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Standardization of scarification and growing media for seed germination and seedling growth of chironji (*Buchanania lanzan* Spreng.)

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ABSTRACT

The present experiment was conducted at the Fruit Nursery, College of Horticulture, Banda University of Agriculture and Technology, Banda during 2022-23. The results showed that T_2 treatment., seeds dipped GA_3 500 ppm for 24 hours, took the minimum germination time of 9.24 days, maximum germination percentage of 59.38% and survival rate of 60.25%. The highest earliness index (0.603), vigour index-I (809.10), and vigour index-II (244.99). The maximum plant height (12.78 cm), stem diameter (0.37 cm), leaf number (10.46), leaf area (24.24 cm²), fresh seedling weight (6.09 g), and dry root weight (2.89 g) at 120 days after sowing. The maximum root length (21.16 cm), number of secondary roots (2.37), fresh root weight (3.65 g), and dry root weight (1.60 g) at 120 days after sowing. Second factor results performed in mixed media T_4 (soil, FYM, cocopeat 1:1:1), the minimum number of days taken for seed germination 10.66, maximum germination percentage of 54.38% and survival rate of 57.41%. The highest plant height (12.33cm), diameter of stem (0.39), number of leaves (9.74), leaf area 24.1 cm²), fresh shoot weight (5.54g), dry weight of shoot (2.61g), length of primary roots (19.16 cm) at observed 120 DAS and highest number of secondary roots (2.51), fresh weight of roots (3.78g) and dry weight of roots (1.59 g) at 120 days after sowing. Both types treatments showed effective in improving seedling establishment and growth, indicating their potential use for optimizing chironji propagation in nursery conditions.

Key words: Earliness index, vigour index, germination, stem diameter, plant height.

INTRODUCTION

Chironji (*Buchanania lanzan* Spreng.) belongs to the family Anacardiaceae and originated in the Indian sub-continent when Francis Hamilton first described it in 1798. Chironji is also known as Char, Achar, Piyal and Charoli. The tree is found naturally in the forests of North, West and Central India mostly in the states of state of Rajasthan, Chhattisgarh, Madhya Pradesh, Jharkhand, Gujarat, Odisha and some part of Utter Pradesh (Tiwari *et al.,* 18). Chironji is a hardy plant and thrives well on undulated, gravelly lateritic soils and also on saline and sodic soils but does not survive under water logged conditions. For better growth and productivity, well-drained deep loam soil is ideal and it prefers tropical and subtropical climate and withstands drought admirably. Chironji is a most important minor fruit crop in India commonly used by Trible community and is also the source of their income (Singh *et al.,* 17). Chironji kernel is the most important economical parts used in the preparation of puddings and confectionary (Chauhan *et al.,* 6).

Due to dormancy, chironji seeds have a low rate of germination even when exposed to favourable germination circumstances. It may be due to morphological reasons such as hard seed coat, thick testa or due to inhibitors present on seed coat. Such type of hard seed coat seeds may require special treatments like scarification, soaking in water, growth regulators etc., for overcoming dormancy. Pre-sowing treatment with chemicals like GA_3, KNO_3 and Thiourea (Atiyeh *et al.,* 2), H_2SO_4 improve the seed germination of Chironji. To break the dormancy, pre-treatment of the seed in GA_3 causes rapid germination of many highly dormant seeds. GA_3 is a natural plant regulator with multiple applications in the agriculture and horticulture industry due to its positive impact on plant growth and development (Mihaiela, *et al.,* 13). GA_3 is reduce abscisic acid in seeds, and in contrast, auxins and cytokinins of the seeds are increased to a level enough for inducing dormancy break. H_2SO_4 helps for converts hard seed coat to softness and due to its softness, it helps to improve the seed germination percentage (Narayan *et al.,* 14).

