Plant Archives Vol. 26, No. 2, 2026 pp. 3231-3240 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.2.448

STUDY OF DIFFERENT PHYSICAL AND CHEMICAL TREATMENTS ON SEED GERMINATION AND SEEDLING GROWTH IN CHAROLI (*Buchanania lanzan* SPRENG.)

M.S. Janbandhu[1*], D.M. Panchbhai[2], S.R. Patil[1], S.G. Bharad[1], M.M. Ganvir[3], V.N. Patil[4], P.P. Debaje[1], W.R. Shinde[1], Vrushali D. Chougale[1], Sujata B. Gaikwad[1], Snehal S. Pisal[1], K.Y. Deshmukh[1], Sarjesh K. Meena[1], L.R. Raut[1] and Prakash S.[1]

[1]Department of Fruit Science, Dr. PDKV, Akola (M.S), India.
[2]Faculty of Agriculture, Dr. PDKV, Akola (M.S), India.
[3]Department of Agronomy, AICRP for Dryland Agriculture, Dr. PDKV, Akola (M.S), India.
[4]Bhausaheb Fundkar Government College of Agriculture, Buldhana, Dr. PDKV, Akola (M.S), India.
*Corresponding author E-mail: mohit_janbandhu@hotmail.com
(Date of Receiving-25-07-2026; Date of Revision-29-09-2026; Date of Acceptance-09-10-2026)

ABSTRACT

The present investigation entitled "Study of Different Physical and Chemical Treatments on Seed Germination and Seedling Growth in Charoli (*Buchanania lanzan* Spreng.)" was carried out during 2024–2025 at the Nursery Unit, Department of Fruit Science, Faculty of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in a Factorial Randomized Block Design (FRBD) comprising two factors, twelve treatment combinations, and three replications. The different treatments evaluated were: T_1 (Scarification with ladle + GA_3 200 ppm for 24 hours), T_2 (Scarification with ladle + GA_3 300 ppm for 24 hours), T_3 (Scarification with ladle + NAA 200 ppm for 24 hours), T_4 (Scarification with ladle + NAA 400 ppm for 24 hours), T_5 (Scarification with 5% H_2SO_4 for 10 minutes + GA_3 200 ppm for 24 hours), T_6 (Scarification with 5% H_2SO_4 for 10 minutes + GA_3 300 ppm for 24 hours), T_7 (Scarification with 5% H_2SO_4 for 10 minutes + NAA 200 ppm for 24 hours), T_8 (Scarification with 5% H_2SO_4 for 10 minutes + NAA 400 ppm for 24 hours), T_9 (Stratification at 4 ^{0}C for 15 days + GA_3 200 ppm for 24 hours), T_{10} (Stratification at 4 ^{0}C for 15 days + GA_3 300 ppm for 24 hours), T_{11} (Stratification at 4 ^{0}C for 15 days + NAA 200 ppm for 24 hours), and T_{12} (Stratification at 4 ^{0}C for 15 days + NAA 400 ppm for 24 hours). The results indicated that the synergistic combination in treatment T_6 (scarification with 5% H_2SO_4 for 10 minutes + GA_3 300 ppm for 24 hours) was significantly superior to the other treatments. It recorded the minimum days to germination (9.67 days), maximum germination percentage (86.33%), highest survival rate (78.33%), maximum number of leaves (14.67), maximum stem diameter (4.20 mm), maximum seedling height (37.33 cm), highest plant fresh weight (22.93 g), and highest plant dry weight (12.57 g).

***Key words*:** Acid scarification, gibberellic acid (GA_3), plant propagation, pre-sowing treatments, seed dormancy, seed germination and seedling vigour.

Introduction

Buchanania lanzan Spreng., commonly recognized as Charoli, Chironji, or Piyal, is a high-value woody perennial within the Anacardiaceae family native to the Indian subcontinent. Initially documented by Francis Hamilton in 1798, the species received its formal botanical description from German botanist Kurt Sprengel in 1801 (denoted by the author abbreviation "Spreng."). Given its exceptional stress tolerance and multi-purpose utility, *B. lanzan* represents an ideal candidate for social agroforestry frameworks designed to enhance rural livelihoods and environmental stability. Currently existing

primarily in wild forest habitats as an underutilized fruit species, it serves as a critical source of non-timber forest income for indigenous communities. The edible kernels are nutritionally dense, containing 25–30% protein along with a sweet oil often used as an alternative to olive and almond oils.

Morphologically, the tree attains a medium height of 40–50 feet with a straight bole. Similar to mango (*Mangifera indica*), it exhibits alternate bearing behavior, flowering between January and February and setting fruit for harvest in April and May. The commercially processed kernels command high market prices, ranging from Rs 1,800 to Rs 2,000 per kilogram. Within the Vidarbha region of Maharashtra, natural populations are predominantly concentrated across the Gadchiroli, Gondia, Amravati and Akola districts. However, unscientific harvesting methods—specifically severe branch lopping and premature fruit gathering—have severely depleted natural stands, prompting its inclusion as a vulnerable species in the IUCN Red Data Book and necessitating immediate conservation interventions.

A major bottleneck in the commercial propagation and ex-situ conservation of *B. lanzan* is seed recalcitrance; stored seeds rapidly lose viability within three months post-harvest (Chauhan *et al*., 2020). Furthermore, fresh seeds display strong exogenous dormancy driven by a hard, stony endocarp (testa) and improper post-harvest handling, resulting in low and erratic germination under natural conditions. Breaking this physical dormancy requires pre-sowing interventions such as mechanical scarification or thermal stratification. Additionally, exogenous application of plant growth regulators and chemical stimulants—including gibberellic acid (GA_3), potassium nitrate (KNO_3), and naphthaleneacetic acid (NAA)—has been shown to enhance germination parameters and initial seedling vigour (Rajamanickam *et al*., 2002). Consequently, standardized pre-sowing seed treatments are essential to support large-scale nursery production, wild population restoration, and the commercial domestication of this valuable species.

