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Effect of Seed Size and Presowing Treatments on Germination, Early Seedling Growth and Seedling Vigour of *Senegalia catechu* (L.f.) P.J.H. Hurter and Mabb. in Nursery Condition

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ABSTRACT

Background: *Senegalia catechu* (L.f.) P.J.H. Hurter and Mabb. (*S. catechu*) is a versatile leguminous tree of the Fabaceae family. Commonly termed "*khair*," it is widely distributed across the country occurring naturally and as a plantation crop. This species flourishes in the Sub-Himalayan region of India, ranging from an altitude of 300 to 1,300 meters. Species is commercially valuable due to the extraction of Katha and cutch, apart from various other uses in traditional medicine. However, natural regeneration is severely hampered in wild due to seed dormancy resulting from the hard seed coat.

Methods: *Senegalia catechu* (L.f.) P.J.H. Hurter and Mabb. seeds were sorted into two size categories *i.e.* small (L_1) and large (L_2) and then subjected to eight presowing treatments to evaluate their effect on germination and initial seedling development in split plot design at Department of Forestry and Natural Resources, Punjab Agricultural University, Ludhiana, India. The treatments were replicated thrice.

Result: Large seed size ($p \leq 0.05$) significantly took lesser number of days taken to emergence (4.79 days), higher germination per cent (71.04%), maximum germination energy (30.57%). Large size seeds also exhibited superior growth and seedling biomass parameters. Amid the presowing treatments, cow dung slurry for 3 days (T_8) showed lesser number of days taken to emergence (3.00 days), higher germination percentage (78.33%), germination value (18.46) and germination rate index (2.30 per cent/days) and minimum mean germination time (8.03 days). Maximum seedling growth and seedling vigour index were found in seeds treated with cow dung slurry for 3 days (T_8). Further, this study seeks to explore the research avenues for conservation and utilization of *Senegalia catechu* (L.f.) P.J.H. Hurter and Mabb. in central and sub mountainous region of Punjab and other parts of India.

Key words: Germination, Presowing treatments, Seedling biomass, Seedling growth, *Senegalia catechu*.

INTRODUCTION

Senegalia catechu (L.f.) P.J.H. Hurter and Mabb. (*S. catechu*), formerly *Acacia catechu*, is a highly valued multipurpose leguminous tree of the Fabaceae family, locally known as "*khair*." It occurs over most regions of the country, both naturally and as a plantation crop. *S. catechu* can be found up to an altitude of 1300 meters in the sub-Himalayan region of India, Pakistan, Nepal, Bhutan, Thailand and China (Sharma and Lingha, 2021). *Senegalia catechu* is a medium sized deciduous tree, distinguished by its twisted, forked trunk and thorny branches, reaching up to 13 meters in height. Its bipinnately compound leaves feature 30-50 leaflets per pair, a hairy main rachis, and a distinct gland at the center. The tree produces pale yellow flowers with axillary spikes, while its glossy, flat brown pods contain 3-10 seeds. Its wood yields valuable products known as katha or cutch, widely used for medicinal and industrial purposes (Singh *et al*., 2018).

Senegalia catechu (L.f.) P.J.H. Hurter and Mabb. commercially utilized for extraction of Katha and cutch, in addition to its traditional uses. Katha is a popular ingredient in Ayurvedic medicine and formulations for its astringent, cooling and digestive properties while cutch is used as a brown dye for tanning and dyeing wool, silk, and cotton and also used in the plywood industry as an adhesive and in the preparation of polishes and paints (Singh and Lal, 2006).

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Senegalia catechu leaves, bark and heartwood exhibit diverse pharmacological properties, being effective in treating conditions such as cough, diarrhea, dysentery, bleeding injuries, skin and respiratory ailments and maintaining gum hygiene (Trishala *et al*., 2019). Beyond its commercial applications, *Senegalia catechu* (L.f.) P.J.H. Hurter and Mabb. holds significant socio-economic value for rural communities residing near catechu forests. These communities rely on the plant as a supplementary source of income, as well as for meeting essential needs such as

fuel, fodder, building materials and other basic necessities. This species also possesses the great potential for the restoring degraded lands and improving soil quality.

The seeds of *Senegalia catechu* (L.f.) P.J.H. Hurter and Mabb. exhibit extremely low germination due to their hard seed coat, which imposes physical dormancy and prevents water absorption. This natural barrier not only delays germination but also hinders consistent seedling emergence in nurseries, with some seeds taking up to six months to emerge. To overcome this challenge and enhance seedling quality, it is crucial to identify the optimal seed size categories and implement effective pre-sowing treatments, ensuring robust and uniform growth for successful plantation establishment. Pre-sowing treatments increase the germination of seeds by breaking the dormancy in many species such as *Acacia spp* (Rasebeka *et al*., 2014), *Acacia nilotica* subsp. *cupressiformis* (J.L. Stewart) Ali and Faruqi (Noor Mohamed *et al.,* 2024), *Rauvolfia serpentina* (L.) (Tiwari *et al*., 2023), *Ziziphus mauritiana* Lamk (Boora, 2016) and other species. In many species, seed size influences germination and subsequent seedling growth. Seed size usually indicates a seed's comparative nutrient pool and energy, which has an impact on its future growth and development (Ambika *et al.,* 2014).