Growing media should be also having good water holding capacity, drainage and other physical and chemical properties. So, it's better to offer a soil medium or combination that meets the criteria for greatest seed germination and best seedling development. Most of the propagation materials used

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for growing horticultural plants in nurseries are either organic or inorganic in composition (Atiyeh *et al.,* 2). Vermicompost, FYM cocopeat, etc. are organic in nature, and vermiculite, perlite and sand are inorganic in nature. Many organic media decompose readily, get compact easily and thus decrease pore space and aeration in soil. Some of the important growing media such as soil, vermicompost, FYM cocopeat and perlite are used in this experiment. Soil has good physical properties *viz.,* fertility, porosity, CEC (Cation Exchange Capacity), and water holding capacity which helps to maintain a balanced carbon and nitrogen ratio. Soil having good texture should be preferred for use as propagation media. It is the reservoir for nutrients and water, allowing oxygen to diffuse in the roots (Abad *et al.,* 1). The standard of seedlings in the nursery is extremely influenced by growing media. FYM is prepared using cow dung, cow urine and crop waste and other wastes and is a rich source of nutrients. It contains 0.5% N, 0.25% P, 0.5% K and about 60-70% moisture at the initial stage. A moisture content of 30-40% of decomposed manure at a temperature of 50-60°C at the bottom of the pile favours the activities of microorganisms. Additionally, it increases the water-holding capacity of the soil, thereby boosting plant growth and productivity. Vermicompost contains plant growth regulating materials, such as humic acid. Which are responsible for the increase in plant growth (Atiyeh *et al.,* 2). Cocopeat is also becoming a very popular material as a growing media. It has an excellent pore space (25-30%) and fine structure required for proper growth and development of seedlings.

Keeping these facts in mind and also to meet the local demand for quality planting material of Chironji, our aim in conducting this research work on the effect of growth regulators (GA_3) and chemicals (KNO_3, H_2SO_4 and Thiourea) and different growing media (Vermicompost, FYM, Cocopeat, and Perlite) on the germination and seedling growth of chironji. It is felt that the planting materials of chironji can be conserved and further increased by bringing more area under new plantations of Chironji.

MATERIALS AND METHODS

The experiment was conducted at Fruit Nursery, Department of Fruit Science, College of Horticulture, Banda University of Agriculture and Technology, Banda-210001 (U.P.) during the year 2022-23. The experimental design was CRD (Completely Randomized Design). The factor one experiment was conducted with nine treatments and four replications of chemical and physical treatments like, T_1 - GA_3 250 ppm for 24 hrs., T_2 - GA_3 500 ppm for 24 hrs., T_3 - GA_3 750 ppm for 24 hrs., T_4 - H_2SO_4 2.5% for 10 minutes, T_5 - H_2SO_4 5% for 10 minutes, T_6 - KNO_3 2.5% for 24 hrs., T_7 - KNO_3 5% for 24 hrs. (Fig. 1), T_8 -Thiourea 0.5% for 24 hrs., T_9 -Thiourea 1% for 24 hrs. and second factor T_1 - Soil + FYM (1:1), T_2 - Soil + Vermicompost (1:1), T_3 - Soil + Vermicompost + Cocopeat (1:1:1), T_4 - Soil + FYM + Cocopeat (1:1:1), T_5 - Soil + Cocopeat (1:1) and T_6 - Soil + perlite (1:2) (Fig. 2). Fresh seeds from fruits were collected from the village Chureh Kesarua, Manikpur, Uttar Pradesh. Healthy seeds of uniform size were selected for the experiment. The seeds were sown in 20 × 15 cm polythene bags, which were perforated to improve drainage. These bags were filled with a potting mixture prepared by combining one-part soil, one-part well-rotted FYM (Farmyard Manure), and one-part sand. All seeds were treated before sowing with different concentrations of plant growth regulators and chemical treatments, including GA_3 (Gibberellic Acid), H_2SO_4 (Sulfuric Acid), KNO_3 (Potassium Nitrate), and Thiourea. The observations regarding days taken to start seed germination, germination percentage, earliness index, vigour index- I and II,