Materials and Methods

The experiment was conducted during 2024-2025 at the Nursery Unit, Department of Fruit Science, Faculty of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The seed germination experiment was laid out in a Factorial Randomized Block Design (FRBD) having two factors with twelve treatment combinations and three replications. The different treatments viz., T_1 - (Scarification with ladle + GA_3 200 ppm for 24 hours), T_2 - (Scarification with ladle + GA_3 300 ppm for 24 hours), T_3 - (Scarification with ladle + NAA 200 ppm for 24 hours), T_4 - (Scarification with ladle + NAA 400 ppm for 24 hours), T_5 - (Scarification with 5% H_2SO_4 for 10 minutes + GA_3 200 ppm for 24 hours), T_6 - (Scarification with 5% H_2SO_4 for 10 minutes + GA_3 300 ppm for 24 hours), T_7 - (Scarification with 5% H_2SO_4 for 10 minutes + NAA 200 ppm for 24 hours), T_8 - (Scarification with 5% H_2SO_4 for 10 minutes + NAA 400 ppm for 24 hours), T_9 - (Stratification at 4 ^{0}C for 15 days + GA_3 200 ppm for 24 hours), T_{10} - (Stratification at 4 ^{0}C for 15 days + GA_3 300 ppm for 24 hours), T_{11} - (Stratification at 4 ^{0}C for 15 days + NAA 200 ppm for 24 hours), and T_{12} - (Stratification at 4 ^{0}C for 15 days + NAA 400 ppm for 24 hours) were used in the research programme.

Fresh, fully ripened, uniform and disease-free charoli fruits were collected from the All India Coordinated Research Project (AICRP) for Dryland Agriculture, Dr. P.D.K.V., Akola. The seeds were manually extracted and washed thoroughly with water. Floating, nonviable and damaged seeds were carefully removed. The remaining viable seeds were shade-dried for one hour. Finally, healthy seeds of uniform size and weight were selected for the experiment.

Various physical treatments, such as scarification with a ladle, scarification with H_2SO_4 (5%) for 10 minutes and stratification at 4 ^{0}C for 15 days, were applied to the freshly extracted charoli seeds. The seeds were then dipped in solutions of gibberellic acid (GA_3) (200 ppm and 300 ppm) and naphthaleneacetic acid (NAA) (200 ppm and 400 ppm) for 24 hours before sowing.

After seed treatment, the seeds were shade-dried for 10 minutes and sown at a depth of 1 cm in 20 × 15 cm polythene bags. These bags were kept in a polyhouse. Bags contained a growth medium consisting of a 1:1:1 ratio of soil, farmyard manure (FYM) and sand. The bags were watered as needed. Observations for germination parameters were recorded daily, while vegetative parameters were recorded monthly, starting from the date of seed sowing.

Days required for germination

The date of first plumule emergence was observed. The time elapsed between the date of sowing and the date of plumule emergence was recorded as the number of days required for germination.

Germination percentage (%)

The germination percentage was recorded at 30 days

after sowing (DAS). It was calculated using the following formula:

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

Survival percentage (%)

The survival percentage was recorded at 365 days after sowing (DAS). It was calculated using the following formula:

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

Number of leaves

The total number of leaves per plant was counted from ten randomly selected and tagged seedlings at 180 DAS. The mean value was computed and expressed as the average number of leaves per seedling.

Stem diameter (mm)

The stem diameter of ten randomly selected and tagged seedlings was measured at a height of 3 cm from the base using a Vernier calliper at 180 DAS. The mean value was computed and expressed in millimeters (mm).

Seedling height (cm)

The height of ten randomly selected and tagged seedlings was measured from ground level to the growing tip at 180 DAS. The mean value was computed and expressed as the average seedling height in centimeters (cm).

Fresh weight of plant (g)

At 180 days after sowing (DAS), ten randomly selected and tagged seedlings from each treatment were carefully uprooted and properly washed. The fresh weight of the entire plant (including both shoot and root systems) was measured immediately using an electronic balance. The average fresh plant weight was computed and expressed in grams (g).

Dry weight of plant (g)

Following the measurement of fresh weight, the same ten randomly selected and tagged seedlings were subjected to drying. The entire plants were dried in a hot air oven at 60–75 °C for 10 to 20 hours until a constant weight was achieved. The average dry plant weight was computed and expressed in grams (g).

The experimental data were subjected to statistical analysis using the analysis of variance (ANOVA) technique, as described by Panse and Sukhatme (1967).

Result and discussion

Days required for germination

The days required for germination in charoli was significantly influenced by the different physical and chemical treatments and their combinations (Table 2, Fig. 1). Among the physical treatments, treatment P_2 (Scarification with H_2SO_4 5% 10 min.) recorded the significantly minimum days for germination (14.33 days), while in chemical treatments, treatment C_2 (GA_3 300 ppm) recorded the significantly minimum days for germination 12.89 days. Regarding the interaction effect between both factors, the treatment combination P_2C_2 (Scarification with H_2SO_4 + GA_3 300 ppm) emerged as the best performer, recording the significantly minimum days to germination (9.67 days). In contrast, the significantly maximum days to germination (23.00 days) was observed in the treatment combination P_3C_3 (Stratification 4 °C + NAA 200 ppm).

Table 1: Details of the different physical and chemical treatments and their combinations.

