17	20.00	11.83	13.21	0.80	1.01	8.80	10.83	0.57	9.5	3.4
SEm±	**1.25**	**1.88**	**1.20**	**1.01**	**0.12**	**0.12**	**1.05**	**0.95**	**0.07**	**0.94**	**0.43**
CD(@5%	**3.77**	**5.64**	**3.59**	**3.03**	**0.38**	**0.36**	**3.15**	**2.87**	**0.23**	**2.83**	**1.29**

T_1: soaking in 100 ppm GA_3 for 24 hours, **T_2**: soaking in 300 ppm GA_3 for 24 hours, **T_3:** soaking in 500 pm GA_3 for 24 hours, **T_4:** soaking in hot water for 24 hours, **T_5**: soaking in hot water for 12 hours, **T_6:** Cow dung slurry treatment for 24 hours, **T_7:** 50% concentrated H_2SO_4 for 2 minutes, **T_8:** 50% concentrated H_2SO_4 for 5 minutes, **T_9:** Control.

SEm± - standard error mean; CD(@5%critical difference at 5% level of significance).

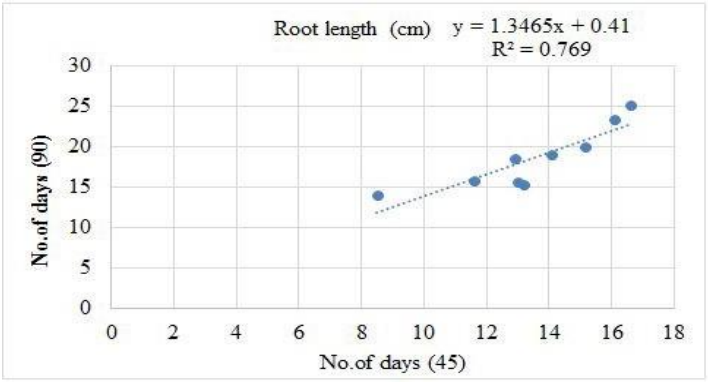

Figure 4. Trend of root length for 45 days and 90 days.

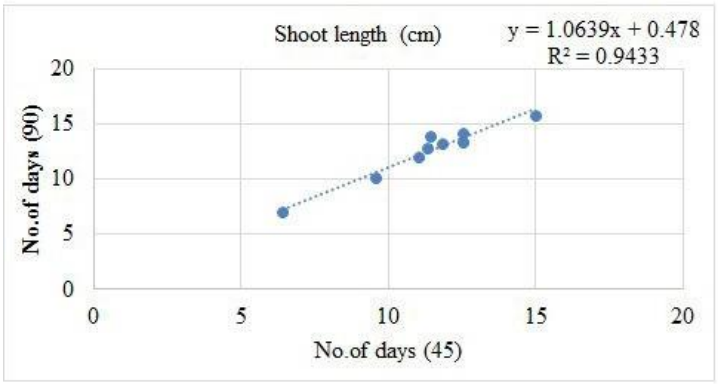

Figure 5. Trend of shoot length for 45 days and 90 days.

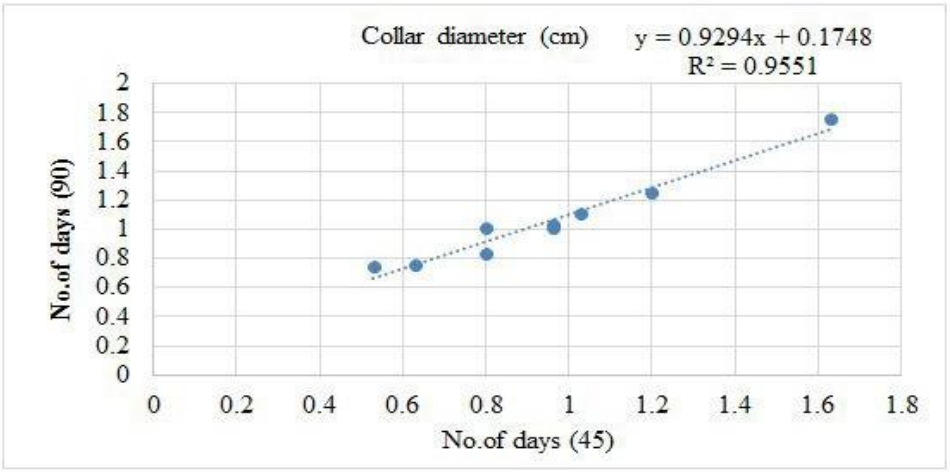

Figure 6. Trend of collar diameter for 45 days and 90 days.