Senegalia catechu (L.f.) P.J.H. Hurter and Mabb. holds immense significance due to its diverse applications in ethno-medicine, katha and cutch production, gum extraction, fuel, fodder, land rehabilitation and soil conservation. With increasing reforestation and afforestation efforts in arid, semi-arid and sub-humid regions, the demand for high quality seedlings has surged. However, the species faces a significant challenge as delayed, low and inconsistent germination hinders efficient seedling production in nurseries. Enhancing germination is therefore critical for large-scale plantation success. While pre-sowing treatments have shown promise in improving germination performance, research on their specific effects remains limited. This study aims to bridge this gap by identifying the optimal seed size and pretreatment methods that maximize total germination, accelerate germination rates and enhance early seedling development in nursery conditions.

MATERIALS AND METHODS

The experiment was conducted in the experimental area of the Department of Forestry and Natural Resources, Punjab Agricultural University, Ludhiana, during 2022-2023. The study aimed to evaluate the impact of seed size and pre-sowing seed treatments on the germination parameters, seedling growth and biomass of *Senegalia catechu* (L.f.) P.J.H. Hurter and Mabb. The research site is situated at 30°45′ N latitude and 75°40′ E longitude, at an elevation of 247 meters above mean sea level. The region experiences a humid subtropical climate, characterized by hot summers and mild winters, with temperatures ranging from 35-45°C in summer and 2-5°C in winter. The average annual rainfall is approximately 680 mm. The soil in the area varies from sandy loam to clayey, with a pH range of 7.8 to 8.5.

Trees with ideal morphological characteristics such as vigorous height, large crown and moderate tree age with high seed production were selected. Healthy seeds were sourced from healthy trees at Ballowal Saunkhri, a dry deciduous forestry area.

The study involved two seed size categories, small (L_1) and large (L_2) and eight pre-sowing treatment such as Control (T_1), Cold water treatment soaking for 24 hours (T_2), Cold water soaking for 72 hours (T_3), Boiling water soaking for 24 hours (T_4), Boiling water soaking for 72 hours (T_5), Conc. H_2SO_4 for 5 minutes (T_6), Conc. H_2SO_4 for 10 minutes (T_7), Dipping in Cow dung slurry for 3 days (T_8). Each treatment had three replications with 100 seeds per replication.

Germination was recorded daily from the date of sowing until the final germination event. Seedlings were grown in nursery beds for 90 days and every 30 days, five randomly selected seedlings per replicate were carefully uprooted to assess growth and biomass. The number of days required for seedling emergence was documented for each treatment. Germination percentage was calculated by dividing the total number of germinated seeds by the total seeds sown and multiplying by 100. Mean germination time (MGT), which indicates the speed and uniformity of germination, was determined by dividing the total days taken for all seeds to germinate by the total number of seeds, while the mean germination rate (MGR) was measured as its reciprocal. Germination energy was assessed as the percentage of seeds germinated at peak germination time. Germination value, a measure of germination completeness, was determined using the peak value and mean daily germination (Czabator, 1962). The germination rate index (GRI) was computed by summing daily germination percentages weighted by time, with a higher percentage in a shorter period resulting in a higher index.

Seedling growth parameters were recorded, including seedling height, measured from the collar to the shoot apex and total seedling length, calculated as the sum of shoot and root lengths. Root length was measured horizontally using a scale, while shoot length was taken from the shoot tip to the collar. Collar diameter was precisely recorded using a digital vernier caliper, and the number of fibrous roots per seedling was counted after thorough washing. For biomass estimation, root and shoot portions were oven-dried at 60°C until a constant weight was achieved, and total dry biomass was determined as the sum of root and shoot dry weights. The root-shoot ratio was calculated by dividing root dry weight by shoot dry weight. Seedling vigor index (SVI) was determined by multiplying the sum of average root and shoot lengths by germination percentage (Abdulbaki and Anderson, 1973). Data analysis followed the split plot design (Gomez and Gomez, 1984). Variance components, analysis of variance (ANOVA),

and critical difference (CD) were calculated using OPSTAT software (Sheron *et al*., 1998).

RESULTS AND DISCUSSION

Germination parameters

All germination parameters significantly ($p \leq 0.05$) affected by seed size and pre sowing treatments. Large seed size (L_2) ($p \leq 0.05$) significantly took lesser number of days taken to emergence (4.79 days), higher germination per cent (71.04%), higher mean germination rate (0.121 days^{-1}), maximum germination energy (30.57%), germination value (15.78%) and germination rate index (1.87 per cent/day) as compared to small seed size. Seed size and pre sowing treatments have significantly effect on ($p \leq 0.05$) germination parameters. Large seed size and seed treated with cow dung slurry for 3 days (T_8) ($p \leq 0.05$) significantly showed highest germination parameters followed by Cold water soaking for 48 hours (T_2) as compared to small and untreated seeds.

