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Evaluation of seed germination behaviour and growth performance of *Kutaja* (*Holarrhena antidysenterica*) from different seed sources of Chhattisgarh

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Abstract
The present study was conducted during 2024-25 to evaluated the germination behaviour and seedlings growth performance of *Kutaja* (*Holarrhena antidysenterica*). Seeds were collected from three districts of Chhattisgarh: T_1 (Mohla-Manpur), T_2 (Kanker), and T_3 (Dantewada). Among the potting mixtures tested, MT_1 (Soil + Vermicompost + FYM in 2:1:1 proportion) recorded the highest germination percentage (81.15%), whereas the lowest (49.49%) was observed in the control (DT_4). Seedling growth parameters also showed superior performance in MT_1, which produced the maximum seedling height (22.41 cm), collar diameter (3.70 mm), number of leaves (19.25), root length (20.02 cm), fresh and dry shoot weights (16.03 g and 3.178 g), fresh and dry root weights (5.2 g and 0.175 g), and the highest seedling vigour index (1818.7). Overall, Soil + Vermicompost + FYM (2:1:1) proved to be the most effective potting mixture across all seed sources. The combination of the T_1 (Mohla-Manpur) seed source with the MT_1 potting mixture resulted in the best germination and seedling growth, therefore this combination is recommended for nursery raising and plantation programmes aimed at the conservation and sustainable utilization of this valuable medicinal tree species in Chhattisgarh.

Keywords: *Holarrhena antidysenterica*, *Kutaja*, germination behavior, seedling growth, potting mixtures and seed source

Introduction
Kutaja (*Holarrhena antidysenterica* L.), belonging to the family Apocynaceae, is a well-known traditional medicinal plant of India. It is commonly referred to as *Kura* or *Kurchi* in Hindi, *Kutaja* and *Inderjo tulkh* in Sanskrit, and *Conessi bark* or *Bitter oleander* in English. Herbal remedies have long played a vital role in global healthcare systems, and modern pharmacology increasingly incorporates bioactive compounds derived from plants, integrating indigenous knowledge with contemporary medicine (Prajapati *et al.*, 2019) [14].
India possesses a rich heritage of traditional medical systems such as Ayurveda, Siddha, and Unani, which are based on the ancient concept of the three *doshas kapha*, *pitta*, and *vata*. Early medical texts, including the Chinese *Pen Tsao* and the Egyptian *Ebers Papyrus*, highlight humanity's long-standing dependence on medicinal plants for healing and wellness (Hamilton *et al*., 2004) [7]. Historically, *Holarrhena antidysenterica* has also been recognized in the *British Materia Medica* for its therapeutic applications, particularly of its bark and seeds.
Holarrhena antidysenterica is native to tropical and subtropical regions of Asia and Africa and is commonly distributed across India, particularly along the Himalayan foothills at elevations of 900-1250 m. It occurs in tropical deciduous forests from Assam and Uttar Pradesh to Kerala and Tamil Nadu (Mahato *et al*., 2013) [9]. The plant is an evergreen, lactiferous, woody shrub or small tree characterized by rough, greyish-brown bark and a pale, smooth stem. Its simple, oblong to elliptical leaves (10-20 cm long) are obtusely acuminate. The small, white flowers are borne in terminal corymbose cymes (7.5-15 cm in diameter), with a corolla tube of 4-13 cm in length, nearly equal to the lobes (Shwetha *et al*., 2014; Rahman *et al*., 2015) [17, 15].
Given its wide ecological distribution and diverse pharmacological potential, studying the seed and morphological variability among different provenances of *Holarrhena*

antidysenterica is essential for identifying superior genotypes. Such information is critical for effective propagation, conservation, and the development of value-added pharmaceutical products. In India, *Holarrhena antidysenterica* holds deep traditional and folkloric significance. Its leaves are ceremonially offered during Odisha's Nabanna festival, while in the Varanasi and Mirzapur districts of Uttar Pradesh, the bark is traditionally used to treat stomach ailments. These practices highlight the plant's enduring role in indigenous healthcare and its potential value for modern pharmacological research (Garje *et al*., 2024) [5].

Materials and Methods

The present study was conducted during 2024-25 to evaluate the germination behaviour and seedling growth performance in *Kutaja* (*Holarrhena antidysenterica*). Seed materials were collected from three districts of Chhattisgarh, designated as T_1 (Mohla-Manpur), T_2 (Kanker), and T_3 (Dantewada).