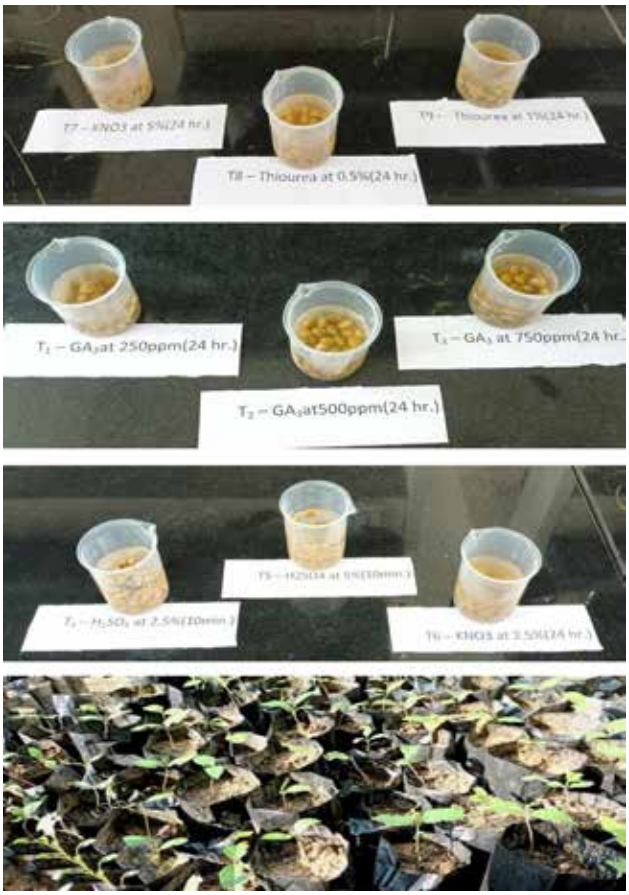
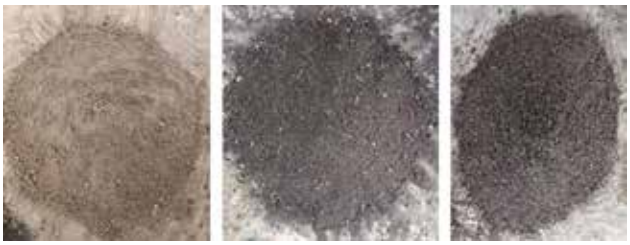


Fig. 1. Effect of plant growth regulators and chemicals on seed germination in chironji.



Soil FYM Vermicompost

Cocopeat Perlite

Nursey view

Fig. 2. Effect of different growing media on seed germination in chironji

Survival percentage, plant height, diameter of stem, number of leaves, leaf area, fresh & dry weight of shoot, number of secondary roots, fresh and dry weigh of roots taken at regular intervals.

Days taken to start seed germination: Seeds were sowing in the week of June and daily observations were made. The beginning and ending of germination for each treatment, as well as the number of days required to start seed germination in response to various plant growth regulators and thiourea, were noted and approximated in days since sowing.

Germination percentage: The number of germinated seeds were counted everyday over a period of 30 days. The final germination percentage for each replication was determined by dividing the total number of seeds that germinated in each treatment by the total number of seeds sown in a treatment.

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

Survival percentage : The number of seedlings alive from each replication was tallied and the mean was calculated, to get the final count of the seedling survival rate. The percentage was used to express it. The formula used to get the survival rate is as follows.

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

Earliness index: The earliness index was calculated by giving each observation made during the experiment a numerical value. For example, if 'n' observations were made, the first observation would be given a value of (n), the second would be given a value of (n-1), the third would be given a value of (n-2), and the fourth would be given a value of n-(n-1). Its total was computed by multiplying it by the number of seeds that sprouted at each observation. This sum was divided by the total number of observations and seeds that eventually germinated to get the earliness index (Bavappa *et al.,* 4).

$$\text{Earliness index} = \frac{n.x1 + (n-1).X2 + (n-2).X3 \ldots\ldots\ldots\ldots n - (n-1)\ n.x}{n.x}$$

Where, n = number of observations made till the completion of germination

X1. k = number of seeds germinated during respective observations

X = number of seeds germinated finally.

Vigour index-I: Vigour index-I was calculated by multiplying the mean seedling length with their corresponding germination percentage (Vasantha *et al.,* 19).

Vigour index-I = Germination % × Mean seedling height (cm)

Vigour index-II: Vigour index-II was calculated by multiplying the mean seedling dry weight with their corresponding germination percentage (Vasantha*et al.,* 19).

Vigour index- II = Germination % × Mean seedling dry weight (g).

The experimental data were statistically analyzed using the Panse and Sukhatme (15) approach and C.D. was be analyzing the results at the 5% level of significance. The method of analysis of variance for Completely Randomized Design was used. The treatment differences were tested by 'F' test of significance based on null hypothesis. The appropriate standard error (S.Em±) was calculated in each treatment and critical difference (CD) at 5 per cent level of probability was worked out to compare the treatment means, where the treatment effects were significant.