Among pre sowing treatments, cow dung slurry for 3 days (T_8) showed higher germination percentage *i.e.* 78.33%, minimum mean germination time (8.03 days) and took lesser number of days taken to emergence (3.00 days) which is statistically at par with T_2 (75.00%) and T_3 (76.67%) for germination per cent and also statistically similar to T_3 (8.16 days), T_5 (8.29 days) and T_6 (8.53 days) for mean germination time. The maximum value for mean germination rate (0.126 days^{-1}) was found in T_2 which was statistically at par with T_3 (0.123 days^{-1}), T_5 (0.121 days^{-1}) and T_8 (0.125 days^{-1}). Seed treated with cold water for 72 hours (T_3) recorded maximum germination energy (33.18%) which was statistically at par with T_2 (33.04 %) and T_8 (32.87%) whereas T_8 recorded maximum value of 18.46 and 2.30 per cent/days for germination value and germination rate index, respectively which was statistically at par with T_2 (17.85) and T_3 (18.26) for germination value. Whereas minimum values for all germination attributes were recorded for untreated seeds (T_1) (Table 1).

The variations may be due that large size seeds have more endosperm nutrient reserves. Therefore, the variations in germination outcomes can likely be attributed to notable dissimilarities in seed dimensions and weight. As a common trend, it has been documented that germination tends to rise in correlation with seed size and weight (Ambika *et al*., 2014). Variations in germinablity parameters across seed size categories have been extensively documented in *Sapindus emerginatus* Vahl. (Venkatesh and Nagarajaiah, 2009), *Acacia catechu* Willd. (Khera *et al*., 2004) and *Acacia senegal* (L.) Willd. (Harsh *et al*., 2004). The results are also in conformity with the earlier findings in *Senna occidantalis* (L.) Link (Saeed and Shaukat, 2000), *Acrocarpus fraxinifolius* Arn. (Gupta and Bhardwaj, 2005) and *Anacardium occidentale* L. (*Anjusha et al*., 2015).

The accelerated emergence and heightened germination observed in cow dung slurry could be due to removal, softening, degradation and fermentation of the seed coat, leading to enhanced absorbency for diffusion and early radicle emergence, thereby promoting the germination process (Ajay *et al*., 2022). Our results are consistent with the previous findings in *Melia dubia Cav*. (Krishna *et al*., 2013), *Phoenix* species (Singh and Bhargawa, 2009), *Artocarpus heterophyllus* Lam. (Parmar *et al*., 2018), *Pterocarpus santalinus* L.f. (Rathod *et al*., 2022) which also reported a higher seed germination with cow dung slurry treatment.

Growth parameters

Seed size and pre-sowing treatments had a substantial impact on shoot length, root length, seedling height and collar diameter. The maximum shoot length (10.24 cm, 21.05 cm and 31.41 cm), root length (6.55 cm, 14.33 cm and 23.21 cm), seedling height (16.79 cm, 35.38 cm and 54.62 cm) and collar diameter (1.26 mm, 2.0 mm and 3.29 mm) at 30, 60 and 90 days after sowing were observed in large seed size (L_2) whereas minimal in small size seeds (L_1).

Table 1: Effect of seed size and pre-sowing treatments on germination parameters of *Senegalia catechu*.

Seed size	Days taken to emergence (days)	Germination per cent (%)	Mean germination time (days)	Mean germination rate (days^{-1})	Germination energy (%)	Germination value (%)	Germination rate index (per cent days^{-1})
L_1	4.88^{a}	63.13^{b}	9.24^{a}	0.111	25.33^{b}	11.81^{b}	1.57^{b}
L_2	4.79^{a}	71.04^{a}	8.29^{b}	0.121	30.57^{a}	15.78^{a}	1.87^{a}
CD 0.05	NS	0.97	0.57	NS	4.77	2.94	0.22
Pre-sowing treatment							
T_1	7.17^{a}	52.5^{f}	10.05^{a}	0.102^{a}	19.81^{c}	7.80^{c}	1.16^{e}
T_2	4.00^{c}	75.00^{ab}	7.98^{b}	0.126^{a}	33.04^{a}	17.85^{a}	2.05^{b}
T_3	3.83^{c}	76.67^{a}	8.16^{b}	0.123^{a}	33.18^{a}	18.26^{a}	2.08^{b}
T_4	4.33^{c}	69.17^{bc}	8.64^{b}	0.116^{a}	28.43^{b}	14.18^{b}	1.77^{c}
T_5	4.33^{c}	65.00^{cd}	8.29^{b}	0.121^{a}	28.16^{b}	13.09^{b}	1.69^{cd}
T_6	6.00^{b}	62.50^{de}	8.53^{b}	0.118^{a}	26.78^{b}	11.95^{b}	1.52^{d}
T_7	6.00^{b}	57.50^{ef}	10.44^{a}	0.099^{a}	21.31^{c}	8.79^{c}	1.21^{e}
T_8	3.00^{d}	78.33^{a}	8.03^{b}	0.125^{a}	32.87^{a}	18.46^{a}	2.30^{a}
CD 0.05	0.40	4.28	0.56	0.007	2.73	2.05	0.14

Table 2: Effect of seed size and pre-sowing treatments on growth attributes of *Senegalia catechu*.