Factor A (Physical treatments)		
P1 Scarification with ladle		
P2 Scarification with H2SO4 (5% for 10 minutes)		
P3 Stratification 4 ^{0}C (15 days)		
Factor B (Chemical treatments)		
C1 GA3 200 ppm (24 hours)		
C2 GA3 300 ppm (24 hours)		
C3 NAA 200 ppm (24 hours)		
C4 NAA 400 ppm (24 hours)		
S. No.	**Treatments**	**Treatment Combinations**
1	T_1	Scarification with ladle + GA3 200 ppm (24 hours)
2	T_2	Scarification with ladle + GA3 300 ppm (24 hours)
3	T_3	Scarification with ladle + NAA 200 ppm (24 hours)
4	T_4	Scarification with ladle + NAA 400 ppm (24 hours)
5	T_5	Scarification with H2SO4 (5% for 10 minutes) + GA3 200 ppm (24 hours)
6	T_6	Scarification with H2SO4 (5% for 10 minutes) + GA3 300 ppm (24 hours)
7	T_7	Scarification with H2SO4 (5% for 10 minutes) + NAA 200 ppm (24 hours)
8	T_8	Scarification with H2SO4 (5% for 10 minutes) + NAA 400 ppm (24 hours)
9	T_9	Stratification 4 ^{0}C (15 days) + GA3 200 ppm (24 hours)
10	T_{10}	Stratification 4 ^{0}C (15 days) + GA3 300 ppm (24 hours)
11	T_{11}	Stratification 4 ^{0}C (15 days) + NAA 200 ppm (24 hours)
12	T_{12}	Stratification 4 ^{0}C (15 days + NAA 400 ppm (24 hours)

Table 2: Effect of different physical and chemical treatments on days required for germination and germination percentage in charoli.

	Factor A (Physical treatments)	Days required for germination	Germination percentage (%)
P_1	Scarification with ladle	14.50	74.92
P_2	Scarification with H_2SO_4 (5% for10 min.)	14.33	70.50
P_3	Stratification 4 ^{0}C (15 days)	19.17	65.67
	S.E (m) ±	0.16	0.37
	C.D. at 5%	0.48	1.09
	Factor B (Chemical treatments)		
C_1	GA_3 200 ppm (24 hrs)	14.11	69.78
C_2	GA_3 300 ppm (24 hrs)	12.89	83.67
C_3	NAA 200 ppm (24 hrs)	18.89	63.89
C_4	NAA 400 ppm (24 hrs)	18.11	64.11
	S.E (m) ±	0.19	0.43
	C.D. at 5%	0.56	1.26
	Treatment combinations		
T_1	Scarification with ladle + GA_3 200 ppm (24 hrs)	15.67	75.33
T_2	Scarification with ladle + GA_3 300 ppm (24 hrs)	10.33	85.00
T_3	Scarification with ladle + NAA 200 ppm (24 hrs)	15.67	71.67
T_4	Scarification with ladle + NAA 400 ppm (24 hrs)	16.33	67.67
T_5	Scarification with H_2SO_4 (5% for10 min.) + GA_3 200 ppm (24 hrs)	12.33	64.33
T_6	Scarification with H_2SO_4 (5% for10 min.) + GA_3 300 ppm (24 hrs)	9.67	86.33
T_7	Scarification with H_2SO_4 (5% for10 min.) + NAA 200 ppm (24 hrs)	18.00	63.67
T_8	Scarification with H_2SO_4 (5% for10 min.) + NAA 400 ppm (24 hrs)	17.33	67.67
T_9	Stratification 4 ^{0}C (15 days) +GA_3 200 ppm (24 hrs)	14.33	69.67
T_{10}	Stratification 4 ^{0}C (15 days) + GA_3 300 ppm (24 hrs)	18.67	79.67
T_{11}	Stratification 4 ^{0}C (15 days) + NAA 200 ppm (24 hrs)	23.00	56.33
T_{12}	Stratification 4 ^{0}C (15 days + NAA 400 ppm (24 hrs)	20.67	57.00
	F Test	Sig	Sig
	S.E (m) ±	0.33	0.74
	C.D. at 5%	0.97	2.17

Treating seeds with H_2SO_4 (5%) significantly shortened the germination timeframe by degrading the dense lignin-cellulose network in the stony endocarp, thereby breaking physical dormancy and promoting seed coat permeability for rapid water entry and respiration. Furthermore, GA_3 (300 ppm) acted as a physiological trigger for the *de novo* production of key hydrolases (α-amylase and proteases). The resulting enzymatic cleavage of stored seed reserves into simple metabolic solutes provided the energy required for early radicle emergence and faster seedling establishment. Similar findings were reported by Sharma (2016), Joshi *et al*., (2017), Chauhan *et al*., (2020), Sharma *et al*., (2020), Homeshvari *et al*., (2022), Prakash *et al*., (2025) and Janbandhu *et al*., (2026) in charoli, Palepad *et al*., (2017) in custard apple and Lalitha *et al*., (2020) in aonla.

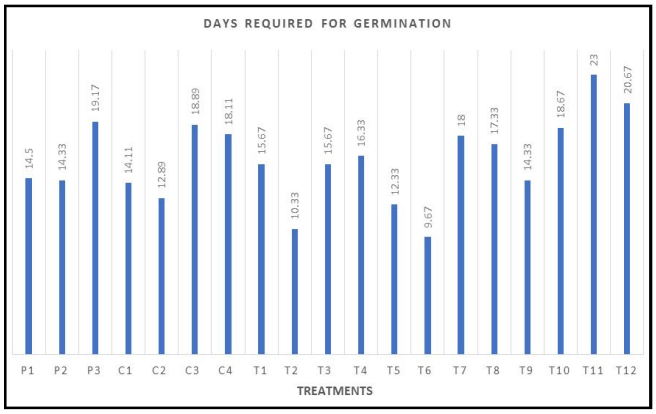


Fig. 1: Effect of different physical and chemical treatments on days required for germination in charoli.

Germination Percentage (%)

The germination percentage of the seedling in charoli was significantly influenced by the different physical and chemical treatments and their combinations (Table 2, Fig. 2). Among the physical treatments, treatment P_1 (Scarification with ladle) showed the highest seed germination percentage (74.92%), while in chemical treatments, treatment C_2 (GA_3 300 ppm) recorded the highest seed germination (83.67%). Regarding the

Table 3: Effect of different physical and chemical treatments on survival percentage and number of leaves in charoli.