RESULTS AND DISCUSSION

The minimum number taken days to start seed germination 9.24 days, maximum germination percentage 59.38 (T_2, GA_3 500 ppm for 24 hours). The minimum days taken to seed, germination percentage and maximum survival percentage could be due to the increased seed germination percentage with

GA_3, the effects of GA_3 on proliferation or inhibitors of naturally occurring compounds such as auxins and gibberellins. may result from the hostile action of the results were compared with those of Chauhan *et al.* (6) for Chironji. Earliness index 0.603, vigour index-I 809.1, vigour index-II 244.99 and maximum survival percentage 60.25% with the seed treatment (T_2) GA_3 500 ppm for 24 hours. The maximum number of days taken for seed germination 13.71, minimum seed germination percentage 37.5, earliness 0.533, vigour index-I 350.44, vigour index-II and minimum survival percentage 31.74. Plant growth regulators and chemicals may have stimulated the enhanced growth. Similar results have been found by Vasantha *et al.* (19) in tamarind. The vegetative growth was pointedly improved by plant growth regulators and thiourea. The data was recorded at 60, 90 and 120 DAS. Seedling height was significantly higher (7.68, 9.21 and 12.78 cm), stem diameter (0.24, 0.31 and 0.37 cm) and number of leaves per plant (4.12, 6.13 and 10.46), the leaf area (cm^2), fresh weight of shoot (g) and dry weight of shoot (g) were recorded at 120 DAS (T_2 GA_3 500 ppm for 24 hours). The maximum plant height, stem diameter and number of leaves increased due to osmotic absorption of nutrients, which leads to cell growth and increase in seedling height and diameter, more rapid division of cells. The findings of the study broadly match those of Chauhan *et al.* (6) in Chironji, Vasantha *et al.* (19). Maximum leaf area was recorded (24.24 cm^2), highest fresh weight of shoot (6.09 g) and Maximum dry weight of shoot (2.64 g) with the treatment was found T_2 GA_3 500 ppm for 24 hours. Increasing leaf area, fresh weight and dry weight of shoot as a result of increased photosynthetic produce creation and their distribution to various plant parts, which is prompted by an increased rate of water and nutrient mobilization. These findings are also similar to Chauhan *et al.* (6), Mahadev *et al.* (12) in chironji. The major root length, fresh weight of root (g) and dry weight of root (g) was measured at 120 DAS and number of secondary roots was measured at 60 and 120 days after sowing. The nonsignificant effect highest root length of 21.16 cm, maximum number of secondary roots [1.38 (60 DAS) and 2.37 (120 DAS)] was observed, highest fresh weight of roots (3.65 g) and dry weight of roots (1.60 g) with recorded treatment T2 GA3 500 ppm for 24 hours (Table 1). GA3 increased auxin levels in the roots, resulting in longer main roots and denser secondary roots due to enhanced nutrient mobilization and absorption which increases vegetative growth. These findings are also similar Mahadev *et al.* (12) in chironji.

The minimum number of days taken for seed germination was recorded 10.66 days, maximum

Table 1: Effect of plant growth regulators and chemicals on different parameters.