Seed size	Shoot length (cm)			Root length (cm)			Seedling height (cm)			Collar diameter (mm)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
L_1	9.21^{b}	19.63^{b}	29.60b	5.89^{b}	13.36^{b}	21.88^{b}	15.1^{b}	32.99^{b}	51.48^{b}	1.14^{a}	1.84^{b}	3.1^{a}
L_2	10.24^{a}	21.05^{a}	31.41^{a}	6.55^{a}	14.33^{a}	23.21^{a}	16.79^{a}	35.38^{a}	54.62^{a}	1.26^{a}	2.01^{a}	3.29^{a}
$CD_{0.05}$	0.72	1.16	1.2	0.46	0.78	0.89	1.19	1.94	2.1	NS	0.144	NS
Pre-sowing treatment												
T_1	7.55^{c}	15.28^{f}	25.68^{e}	4.83^{d}	10.4^{f}	18.98^{e}	12.38^{c}	25.68^{f}	44.65^{e}	0.88^{d}	1.49^{d}	2.53^{d}
T_2	11.15^{a}	22.56^{b}	33.12^{b}	7.13^{b}	15.36^{b}	24.48^{b}	18.28^{a}	37.92^{b}	57.60^{b}	1.33^{ab}	2.15^{abc}	3.59^{a}
T_3	11.55^{a}	23.04^{ab}	33.84^{ab}	7.38^{ab}	15.68^{ab}	25.01^{ab}	18.93^{a}	38.71^{ab}	58.85^{ab}	1.38^{a}	2.20^{ab}	3.66^{a}
T_4	10.06^{b}	21.12^{c}	31.56^{c}	6.43^{c}	14.38^{c}	23.33^{c}	16.48^{b}	35.50^{c}	54.89^{c}	1.19^{bc}	2.01^{bc}	3.36^{b}
T_5	9.66^{b}	20.71^{c}	30.79^{c}	6.17^{c}	14.09^{c}	22.76^{c}	15.83^{b}	34.80^{c}	53.55^{c}	1.17^{bc}	1.96^{c}	3.25^{b}
T_6	8.18^{c}	18.99^{d}	28.22^{d}	5.23^{d}	12.92^{d}	20.85^{d}	13.40^{c}	31.91^{d}	49.07^{d}	1.12^{c}	1.68^{d}	2.81^{c}
T_7	7.47^{c}	17.03^{e}	26.16^{e}	4.78^{d}	11.59^{e}	19.34^{e}	12.25^{c}	28.63^{e}	45.49^{e}	1.08^{c}	1.55^{d}	2.56^{d}
T_8	12.21^{a}	24.00^{a}	34.66^{a}	7.81^{a}	16.34^{a}	25.61^{a}	20.02^{a}	40.34^{a}	60.27^{a}	1.46^{a}	2.32^{a}	3.79^{a}
$CD_{0.05}$	0.72	0.96	0.94	0.46	0.66	0.70	1.18	1.62	1.64	0.117	0.155	0.14

But collar diameter was found to be non significant at 30 DAS and 90 DAS. Among pre-sowing treatments, cow dung slurry for 3 days (T_8) showed highest shoot length (12.21 cm, 24.00 cm and 34.66 cm), root length (7.81 cm, 16.34 cm and 25.61 cm), seedling height (20.02 cm, 40.34 cm and 60.27 cm), collar diameter (1.46 mm, 2.32 mm, 3.79 mm) at 30, 60 and 90 days after sowing followed by T_3 and T_2. Whereas T_1 (control) had poorest values in all growth parameters (Table 2).

The variability in growth parameters, including shoot and root length, seedling height, and collar diameter, among different seed size categories has been observed in *Sapindus emerginatus* L. (Venkatesh and Nagarajaiah, 2009), *Sapindus mukorossi* Gaertn (Attri *et al*., 2015), *Jatropha curcas* L. (Singh and Saxena, 2009) and *Acacia catechu* Willd. (Khera *et al*., 2004), *Jatropha curcas* L., *Salvadora persica* Linn. (Dagar *et al*., 2004), *Gmelina arborea* Roxb. (Owoh *et al*., 2011) *Elaeocarpus munronii* (Wight) Mast. and *Canarium striuctum* Roxb. (Tamadaddi and Prabhuling, 2020).

The heightened growth observed in cow dung slurry could be attributed to early radicle emergence, thereby promoting the germination process (Ajay *et al*., 2022). Our observations corroborate prior studies in Melia dubia Cav. (Anand *et al*., 2012), *Pterocarpus santalinus* L. (Thanuja *et al*., 2019) karonda (Mistry and Sitapara, 2020), *Passiflora edulis* Sims (Gurung *et al*., 2014), *Mansonia altissima* A. Chev. (Fasalejo *et al*., 2019).