	Factor A (Physical treatments)	Survival percentage (%)	Number of Leaves
P_1	Scarification with ladle	65.33	11.83
P_2	Scarification with H_2SO_4 (5% 10 min.)	61.25	11.58
P_3	Stratification 4 ^{0}C (15 days)	52.17	9.50
	S.E (m) ±	0.49	0.16
	C.D. at 5%	1.44	0.46
	Factor B (Chemical treatments)		
C_1	GA_3 200 ppm (24 hrs)	60.11	10.89
C_2	GA_3 300 ppm (24 hrs)	74.67	13.56
C_3	NAA 200 ppm (24 hrs)	51.56	9.44
C_4	NAA 400 ppm (24 hrs)	52.00	10.00
	S.E (m) ±	0.57	0.18
	C.D. at 5%	1.67	0.54
	Treatment combinations		
T_1	Scarification with ladle + GA_3 200 ppm (24 hrs)	65.67	11.67
T_2	Scarification with ladle + GA_3 300 ppm (24 hrs)	75.67	13.67
T_3	Scarification with ladle + NAA 200 ppm (24 hrs)	62.00	11.33
T_4	Scarification with ladle + NAA 400 ppm (24 hrs)	58.00	10.67
T_5	Scarification with H_2SO_4 (5% for10 min.) + GA_3 200 ppm (24 hrs)	54.67	10.33
T_6	Scarification with H_2SO_4 (5% for10 min.) + GA_3 300 ppm (24 hrs)	78.33	14.67
T_7	Scarification with H_2SO_4 (5% for10 min.) + NAA 200 ppm (24 hrs)	54.00	10.33
T_8	Scarification with H_2SO_4 (5% for10 min.) + NAA 400 ppm (24 hrs)	58.00	11.00
T_9	Stratification 4 ^{0}C (15 days) +$GA_3$200 ppm (24 hrs)	60.00	10.67
T_{10}	Stratification 4 ^{0}C (15 days) + GA_3 300 ppm (24 hrs)	70.00	12.33
T_{11}	Stratification 4 ^{0}C (15 days) + NAA 200 ppm (24 hrs)	38.67	6.67
T_{12}	Stratification 4 ^{0}C (15 days + NAA 400 ppm (24 hrs)	40.00	8.33
	F Test	Sig	Sig
	S.E (m) ±	0.98	0.32
	C.D. at 5%	2.88	0.93

interaction effect between both factors, the treatment combination P_2C_2 (Scarification with H_2SO_4 + GA_3 300 ppm) emerged as the best performer by recording the significantly highest seed germination percentage (86.33%). In contrast, the lowest seed germination percentage (56.33%) was observed in the treatment combination P_3C_3 (Stratification 4 °C + NAA 200 ppm).

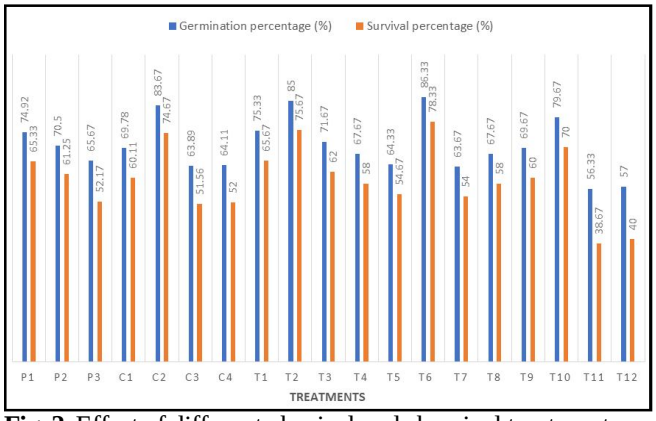


Fig. 2: Effect of different physical and chemical treatments on germination percentage and Survival percentage in charoli.

An increase in overall germination percentage may be explained by the dual effect of acid scarification and gibberellic acid treatment. The application of H_2SO_4 weakened the tough endocarp, thereby eliminating physical dormancy and allowing spatial expansion of the embryo. On the other hand, priming with GA_3 at 300 ppm shifted the ratio of growth promoters to inhibitors by neutralizing ABA-induced suppression. This physiological activation enhanced cellular elongation in the embryonic axis, ultimately driving higher total germination rates across the treated seed lot. Similar results were found by Shukla and Solanki (2000), Narayan *et al.*, (2014), Sharma (2016), Joshi *et al.*, (2017), Sadashiv *et al.*, (2017), Ajith *et al.*, (2018), Chauhan *et al.*, (2020), Sharma *et al.*, (2020), Thounaojam and Dhaduk (2020), Khobragade *et al.*, (2021), Homeshvari *et al.*, (2022), Prakash *et al.*, (2025) and Janbandhu *et al.*, (2026) in charoli, Vasantha *et al.*, (2014) in tamarind and Palepad *et al.*, (2017) in custard apple.

Table 4: Effect of different physical and chemical treatments on stem diameter and height of the seedling in charoli.