1 g in shoot was recorded in T3 treatment treated with 500 ppm GA_3. Highest shoot to root ratio: of 0.72 was recorded in T_8 treatment treated with 50% concentrated H_2SO_4 for 5 minutes followed by 0.57 T_9 control while, minimum shoot to root ratio was 0.22 recorded in T_3 treatment for seeds soaked in 500 ppm GA_3 for 24 hours. The results are summarized in Table 4. The growth parameters are depicted in Figures 4-7.

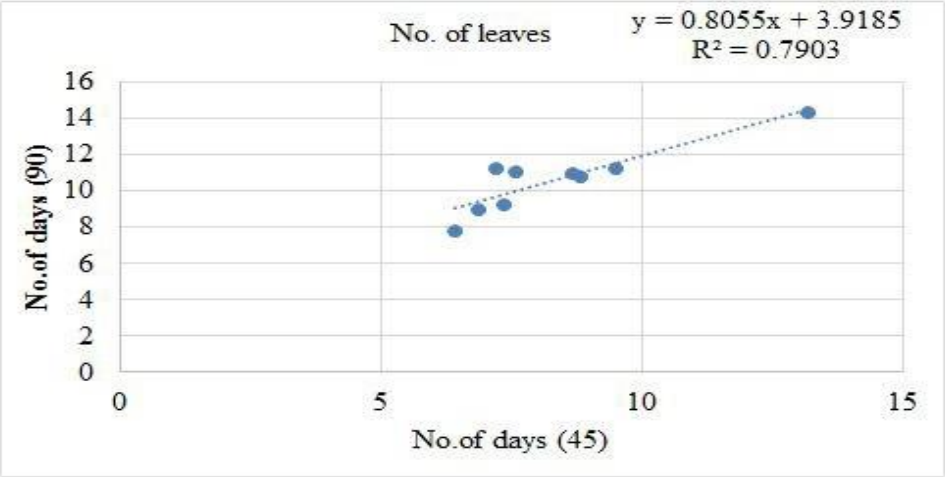

Figure 7. Trend of number of leaves for 45 days and 90 days.

DISCUSSION

Different approaches of breaking hard seed coat in order to enhance germination rate and increase the germination process have been suggested by Azad *et al.,*(2011, 2013); Hossain (2005), Billah (2015), Patil *et al.,*(2021), Amoakoh, (2017), Anand (2012). Different species responds to different pre-sowing treatments based upon the seed type, dormancy type and seed maturity and season of seed testing (Amoakoh, 2017; Azad et al., 2011). Hence presowing treatments are to be adjusted as per species. Mechanical scarification (Catalan and Macchiavelli, 1991), hot water treatment (Kobmoo and Hellum,1984; Khasa,1992) and acid treatment (Kobmoo and Hellum, 1984) are some of the treatments which can be performed to overcome the dormancy. Generally, the untreated drupes germinate slowly and irregularly (Md Salleh, 2021; Singh, 2018; Hossain et al. 2005). The seeds with hard, solid, inflexible seed coat were reported to recover germination with pre-sowing treatments (Sarkar et al., 2020; Mohammed, 2016; Azad, 2011). Furthermore, the findings in the present study indicate that the seeds of *T. tomentosa* under different treatments have shown improved germination parameters significantly while comparing to untreated seeds. The fact that hot water treatment gave earlier germination might be due to the stimulating effect of imbibitions on seed germination caused by increased water absorbing capacity and killing pathogens (Cho and Lee 2018). Besides, hot water treatment also reported to enhance seed germination by affecting various factors, viz., seed coat permeability for gases and water exchange and release of inhibitor (Sharma *et al.* 2008). Hamad and Anwer (2021) studied the effects of presowing treatment of subabal and suggested that seeds soaked in hot water for 12 hours and sown at 1 cm depth have given significantly increased germination percentage (42.22%).