Seedling biomass

All seedling biomass parameters significantly ($p \leq 0.05$) affected by size and pre sowing treatments. Among size categories, large seed size showed maximum values for dry shoot biomass (0.34 g, 0.86 g and 1.13 g), dry root biomass (0.16 g, 0.52 g and 0.86 g) and total dry biomass (0.50 g, 1.37 g and 1.99 g) while minimum dry shoot biomass (0.29 g, 0.78 g and 1.05 g), dry root biomass (0.12 g, 0.46 g and 0.78 g) total dry biomass (0.41 g, 1.24 g and 1.83 g), at 30,60 and 90 DAS were recorded for small seeds. In pre-sowing treatments, cow dung slurry for 3 days (T_8) produces highest dry biomass of shoot (0.36 g, 0.96 g and 1.32 g), dry biomass of root (0.18 g, 0.62 g and 1.04 g) and total dry biomass of seedling (0.54 g, 1.58 g and 2.36 g) which was statistically at par with T_3 (0.36 g, 0.96 g and 1.36 g) for dry biomass of shoot at 30, 60 and 90 DAS and also statistically similar to T_3 (0.51 g, 1.55 g and 2.35 g) for total dry biomass at 30, 60 and 90 DAS. Whereas T_1 (untreated) showed minimum values for total fresh weight of seedling(1.57 g, 3.43 g and 5.47 g), total dry biomass (0.45 g, 1.08 g and 1.37 g), dry biomass of root (0.13 g, 0.38 g and 0.57 g) and dry biomass of shoot (0.32 g, 0.69 g and 0.80 g) (Table 3).

Large seed size showed maximum value of 0.46 for root shoot ratio whereas small seed have minimum root shoot ratio (0.43) at 30 DAS but statistically insignificant difference were observed at 60 and 90 DAS (Fig 1a). Large seed size had statistically superior for seedling vigour

Table 3: Effect of seed size and pre-sowing treatments on seedling biomass of *Senegalia catechu*.

Seed size	Dry biomass of shoot (g)			Dry biomass of root (g)			Total dry biomass of seedling (g)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
L_1	0.29^{b}	0.78^{b}	1.05^{a}	0.12^{b}	0.46^{b}	0.78^{b}	0.41^{b}	1.24^{b}	1.83^{b}
L_2	0.34^{a}	0.86^{a}	1.13^{a}	0.16^{a}	0.52^{a}	0.86^{a}	0.50^{a}	1.37^{a}	1.99^{a}
$CD_{0.05}$	0.024	0.052	NS	0.014	0.028	0.018	0.039	0.072	0.107
Pre-sowing treatment									
T_1	0.32^{ab}	0.69^{d}	0.8^{e}	0.13^{abc}	0.38^{d}	0.57^{e}	0.45^{b}	1.08^{d}	1.37^{f}
T_2	0.35^{a}	0.86^{b}	1.28^{b}	0.18^{a}	0.55^{b}	0.96^{b}	0.53^{a}	1.41^{b}	2.24^{b}
T_3	0.36^{a}	0.96^{a}	1.36^{a}	0.15^{abc}	0.59^{ab}	0.99^{ab}	0.51^{a}	1.55^{a}	2.35^{a}
T_4	0.29^{b}	0.77^{cd}	1.12^{c}	0.13^{abc}	0.49^{c}	0.86^{c}	0.42^{bc}	1.26^{c}	1.99^{c}
T_5	0.31^{ab}	0.81^{bc}	1.07^{c}	0.13^{abc}	0.48^{c}	0.81^{c}	0.44^{bc}	1.28^{c}	1.88^{d}
T_6	0.26^{b}	0.72^{d}	0.91^{d}	$0.12^{a\,c}$	0.41^{d}	0.69^{d}	0.38^{c}	1.13^{d}	1.6^{e}
T_7	0.27^{b}	0.77^{cd}	0.86^{de}	0.11^{c}	0.38^{d}	0.63^{e}	0.38^{c}	1.15^{d}	1.49^{f}
T_8	0.36^{a}	0.96^{a}	1.32^{ab}	0.18^{ab}	0.62^{a}	1.04^{a}	0.54^{a}	1.58^{a}	2.36^{a}
$CD_{0.05}$	0.032	0.059	0.054	0.021	0.022	0.025	0.041	0.068	0.073

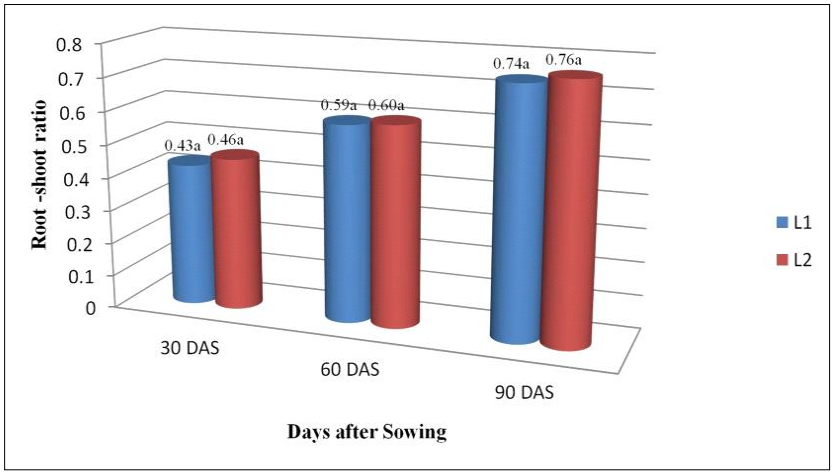


Fig 1a: Effect of Seed size on root-shoot ratio of *Senegalia catechu*.

Table 4: Effect of seed size and pre-sowing treatments on seedling vigour index of *Senegalia catechu*.