Treatment	Number of days taken for seed germination	Germination %	Earliness index	Vigour index - I	Vigour index - II	Survival %	Plant height (cm)			Diameter of stem			Number of leaves			Leaf area (cm^2) 120 DAS	Fresh weight of shoot (g) 120 DAS	Dry weight of shoot (g) 120 DAS	Length primary roots (cm) 120 DAS	Number of secondary roots		Fresh weight of root (g) 120 DAS	Dry weight of root (g) 120 DAS
							60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS					60 DAS	120 DAS		
T1	10.88	50.63	0.575	620.2	209.88	48.22	6.68	8.13	12.16	0.21	0.28	0.34	3.32	5.04	8.28	20.81	5.36	2.58	19.19	0.81	1.66	3.46	1.49
T2	9.24	59.38	0.603	809.1	244.99	60.25	7.68	9.21	12.78	0.24	0.31	0.37	4.12	6.13	10.46	24.24	6.09	2.89	21.16	1.38	2.37	3.65	1.6
T3	9.76	54.38	0.593	697.81	214.88	51.73	6.98	8.98	12.38	0.22	0.29	0.35	2.81	4.97	8.9	21.28	5.54	2.67	19.25	1.15	1.36	3.53	1.45
T4	12.31	47.5	0.555	582.38	182.42	35.46	6.23	7.83	11.08	0.19	0.25	0.29	3.24	4.64	8.15	20.13	5.06	2.44	18.81	0.45	0.9	3.42	1.4
T5	9.63	56.25	0.585	705.79	229.65	56.24	7.61	9.18	12.75	0.23	0.3	0.36	3.79	5.2	9.51	22.28	5.83	2.7	20.29	1.27	1.77	3.61	1.51
T6	12.38	50	0.543	527.19	187.03	36.36	5.9	7.53	10.08	0.17	0.22	0.27	2.66	4.38	7.44	17.79	4.6	2.36	17.38	0.15	0.38	3.09	1.28
T7	11.5	51.88	0.563	561.61	197.27	42.18	6.03	7.6	10.2	0.18	0.23	0.28	3.05	4.79	8.29	18.49	5.14	2.52	17.93	0.56	1.09	3.4	1.36
T8	13.71	37.5	0.533	350.44	117.48	31.74	5.63	7.3	9.35	0.16	0.21	0.26	2.28	3.38	6.63	17.01	4.41	2.14	13.56	0.1	0.35	2.68	1.12
T9	13.41	41.88	0.555	411.09	147.83	35.1	5.98	7.45	9.75	0.17	0.22	0.27	2.75	3.68	7.33	17.46	4.54	2.3	14.78	0.31	0.85	2.82	1.23
SEm±	0.58	1.54	0.016	22.63	10.6	1.52	0.24	0.24	0.32	0.01	0.01	0.17	0.33	0.4	0.58	0.91	0.32	0.09	2.04	0.27	0.32	0.19	0.09
CD@5%	1.7	4.48	0.045	66.01	30.92	4.69	0.69	0.7	0.92	0.03	0.04	0.49	0.97	1.18	1.71	2.64	0.93	0.28	NS	0.38	0.95	0.27	0.14

Where: T_1 - GA_3 250 ppm, T_2 - GA_3 500 ppm, T_3 - GA_3 750ppm, T_4 - H_2SO_4 2.5%, T_5 - H_2SO_4 5%, T_6 - KNO_3 2.5%, T_7 - KNO_3 5%, T_8 -Thiourea 0.5%, T_9 -Thiourea 1%. DAS: Days after sowing

germination percentage 54.38%, earliness index 0.600%, seedling vigour index I 670.34, vigour index-II of 141.80 and maximum survival percentage 57.41 % were recorded in treatment [T_4 Soil + FYM + Cocopeat (1:1:1)]. According to Hartmann and Kester (9), soil provides natural support to plants, while materials like cocopeat, which retain moisture in heated conditions, and FYM (Farmyard Manure), an organic nutrient source, offer additional benefits during seedling germination. Well-decomposed FYM enhances soil moisture retention, boosts nutrient availability, and improves soil structure, thereby promoting water absorption, maintaining cell turgidity and elongation, and optimizing respiration, which contributes to successful seed sprouting. Organic matter also improves phosphorus absorption (Karama and Manwan, 10; Rajamanickam *et al.,* 16). Bisla *et al.* (5) noted that the decomposition of organic matter releases acids, and the resulting increased moisture, microbial activity, and acid generation aid in breaking down hard seed coats, leading to earlier germination in mango. The maximum plant height (7.93, 9.68 and 12.33 cm), maximum Stem diameter (0.27, 0.34 and 0.39 cm) and number of leaves (4.28, 6.19 and 9.74) respectively at all the stages of growth 60, 90 and 120 DAS, larger leaf area (24.10 cm^2), maximum fresh weight of seedling (5.54 g) and maximum dry weight of seedling (2.61 g) was found in treatment T_4 [Soil + FYM + Cocopeat (1:1:1)]. The combined application of soil, FYM, and cocopeat likely had a substantial effect on seedling height and diameter development. The advantages of using media mixtures over soil alone for seedling and root growth stem from their positive influence on water retention, porosity, aeration, and nutrient availability, particularly nitrogen and micronutrients. This effect is likely due to the synergistic improvement in the physical and nutritional properties of the media. The increased leaf production observed when these treatments are combined may result from enhanced nutrient availability, promoting leaf development for photosynthesis and improving seedling girth, Nitrogen from FYM and cocopeat, along with the increased fresh and dry weight of shoots, supports the plant's growth (Awasthi *et al.*, 3). Similar findings were reported by Vasanth *et al.* (19) in tamarind. The highest length of tap root (19.16 cm) at 120 DAS, highest number of secondary roots (1.57 and 2.51) of seedlings at observed 60 and 120 DAS, highest fresh weight of roots (3.78 g) and maximum dry weight of roots (1.59 g) was recorded in treatment T_4 [Soil + FYM + Cocopeat (1:1:1)] (Table 2). According to Hartmann and Kester (9), factors like improved soil structure, porosity, water-holding capacity, the activity of beneficial soil microorganisms, overall

Table 2: Effect of different growing media on growth parameters.