	Factor A (Physical treatments)	Stem diameter (mm)	Height of the seedling (cm)
P_1	Scarification with ladle	3.51	29.96
P_2	Scarification with H_2SO_4 (5% 10 min.)	3.34	32.76
P_3	Stratification 4 ^{0}C (15 days)	2.94	25.40
	S.E (m) ±	0.02	0.08
	C.D. at 5%	0.07	0.22
	Factor B (Chemical treatments)		
C_1	GA_3 200 ppm (24 hrs)	3.40	33.22
C_2	GA_3 300 ppm (24 hrs)	3.82	34.72
C_3	NAA 200 ppm (24 hrs)	2.92	23.36
C_4	NAA 400 ppm (24 hrs)	2.91	26.19
	S.E (m) ±	0.03	0.09
	C.D. at 5%	0.08	0.26
	Treatment combinations		
T_1	Scarification with ladle + GA_3 200 ppm (24 hrs)	3.63	33.90
T_2	Scarification with ladle + GA_3 300 ppm (24 hrs)	4.00	34.77
T_3	Scarification with ladle + NAA 200 ppm (24 hrs)	3.50	23.90
T_4	Scarification with ladle + NAA 400 ppm (24 hrs)	2.90	27.27
T_5	Scarification with H_2SO_4 (5% for10 min.) + GA_3 200 ppm (24 hrs)	3.37	34.60
T_6	Scarification with H_2SO_4 (5% for10 min.) + GA_3 300 ppm (24 hrs)	4.20	37.33
T_7	Scarification with H_2SO_4 (5% for10 min.) + NAA 200 ppm (24 hrs)	2.73	28.80
T_8	Scarification with H_2SO_4 (5% for10 min.) + NAA 400 ppm (24 hrs)	3.07	30.30
T_9	Stratification 4 ^{0}C (15 days) + GA_3 200 ppm (24 hrs)	3.20	31.17
T_{10}	Stratification 4 ^{0}C (15 days) + GA_3 300 ppm (24 hrs)	3.27	32.07
T_{11}	Stratification 4 ^{0}C (15 days) + NAA 200 ppm (24 hrs)	2.53	17.37
T_{12}	Stratification 4 ^{0}C (15 days + NAA 400 ppm (24 hrs)	2.77	21.00
	F Test	Sig	Sig
	S.E (m) ±	0.05	0.15
	C.D. at 5%	0.13	0.45

Survival Percentage (%)

The survival percentage of the seedling in charoli was significantly influenced by the different physical and chemical treatments and their combinations (Table 3, Fig. 2). Among the physical treatments, treatment P_1 (Scarification with ladle) showed the significantly highest survival percentage (65.33%), while in chemical treatments, treatment C_2 (GA_3 300 ppm) recorded the significantly highest survival percentage (74.67%). Regarding the interaction effect between both factors, the treatment combination P_2C_2 (Scarification with H_2SO_4 + GA_3 300 ppm) emerged as the best performer by recording the significantly Highest survival percentage of 78.33%. In contrast, the lowest survival percentage of 38.67% was observed in the treatment combination P_3C_3 (Stratification 4 °C + NAA 200 ppm).

An increase in survival percentage may be explained by the physiological advantages imparted by acid scarification and gibberellin application. The H_2SO_4 (5%) treatment minimized physical restriction by weakening the tough endocarp, thereby preserving seed energy reserves for initial vegetative proliferation rather than emergence effort. On the other hand, GA_3 (300 ppm) stimulated cell division and elongation in the hypocotyl-radicle axis, facilitating rapid root architecture development. This improved early resource capture and bolstered seedling tolerance against dampening-off and environmental stress. The current results are in accordance with the findings of Narayan *et al*., (2014), Joshi *et al*., (2017), Chauhan *et al*., (2020), Sharma *et al*., (2020), Homeshvari *et al*., (2022), Prakash *et al*., (2025) and Janbandhu *et al*., (2026) in charoli, Manekar *et al*., (2011) and Lalitha *et al*., (2020) in aonla, Patel *et al*., (2017) in mango and Palepad *et al*., (2017) in custard apple.

Number of Leaves

The number of leaves in charoli seedlings was significantly influenced by the different physical and chemical treatments and their combinations (Table 3, Fig. 3). Among the physical treatments, treatment P_1

(Scarification with ladle) showed the significantly maximum number of leaves (11.83), while in chemical treatments, treatment C_2 (GA_3 300 ppm) was recorded the significantly maximum number of leaves (13.56). Regarding the interaction effect between both factors, the treatment combination P_2C_2 (Scarification with H_2SO_4 + GA_3 300 ppm) emerged as the best performer by recording the significantly maximum number of leaves (14.67). In contrast, the minimum number of leaves (6.67) was observed in the treatment combination P_3C_3 (Stratification 4 °C + NAA 200 ppm).

An increase in the number of leaves per plant may be explained by the combined influence of acid scarification and gibberellin-mediated growth. The H_2SO_4 (5%) treatment effectively weakened the stony seed coat, advancing the onset of autotrophic growth. On the other hand, GA_3 (300 ppm) stimulated mitotic activity and cell expansion in the shoot apex, leading to rapid internodal development and earlier leaf primordia formation. Furthermore, gibberellin-induced enhancements in nitrogen utilization and chlorophyll biosynthesis provided the metabolic foundation for increased leaf production. These results are in close agreement with the findings reported by Sharma (2016), Joshi *et al*., (2017), Chauhan *et al*., (2020), Sharma *et al*., (2020), Mahadev *et al*., (2021), Homeshvari *et al*., (2022), Prakash *et al*., (2025) and Janbandhu *et al*., (2026) in charoli, Vasantha *et al*., (2014) in tamarind, Palepad *et al*., (2017) in custard apple and Lalitha *et al*., (2020) in aonla.

Stem Diameter (mm)

The stem diameter of the seedling in charoli was significantly influenced by the different physical and chemical treatments and their combinations (Table 4, Fig. 4). Among the physical treatments, treatment P_1 (Scarification with ladle) showed the significantly maximum stem diameter (3.51 mm), while in chemical treatments, treatment C_2 (GA_3 300 ppm) recorded the significantly maximum stem diameter (3.82 mm). Regarding the interaction effect between both factors, the treatment combination P_2C_2 (Scarification with H_2SO_4 + GA_3 300 ppm) emerged as the best performer by recording the significantly maximum stem diameter (4.20 mm). In contrast, the minimum stem diameter (2.53 mm) was observed in the treatment combination P_3C_3 (Stratification 4 °C + NAA 200 ppm).