Seed size	Seedling vigour index		
	30 DAS	60 DAS	90 DAS
L_1	975.44^{b}	2127.5^{b}	3300.97_{b}
L_2	1218.74^{a}	2553^{a}	3926.38^{a}
$CD_{0.05}$	58.55	88.65	98.49
Pre-sowing treatment			
T_1	655.13^{e}	1368.7^{e}	2371.56^{f}
T_2	1376.54^{b}	2849.3^{b}	4322.93^{b}
T_3	1454.29^{ab}	2973.8^{ab}	4513.85^{ab}
T_4	1141.52^{c}	2457.1^{c}	3800.91^{c}
T_5	1031.36^{c}	2264^{c}	3482.08^{d}
T_6	837.96^{d}	1994.5^{d}	3068.08^{e}
T_7	706.47^{de}	1648.5^{e}	2618.4^{f}
T_8	1573.46^{a}	3166^{a}	4731.61^{a}
$CD_{0.05}$	106.07	186.17	223.24

index with the value of 1218.74, 2553.00 and 3926.38 at 30, 60 and 90 days after sowing, respectively while small seeds showed lowest values (975.44, 2127.50 and 3300.97) for seedling vigour index at different intervals (Table 4). Among pre-sowing treatments T_8 having maximum values for root shoot ratio (0.51, 0.65 and 0.79) and seedling vigour index (1573.46, 3166.00 and 4731.61) which was significantly at par with T_2 (0.50), T4 (0.47) and T_6 (00.47) treatments for root shoot ratio at 30 DAS, T_2 (0.65), T_3 (0.61) and T_4 (0.64) for root shoot ratio at 60 DAS and statistically similar with T_2 (0.76), T_4 (0.77) and T_6 (0.76) at 90 DAS for root-shoot ratio (Fig 1b). In seedling vigour index T_8 statistically at par with T_3 (4513.85) at 90 after sowing whereas T_1 recorded lowest values for root shoot ratio (0.39, 0.55 and 0.72) and seedling vigour index (655.13, 1368.70 and 2371.56) (Table 4).

Large seed size and seed treated with cow dung slurry for 3 days (T8) ($p \leq 0.05$) significantly showed maximum seedling biomass and seedling vigour index as compared to

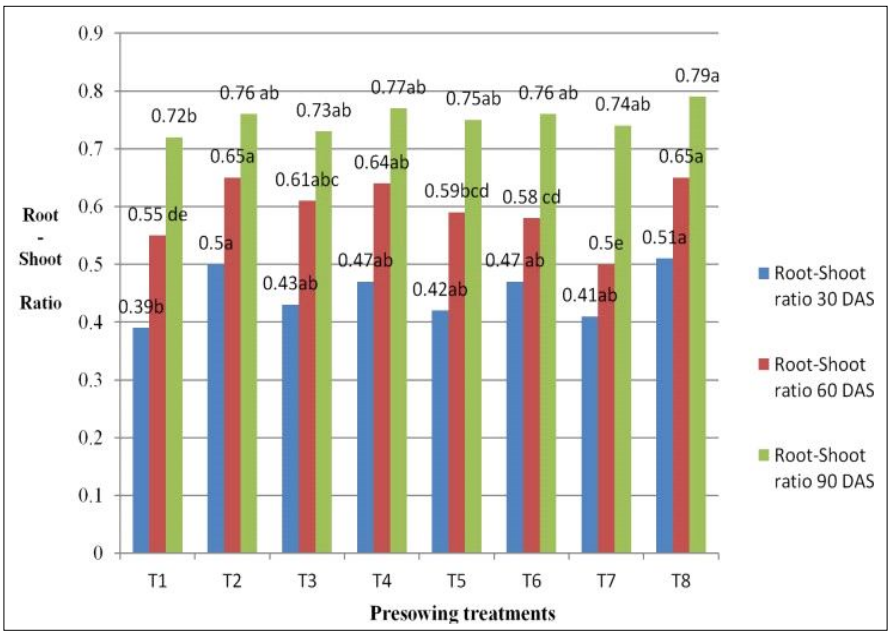


Fig 1b: Effect of Pre-sowing treatments on root-shoot ratio of *Senegalia catechu*.

small and untreated seeds. The similar conclusions were drawn in *Sapindus emerginatus* Vahl. (Venkatesh *et al*., 2009) *Cercis Canadensis* L. (Couvillon, 2002) *Symphonia globulifera* L.f. (Omokhua *et al*., 2015), *Melia dubia* Cav. (Anand *et al*., 2012; Krishna *et al*., 2013), *Artocarpus heterophyllus Lam*. (Parmar *et al*., 2018), *Terminalia bellirica* (Gaertn.) Roxb. (Kumar, 2016; Hossain *et al*., 2013), *Pterocarpus santalinus* L.f. (Vijayalakshmi *et al*., 2017), Sapota (Patel *et al*., 2021).