Similar results are also reported by Azad *et al.,* (2010) in *Albizia richardiana* that hot water treatment has recorded the highest germination percentage (96%), whereas, Sharma *et al.,* (2008) concluded that the hot-water pre-sowing treatment is best for seeds of *Albizia lebbek* and *Peltophorum pterocarpum* @ 1 min 94% and 97% germination, respectively. Furthermore, Zazai *et al.,* (2018) in their study on effect of pre-sowing treatments and fruit size on germination of *T. arjuna* reported that seed soaking of *T. arjuna* in hot water recorded the maximum survival percentage (64.58%).The study conducted by Kumar *et al.* (2014) on *Pinus gerardiana* reported highest germination energy (9.30%) in seeds treated with 150 ppm GA_3 for 24 hours. Similar results are also reported by Maharana *et al.,* (2018) with maximum germination energy (35.83%) in *Gmelina arborea* when seeds treated with 200 ppm GA_3. Soliman and Abbas (2013) reported that soaking in hot water for 6 minutes have resulted in shorter days for germination period (13.60 days) as well. Similar results are also reported by Azad *et al.,* (2011) stating that seeds of *Acacia auriculiformis* when immersed in hot water for 10 minutes have shown shorter days for germination (7.25 days).

In case of root length, numbers of leaves, dry weight of shoot and root, hot water treatment have significantly performed best**.** Hamad and Anwer (2021) reported that maximum root length (11.18 cm) was observed in subabul seeds soaked in hot water for 12 hours at a depth of 1 cm and similar results are also obtained by Haider *et al.,* (2016) who stated that maximum root length (6.1 cm) was observed in *Sapindus mukorssi* seeds treated with hot water for 10 seconds. While shoot length was influenced by Gibberillic acid treatment that might be involved in the release of apical dominance. Patil *et al.,* (2021) in *Colubrina asiatica* reported maximum shoot

length (8.2 cm) when treated with 200 ppm GA_3. Similar results were also reported by Bosale (2014) for *S. anacardium* where maximum shoot length (22.10 cm) was recorded when seeds soaked in 500 ppm GA_3. Hemalatha and Chandari (2021), mentioned that collar diameter was maximum (2.23 mm) in *Santalum album* seeds treated with 200 ppm GA_3. Priya (2017) has also stated that 200 ppm GA_3 application significantly influenced the collar diameter with the highest (2.87 mm) in *Olea glandulifera.* Haider *et al.,* (2016) reported that maximum leaf number (5.2) was observed in seeds of *Sapindus mukorssi* treated with hot water for 10 seconds. Hossain *et al.,* (2005) in his experiment mentioned that maximum dry weight of root (0.9 g) and maximum dry weight of shoot (1.53 g) of *Terminalia chebula* root was obtained in fruits depulped and soaked in hot water for 2 minutes. This might be because the generation of maximum fresh weight of shoot and root in the seedlings of treatment of hot water for 24 hours that resulted in the production of maximum dry weight of shoot and root (Hossain *et al.,* 2005). Thangjam and Sahoo (2017) who stated that Conc. H_2SO_4 for 5 minutes influenced shoot to root ratio (0.28) in *Parkia timoriana.*

CONCLUSION

The study concluded that various pre sowing seed treatments have significantly improved the germination and growth attributes of *T. tomentosa* Wight & Arn. The seeds presoaked in hot water for 24 hours have significantly shown superior performance with respect to germination as well as growth parameters under study. However, earlier studies put forth the medicinal importance of the species. The finding of this study will help the farmers and tree growers in popularizing the species for large scale afforestation, reforestation and commercial plantations in Telangana as it is first of its kind as vegetative propagation method.

ACKNOWLEDGEMENT

Thanks are due to authorities of Indira Gandhi Krishi Vishwavidyalaya, Raipur, India and Forest College and Research Institute, Mulugu, Telangana, India.

CONFLICT OF INTEREST DISCLOSURES

The authors hereby certify that this is an original, unpublished work that is not under consideration elsewhere. We have no conflicts of interest to disclose.

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