An increase in stem diameter may be explained by the synergistic action of acid scarification and gibberellic acid application. Treatment with H_2SO_4 (5%) facilitated prompt seed germination, allowing early root architecture development for effective nutrient foraging and baseline stem structuring. On the other hand, GA_3 (300 ppm) stimulated vascular cambial activity and accelerated radial cell proliferation. Moreover, the enhanced foliar canopy produced higher levels of photo-assimilates, providing the energetic foundation needed to increase radial stem growth. Similar results were found by Sharma (2016), Joshi *et al*., (2017), Chauhan *et al*., (2020), Sharma *et al*., (2020), Mahadev *et al*., (2021) and Janbandhu *et al*., (2026) in charoli, Vasantha *et al*., (2014) in tamarind, Palepad *et al*., (2017) in custard apple and Lalitha *et al*., (2020) in aonla.

Height of the Seedling (cm)

The height of the seedling in charoli was significantly influenced by the different physical and chemical treatments and their combinations (Table 4, Fig. 4). Among the physical treatments, treatment P_2 (Scarification with H_2SO_4 5% 10 min.) showed the significantly maximum seedling height (32.76 cm), while in chemical treatments, treatment C_2 (GA_3 300 ppm) recorded the significantly maximum seedling height (34.72 cm). Regarding the interaction effect between both factors, the treatment

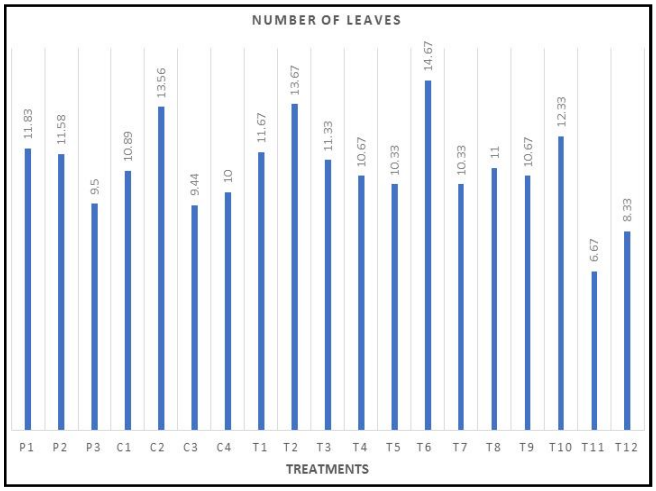


Fig. 3: Effect of different physical and chemical treatments on number of leaves in charoli.

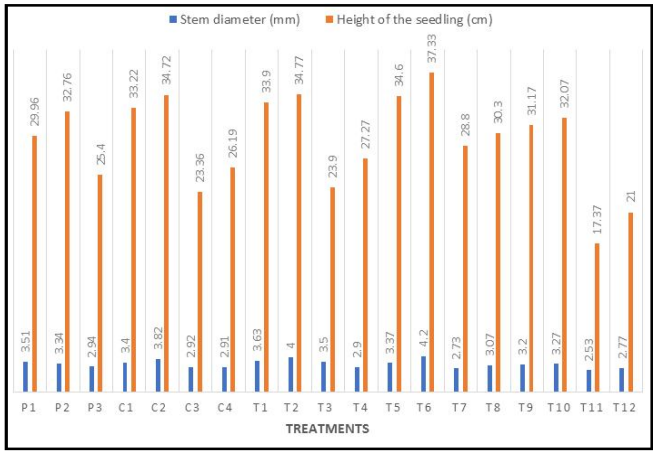


Fig. 4: Effect of different physical and chemical treatments on stem diameter and height of the seedling in charoli.

Table 5: Effect of different physical and chemical treatments on fresh weight of plant and dry weight of plant in charoli.

	Factor A (Physical treatments)	Fresh weight of plant (g)	Dry weight of plant (g)
P_1	Scarification with ladle	18.93	8.57
P_2	Scarification with H_2SO_4 (5% 10 min.)	19.53	9.18
P_3	Stratification 4 ^{0}C (15 days)	16.52	6.14
	S.E (m) ±	0.01	0.02
	C.D. at 5%	0.04	0.05
	Factor B (Chemical treatments)		
C_1	GA_3 200 ppm (24 hrs)	20.38	10.01
C_2	GA_3 300 ppm (24 hrs)	21.53	11.17
C_3	NAA 200 ppm (24 hrs)	14.68	4.32
C_4	NAA 400 ppm (24 hrs)	16.72	6.36
	S.E (m) ±	0.02	0.02
	C.D. at 5%	0.05	0.06
	Treatment combinations		
T_1	Scarification with ladle + GA_3 200 ppm (24 hrs)	21.10	10.73
T_2	Scarification with ladle + GA_3 300 ppm (24 hrs)	21.80	11.43
T_3	Scarification with ladle + NAA 200 ppm (24 hrs)	15.10	4.73
T_4	Scarification with ladle + NAA 400 ppm (24 hrs)	17.73	7.37
T_5	Scarification with H_2SO_4 (5% for10 min.) + GA_3 200 ppm (24 hrs)	21.30	10.93
T_6	Scarification with H_2SO_4 (5% for10 min.) + GA_3 300 ppm (24 hrs)	22.93	12.57
T_7	Scarification with H_2SO_4 (5% for10 min.) + NAA 200 ppm (24 hrs)	15.60	5.30
T_8	Scarification with H_2SO_4 (5% for10 min.) + NAA 400 ppm (24 hrs)	18.30	7.93
T_9	Stratification 4 ^{0}C (15 days) +$GA_3$200 ppm (24 hrs)	18.73	8.37
T_{10}	Stratification 4 ^{0}C (15 days) + GA_3 300 ppm (24 hrs)	19.87	9.50
T_{11}	Stratification 4 ^{0}C (15 days) + NAA 200 ppm (24 hrs)	13.33	2.93
T_{12}	Stratification 4 ^{0}C (15 days + NAA 400 ppm (24 hrs)	14.13	3.77
	F Test	Sig	Sig
	S.E (m) ±	0.03	0.04
	C.D. at 5%	0.08	0.11

combination P_2C_2 (Scarification with H_2SO_4 + GA_3 300 ppm) emerged as the best performer by recording the significantly maximum height of the seedling (37.33 cm). In contrast, the minimum height of the seedling (17.37 cm) was observed in the treatment combination P_3C_3 (Stratification 4 °C + NAA 200 ppm).