Treatment	Number of days taken for seed germination	Germination %	Earliness index	Vigour index-I	Vigour index-II	Survival %	Plant height (cm)			Diameter of stem (cm)			Number of leaves			Leaf area (cm^2) 120 DAS	Fresh weight of shoot (g) 120 DAS	Dry weight of shoot (g) 120 DAS	Length of primary roots (cm) 120 DAS	Number of secondary roots		Fresh weight of roots (g) 120 DAS	Dry weight of roots (g) 120 DAS
							60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS					60 DAS	120 DAS		
T_1	12.8	50	0.568	575.47	126.72	49.75	7.3	8.49	11.49	0.23	0.28	0.32	2.43	3.72	7.82	21.08	4.8	2.51	16.31	0.81	1.31	3.34	1.26
T_2	12.51	47.5	0.578	556.18	114.43	47.75	7.26	8.3	11.68	0.21	0.27	0.31	3.32	4.64	8.15	21.22	5.24	2.4	15.64	0.59	1.09	3.48	1.24
T_3	12.08	52.5	0.593	641.06	134.69	55.9	7.65	9.47	12.2	0.25	0.31	0.36	3.84	5.5	8.64	23.05	5.39	2.56	18.66	1.26	2.06	3.56	1.54
T_4	10.66	54.38	0.6	670.34	141.8	57.41	7.93	9.68	12.33	0.27	0.34	0.39	4.28	6.19	9.74	24.1	5.54	2.61	19.16	1.57	2.51	3.78	1.59
T_5	11.2	45	0.56	504.69	106.09	53.13	6.68	8.14	11.19	0.2	0.26	0.29	2.81	4.18	7.91	20.26	4.52	2.35	15.57	1.01	2.29	3.55	1.5
T_6	13.27	49.38	0.543	542.34	107.46	48.5	6.16	7.76	10.95	0.18	0.23	0.27	2.33	3.46	7.31	18.28	4.26	2.17	14.5	0.56	0.9	2.75	1.13
SEm±	0.47	1.79	0.011	26.58	5.72	0.75	0.18	0.35	0.2	0.01	0.02	0.01	0.25	0.26	0.49	0.42	0.26	0.07	0.8	0.18	0.21	0.09	0.06
CD@5%	1.41	5.39	0.032	80.13	17.24	2.27	0.53	1.06	0.6	0.03	0.05	0.03	0.75	0.79	1.48	1.26	0.77	0.21	2.41	0.54	0.62	0.26	0.18

Whereas, T_1 - Soil + FYM (1:1), T_2 - Soil + Vermicompost (1:1), T_3 - Soil + Vermicompost + Cocopeat (1:1:1), T_4 - Soil + FYM + Cocopeat (1:1:1), T_5 - Soil + Cocopeat (1:1) and T_6 - Soil + perlite (1:2)

soil health, nutrient availability, and soil temperature can significantly enhance root development, root length, and the fresh and dry weight of roots. These findings align with the results of studies by Kumawat *et al.* (11) and Yadav *et al.* (20) in acid lime. This study demonstrated that GA_3 500 ppm seeds dipped for 24 hours' treatment significantly improved seed germination percentage, seedling vigour, and overall growth parameters of chironji. It results in the shortest germination time, highest germination percentage, and superior vegetative and root growth attributes. Additionally, the mixed media T_4 (soil, FYM, cocopeat in a 1:1:1 ratio) also contributed to enhanced germination and seedling growth. Both types treatments showed effective in improving seedling establishment and growth, indicating their potential use for optimizing chironji propagation in nursery conditions.

AUTHORS CONTRIBUTION

Conceptualization of research (OP, DKG), designing of the experiments (OP, AKS), contribution of experiment materials (OP, SK), execution of lab experiments (OP, SCS), analysis of data interpretation (OP, PP) and preparation of manuscript (OP, DKG).

DECLARATION

The authors confirm that no conflicts of interest are associated with this work.

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