CONCLUSION

The present study on seed size and pre-sowing treatments demonstrates its practical potential for field applications. The findings reveal significant variations among different seed size categories and pre-sowing treatments, highlighting their impact on germination and seedling development. Among seed size, large size seed were found superior over small seeds in germination, seedling growth and biomass attributes. Treatment T_8 (dipping in Cow dung slurry for 3 days) performed well over other treatment in each parameter in aspect of germination, seedling growth parameters and seedling biomass attributes but T_1 (Control) showed lowest results. This method is cost-effective and easy to implement, requiring no specialized equipment. It effectively addresses various types of dormancy by modifying the seed coat, removing inhibitors, and softening the seed to facilitate germination. The enhanced germination technique developed through this study can be applied for large-scale seedling production and the conservation of Khair. Therefore, burying large seeds in cow dung slurry for three days is recommended to achieve higher germination rates, improved seedling growth, and enhanced vigour in *Senegalia catechu* L.f.) P.J.H. Hurter and Mabb.

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Disclaimers

The authors' views are their own and do not reflect their institutions. They ensure accuracy but are not liable for any losses from this content's use.

Informed consent

This study does not involve any experiments on animals. Therefore, ethical approval for animal use was not required.

Conflict of interest

No potential conflicts of interest. This work was not supported by the any funding Agency.

REFERENCES

Abdul-Baki, A.A., Anderson, J.D. (1973). Vigour determination in soybean seeds by multiple criteria. Crop Science. 13(6): 630-633.

Ajay, Arya, S., Nanda, K., Redhu, I., Bhupender. (2022). Effect of different pre-sowing treatments on viability, germination and seedling characters of Malabar. neem (*Melia dubia Cav.*) fruits. Pharma Innovation Journal. 11: 974-977.

Ambika, S., Manonmani, V., Somasundaram, G. (2014). Review on effect of seed size on seedling vigour and seed yield. Research Journal of Seed Science. 7(2): 31-38.

Anand, B., Devagiri, G.M., Maruti, G., Vasudev, H.S., 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. 1(3): 59-63.

Anjusha, J.R., Vidyasagaran, K., Kumar, V., Ajeesh, R. (2015). Effect of seed weight on germination and seedling characters of *Anacardium occidentale* L.: An important plantation crop of India. Plant Archives. 15(1): 595-601.

Attri, V., Pant, K.S., Dhima, R., Lal, C., Sarvade, S. (2015). Effect of seed size and pre-sowing treatments on growth parameters and biomass of *Sapindus mukorossi* (Gaertn.) seedlings under nursery condition. Environment and Ecology. 33(1): 46-49.

Boora, R.S. (2016). Effect of various treatments on seeds germination in Indian jujube (*Ziziphus mauritiana* Lamk). Agricultural Science Digest. 36(3): 237-239. doi: 10.18805/asd.v36i3.11451.

Couvillon, G.A. (2002). *Cercis canadensis* L. seed size influences germination rate, seedling dry matter and seedling leaf area. Hort Science. 37(1): 206-207.

Czabator, F.J. (1962). Germination value: An index combining speed and completeness of pine seed germination. Forest Science. 8(4): 386-396.

Dagar, J.C., Bhagwan, H., Kumar, Y. (2004). Seed germination studies on *Salvadora persica* and *Jatropha curcas*. Indian Journal of Forestry. 27(3): 283-289.

Fasalejo, O.F., Abanikanda, D.E. and Offiah, C.J. (2019). Effect of fertilizer application on growth performance of *Mansonia altissima* (A Chev) seedlings. International Research Journal of Biological Sciences. 8(12): 1-7.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agri cultural Research (2nd ed.). John Wiley and Sons, New York.

Gupta, S.K., Bhardwaj, S.D. (2005). Pre-sowing seed treatment to improve germination of Acrocarpus fraxinifolius. Advances in Plant Sciences. 18(1): 265-267.

Gurung, N., Swamy, G.S.K., Sarkar, S.K. and Ubale, N.B. (2014). Effect of chemicals and growth regulators on germination, vigour and growth of passion fruit (*Passiflora edulis Sims*.). International Quarterly Journal of Life Sciences. 9(1): 155-157.

Harsh, L.N., Bohra, M.D., Khan, H.A. and Tewari, J.C. (2004). Effect of drought on seed quality and germination of *Acacia senegal* Willd. Indian Journal of Forestry. 27(2): 181-185.

Hossain, M.A., Uddin, M.S., Rahman, M.M., Shukor, N.A.A. (2013). Enhancing seed germination and seedling growth attributes of a medicinal tree species *Terminalia chebula* through depulping of fruits and soaking the seeds in water. Journal of Food Agriculture and Environment. 11(3-4): 2573-2578.

Khera, N., Saxena, A.K., Singh, R.P. (2004). Seed size variability and its influence on germination and seedling growth of five multipurpose tree species. Seed Science and Technology. 32(2): 319-330.

Krishna, A., Kumar, V. and Lebba, J.J. (2013). Pre-sowing seed treatments in *Melia dubia.* Indian Journal of Agricultural Sciences. 83(12): 1416-1419.

Kumar, V. (2016). Effect of pre-sowing seed treatment on germi nation and seedling growth of *Terminalia bellirica* (Gaertn.) Roxb. Indian Journal of Ecology. 43(1): 233-238.

Mistry, J.M., Sitapara, H.H. (2020). Effect of seed treatments on seedling growth of Karonda (*Carissa carandas* L.) cv. Local. International Journal of Current Microbiology and Applied Sciences. 9(12): 1980-1986.