An increase in seedling height may be explained by

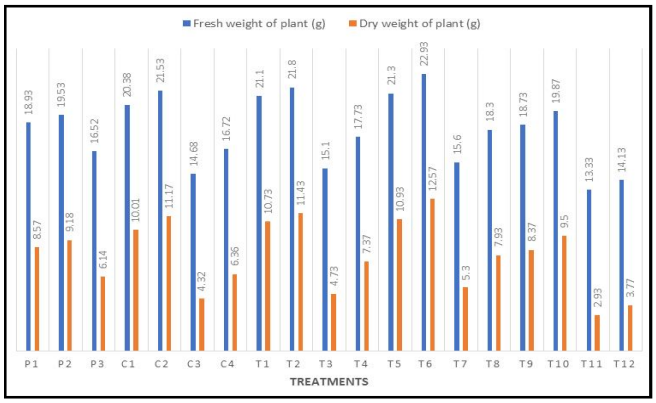


Fig. 5: Effect of different physical and chemical treatments on fresh weight of plant and dry weight of plant in charoli.

the combined influence of acid scarification and gibberellin priming. Treatment with H_2SO_4 (5%) enabled uniform and early emergence, providing seedlings with an extended timeframe for biomass accumulation and vegetative development. On the other hand, GA_3 (300 ppm) application enhanced cell wall compliance and stimulated rapid cellular elongation across the stem internodes. This physiological response, alongside increased assimilate partitioning toward the apical meristem, significantly augmented final seedling height. These results are in close agreement with the findings reported by Sharma (2016), Joshi *et al*., (2017), Sadashiv *et al*., (2017), Chauhan *et al*., (2020), Sharma *et al*., (2020), Khobragade *et al*., (2021), Mahadev *et al*., (2021), Homeshvari *et al*., (2022), Prakash *et al*., (2025) and Janbandhu *et al*., (2026) in charoli, Vasantha *et al*., (2014) in tamarind, Palepad *et al*., (2017) in custard apple, Patel *et al*., (2017) in mango and Lalitha *et al*., (2020) in aonla.

Fresh Weight of Plant (g)

The fresh weight of the seedling in charoli was

significantly influenced by the different physical and chemical treatments and their combinations (Table 5, Fig. 5). Among the physical treatments, treatment P_2 (Scarification with H_2SO_4 5% 10 min.) showed the significantly highest fresh weight of the plant (19.53 g), while in chemical treatments, treatment C_2 (GA_3 300 ppm) recorded the significantly highest fresh weight of the plant (21.53 g). Regarding the interaction effect between both factors, the treatment combination P_2C_2 (Scarification with H_2SO_4 + GA_3 300 ppm) emerged as the best performer by recording the significantly highest fresh weight of the plant (22.93 g). In contrast, the lowest fresh weight of the plant (13.33 g) was observed in the treatment combination P_3C_3 (Stratification 4 °C + NAA 200 ppm).

An increase in seedling fresh weight may be explained by the complementary effects of acid scarification and gibberellic acid treatment. The H_2SO_4 (5%) treatment removed physical barriers to radicle emergence, facilitating early root system architecture development and efficient nutrient-water uptake. On the other hand, GA_3 (300 ppm) application upregulated cellular volume and tissue hydration status while accelerating overall vegetative growth across the main axis, stem diameter, and leaf surface. Together, these physiological enhancements culminated in significantly elevated fresh weight values. The current results are in accordance with the findings of Sharma (2016), Mahadev *et al*., (2021), Homeshvari *et al*., (2022), Prakash *et al*., (2025) and Janbandhu *et al*., (2026) in charoli, Vasantha *et al*., (2014) in tamarind, Palepad *et al*., (2017) in custard apple and Lalitha *et al*., (2020) in aonla.

Dry Weight of Plant (g)

The dry weight of the plant in charoli was significantly influenced by the different physical and chemical treatments and their combinations (Table 5, Fig. 5). Among the physical treatments, treatment P_2 (Scarification with H_2SO_4 5% 10 min.) showed the significantly highest dry weight of the plant (9.18 g), while in chemical treatments, treatment C_2 (GA_3 300 ppm) recorded the significantly highest dry weight of the plant (11.17 g). Regarding the interaction effect between both factors, the treatment combination P_2C_2 (Scarification with H_2SO_4 + GA_3 300 ppm) emerged as the best performer by recording the significantly highest dry weight of the plant (12.57 g). In contrast, the lowest dry weight of the plant (2.93 g) was observed in the treatment combination P_3C_3 (Stratification 4 °C + NAA 200 ppm).

The higher dry weight likely resulted from the synergistic integration of accelerated canopy establishment and gibberellin-driven metabolic sink strength. By breaking mechanical seed coat resistance, H_2SO_4 (5%) advanced the transition to autotrophic growth, enabling early leaf area development and maximum light absorption. Concurrently, GA_3 (300 ppm) served as a metabolic catalyst by modulating auxin pathways and cell expansion mechanisms. This hormonal priming enhanced photosynthetic efficiency and optimized the source-sink balance, driving greater dry matter synthesis and structural biomass partitioning within the developing seedling. These results are in close agreement with the findings reported by Sharma (2016), Homeshvari *et al*., (2022) and Janbandhu *et al*., (2026) in charoli, Vasantha *et al*., (2014) in tamarind, Palepad *et al*., (2017) in custard apple, Patel *et al*., (2017) in mango and Lalitha *et al*., (2020) in aonla.

Conclusions

Based on the results of the present investigation entitled "Study of Different Physical and Chemical Treatments on Seed Germination and Seedling Growth in Charoli (*Buchanania lanzan* Spreng.)", It can be concluded that the seed treatment with H_2SO_4 (5%) for 10 minutes followed by soaking in GA_3 at 300 ppm for 24 hours gave the earliest germination, the maximum germination percentage, optimum vegetative growth and the highest survival percentage of charoli seedlings.

References

Ajith, S., Krishna V., Sudhesh L. and Shastri R.K. (2018). Dormancy breaking of stored seeds of Chironji (*Buchanania lanzan* Spreng.) An endangered medicinal plant of the Western Ghats. *Journal of Emerging Technologies and Innovative Research,* **5**, 2349–5162.

Chauhan, P.S., Sharma M., Pandey S.B.S., Bhatnagar P., Sharma M.K. and Nagar B. (2020). Effect of seed treatments on plus trees of *Buchanania lanzan* in South-Eastern Rajasthan. *Journal of Pharmacognosy and Phytochemistry,* **9(4)**, 301–303.

Homeshvari, Kanpure R.N., Sahu D.K. and Nagar B.L. (2022). Effect of different chemical and physical treatments on germination and seedling vigour of chironji (*Buchanania lanzan* Spreng.). *The Pharma Innovation Journal*, **11(1)**, 714–717.

Janbandhu, M.S., Panchbhai D.M., Patil S.R., Bharad S.G., Ganvir M.M., Walke R.D., Patil V.N. and Ramteke N.H. (2026). Effect of Different Physical and Chemical Treatments on Seed Germination and Seedling Growth in Charoli (*Buchanania lanzan* Spreng.). *Int. J. Adv. Biochem. Res*., **10(7S)**, 700-708.

Joshi, C.J., Sharma D.K., Mutteppa G. and Rajni R. (2017). Effect of different chemicals on germination and seedling growth of chironji (*Buchanania lanzan* Spreng.). *Plant Archives*, **17(2)**, 1483–1486.

Khobragade, N.D. and Rai N. (2022). Effect of pretreatments on seed germination and seedling growth of *Buchanania*

lanzan Spreng. *The Pharma Innovation Journal,* **11(1)**, 104–106.

Lalitha, K.R., Tank R.V., Chawla S.L. and Jena S. (2020). Effect of chemicals on seed germination and seedling growth of aonla (*Emblica officinalis* Gaertn.). *The Pharma Innovation Journal,* **9(12)**, 239–243.

Mahadev, L.P., Ahire D.K. and Kumar D.B. (2021). Influence of different chemical on vegetative growth of chironji (*Buchanania lanzan* Spreng). *IAR Journal of Agriculture Research and Life Sciences*, 2708–5104.

Manekar, R.S., Sable P.B. and Rane M.M. (2011). Influence of different plant growth regulators on seed germination and subsequent seedling growth of aonla (*Emblica officinalis* Gaertn.). *Green Farming,* **2(4)**, 477–478.

Narayan, K., Patra H.K. and Dhruw S.K. (2014). Standardization of propagation methods of charoli (*Buchnania lanzan* Spreng). *Asian Journal of Horticulture,* **9(1)**, 283–284.

Palepad, K.B., Bharad S.G. and Bansode G.S. (2017). Effect of seed treatments on germination, seedling vigour and growth rate of custard apple (*Annona squamosa*). *Journal of Pharmacognosy and Phytochemistry,* **6(5)**, 20–23.

Panse, V.G. and Sukhatme P.V. (1967). *Statistical methods for agricultural workers* (2nd ed.). Indian Council of Agricultural Research (ICAR).

Patel, R.J., Ahlawat T.R., Patel A.I., Amarcholi J.J., Patel B.B. and Sharma K. (2017). Growth of mango (*Mangifera indica* L.) rootstocks as influenced by pre-sowing treatments. *Journal of Applied and Natural Science,* **9(1)**, 582–586.

Prakash, O., Srivastava A.K., Gautam D.K., Singh S.C., Gangwar V., Kumar S. and Prajapati P. (2025). Standardization of scarification and growing media for seed germination and seedling growth of chironji (*Buchanania lanzan* Spreng.). *Indian Journal of Horticulture,* **82(4)**, 433–439.

Rajamanickam, C., Anbu S. and Balakrishnan K. (2002). Effect of chemicals and growth regulators on seed germination in aonla (*Emblica officinalis* G.). *South Indian Horticulture,* **50(1/3)**, 211-214.

Sadashiv, D., Nimbalkar D.S., Patil and Vitthal K.K. (2017). Effect of seed treatment methods on germination and seed vigor of *Buchanania lanzan* Spreng, charoli. *Trends in Biosciences,* **10(27)**, 5729–5732.

Sharma, D.K. (2016). Effect of plant growth regulators and scarification on germination and seedling growth of chironji (*Buchanania lanzan* Spreng.). *Advances in Life Sciences,* **5(8)**, 3237–3241.

Sharma, M., Chauhan P.S., Pandey S.B.S., Bhatnagar P., Sharma M.K. and Nagar B. (2020). Seed germination behaviour and seedling attributes of *Buchanania lanzan* (Spreng.) in South-Eastern Rajasthan. *The Pharma Innovation Journal,* **9(1)**, 123–128.

Shukla, S.K. and Solanki K.R. (2000). Studies on seed germination, plant survival and growth of chironji (*Buchanania lanzan* Spreng.). *Journal of Tropical Forestry,* **16(1)**, 44–49.

Thounaojam, A.S. and Dhaduk H.L. (2020). Enhancement of seed germination in chironji (*Buchanania lanzan* Spreng) through physical and chemical treatments. *Journal of Pharmacognosy and Phytochemistry,* **9(1)**, 1354–1359.

Vasantha, P.T., Vijendrakumar R.C., Guruprasad T.R., Mahadevamma M. and Santhosh K.V. (2014). Studies on growth regulators and biofertilizers on seed germination and seedling growth of tamarind (*Tamarindus indica* L.). *Plant Archives,* **14(1)**, 155–160.