Noor Mohamed, M.B., Shukla, A.K., Mehta, R.S., Keerthika, A. and Gupta, D.K. (2024). Effect of presowing treatments on seed and seedling quality attributes of an endemic agroforestry tree *Acacia nilotica* subsp. *cupressiformis* (J.L. Stewart) Ali and Faruqi. Legume Research- An International Journal. 47(6): 1007-1010. doi: 10.18805/LR-4601.

Omokhua, G.E., Oyebade, B.A. and Ebosele, C. (2015). The effects of seed size on germination and early seedling growth performance of *Symphonia globulifera* L. f. in Nigeria. Journal of Agriculture and Veterinary Science. 8(3): 82-87.

Owoh, P.W., Offiong, M.O., Udofia, S.I., Ekanem, V.U. (2011). Effects of seed size on germination and early morphological and physiological characteristics of *Gmelina arborea*, Roxb. An International Multidisciplinary Journal Ethiopia. 5(6): 422-433.

Parmar, B.R., Patel, F., Parmar, A.B., Pandey, A.K. (2018). Effect of organic compounds on seed germination and seedling growth of jack fruit (*Artocarpus heterophyllus* Lam.) seed. Pharma Innovation Journal. 7(10): 702-704.

Patel, N.R., Tandel, Y.N., Patel, S.B. (2021). Effect of seed scarification and priming treatments on seedling growth, survival and vigour index of sapota. Pharma Innovation Journal. 10(4): 1105-1109.

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 and Soil Science. 3(1): 62-70.

Rathod, R., Patil, S.J. and Chavan, R. (2022). Effect of seed scarification on pod germination and seedling growth of *Pterocarpus santalinus* (Linn F.). Pharma Innovation Journal. 11(7): 472-474.

Saeed, S., Shaukat, S.S. (2000). Effect of seed size on germination, emergence, growth and seedling survival of *Senna occidentalis* Link. Pakistan Journal of Biological Sciences. 3(2): 292-295.

Sharma, P. and Lingha, R. (2021). A recent update on the pharma cognostical as well as pharmacological profiles of the *Acacia catechu* heartwood: A mini review. Journal of Ayurveda and Holistic Medicine. 7(3): 188-192.

Sheoran, O.P., Tonk, D.S., Kaushik, L.S., Hasija, R.C. and Pannu, R.S. (1998). Statistical Software Package for Agricultural Research Workers. In Recent Advances in Information Theory, Statistics and Computer Applications, [(ed.) D.S. Hooda and R.C. Hasija]. CCS HAU, Hisar. pp. 139-143.

Singh, A., Thakur, V.S., Ambwani, S., Ambwani, T.K. (2018). Preliminary phytochemical screening and GC-MC analysis of leaf extract of *Acacia catechu* (L.f.) Willd. International Journal of Herbal Medicine. 6(2): 81-85.

Singh, K.N., Lal, B.(2006). Notes on traditional uses of kair (*Acacia catechu* Willd.) by inhabitants of Shivalik range in western Himalaya. Ethnobotanical Leaflets. 1: 109-112.

Singh, N., Saxena, A.K. (2009). Seed size variation and its effect on germination and seedling growth of *Jatropha curcas* L. Indian Forester. 135(8): 1135-1142.

Singh, R.S., Bhargava, R.(2009). Effect of seed treatments on germination and growth behaviour in date palm (*Phoenix species*) under hot arid conditions. Journal of Tropical Forestry. 25(1-2): 42-48.

Tamadaddi, B. and Prabhuling, G. (2020). Studies on effects of seed size on germination and seedling growth of *Elaeocarpus* and *Canarium* tree species. International Journal of Agricultural Sciences. 16(2): 265-271.

Thanuja, P.C., Nadukeri, S. and Kolakar, S.S. (2019). Effect of presowing seed treatments on seed germination and seedling growth in Rakta Chandana (*Pterocarpus santalinus* L.): An endangered medicinal plant. International Journal of Chemical Studies. 7(3): 1577-1580.

Tiwari, A.K., Verma, P.P.S., Kumar, D., Singh, S., Kumar, R., Padalia, R.C. and Upadhyay, R.K. (2023). Germination behavior of *Rauvolfia serpentina* (L.) seeds with the use of different seed treatments. Indian Journal of Agricultural Research. 57(5): 671-675. doi: 10.18805/IJARe.A-5624.

Trishala, A., Lakshmi, T., Rajeshkumar, S., Gurunathan, D. and Roy, A. (2019). Physicochemical profile of *Acacia catechu* bark extract- An *in vitro* study. Indian Journal of Public Health Research and Development. 10(11): 3513-3517.

Venkatesh, L., Lakshmipathaiah, O.R. and Panduranga. (2009). Effect of seed size on germination, viability and seedling biomass in *Sapindus emerginatus* (Linn). Mysore Journal of Agricultural Sciences. 43(4): 827-829.

Vijayalakshmi, K.P. and Renganayaki, P.R. (2017). Effect of cow dung slurry and termite mount as seed treatment on germination and seedling characteristics of Red Sanders (*Pterocarpus santalinus* L.f). Advances in Research. 11(4): 1-4.