Seed treatment

Seeds were randomly selected from seed sample collected from three district of Chhattisgarh and pre-sowing seed treatments were adopted in which seeds were soaked in water for 24 hours then seed were removed Immediately and sowing war done just after.

Treatment details of potting mixture

Treatment	Potting mixture	Ratio used
T_1	Soil+FYM+Vermicompost	2:1:1
T_2	Soil + Vermicompost	2:2
T_3	Soil + FYM	2:2
T_4	Soil (control)	

Results and Discussion

1. To assess the seed germination behavior in Kutaja from different seed source of Chhattisgarh.

Seed source significantly influenced germination, with T_1 (Mohla-Manpur) showing the highest rate (71.61%). Potting mixtures also had a significant effect, and MT_1 (Soil + Vermicompost + FYM) recorded the highest germination (78.36%). The interaction between seed sources and potting mixtures was non-significant; however, the highest germination (81.15%) occurred in the MT_1 combination, while the lowest (49.49%) was observed in the control (DT_4). The research findings in the present investigation are similar with Ghising *et al.* (2022) [4], who reported potting media in *Tectona grandis* seeds based on location. Similar conclusions were separated by Panchal *et al*. (2014) [13] and Kumar *et al.* (2016) [8].

2. To study the seedling growth of Kutaja collected from different seed source of Chhattisgarh

Seedling height

Seedling height differed significantly among seed sources, with T_1 (Mohla-Manpur) producing the tallest seedlings at all stages, followed by T_2 (Kanker), while T_3 (Dantewada) recorded the lowest heights. Potting mixtures also showed a significant effect, and MT_1 (Soil + Vermicompost + FYM) consistently produced the maximum height, whereas the control (MT_4) showed the minimum. The interaction effect was non-significant; however, the highest height (22.41 cm) occurred in MT_1, and the lowest (12.19 cm) in DT_4. Similarly, Negi and Sharma (2023) [11] observed that the application of vermicompost in suitable proportions significantly enhances seedling growth and overall quality attributes in *Juniperus polycarpos*, as evidenced by improvements in seedling height, collar diameter, biomass accumulation, and vigour indices.

Collar diameter

Collar diameter varied significantly among seed sources, with T_1 (Mohla-Manpur) recording the highest values at all stages, followed by T_2 (Kanker), while T_3 (Dantewada) remained lowest. Potting mixtures also showed significant effects, and MT_1 (Soil + Vermicompost + FYM) consistently produced the maximum collar diameter, whereas the control (MT_4) recorded the minimum. The interaction was significant, with MT_1 showing the highest collar diameter (3.70 mm) and MT_4 the lowest (2.24 mm). The superior performance of T_1 (Mohla-Manpur) and the MT_1 potting mixture can be attributed to their favourable genetic traits and enhanced nutrient availability. Genetically superior seed sources naturally exhibit stronger growth potential, while the balanced nutrient composition of Soil + Vermicompost + FYM improves root development, metabolic activity, and overall seedling vigour resulting in greater collar diameter and overall seedling quality. The research findings in the present investigation are similar with Nagesh *et al*. (2007) [10] observed significant variation in *Tectona grandis* seedlings across seed sources, influenced by genetic and environmental factors. Superior sources showed better growth and biomass, while balanced shoot-root ratios contributed to higher seedling quality and survival Deshmukh *et al*. (2019) [2] also noted that collar diameter is an important indicator of seedling robustness, which varies significantly among provenances due to differences in seed source and environmental conditions.

Number of leaves

Different seed sources significantly influenced leaf number, with T_1 (Mohla-Manpur) consistently highest across all stages and showing the maximum overall mean (17.02). Potting mixtures also showed significant effects, where T_1 (Soil + Vermicompost + FYM) recorded the highest leaf numbers throughout, with the greatest mean (17.91). The interaction effect was non-significant, though MT_1 produced the maximum leaves (19.25) and DT_4 the minimum (10.00).The research findings in the present investigation are similar to those of Negi and Sharma (2023) [11] in *Juniperus polycarpos*, where vermicompost application led to a significant increase in the number of leaves and overall seedling performance.

Number of branches

Different seed sources significantly influenced branch number, with T_1 (Mohla-Manpur) highest at all stages and showing the maximum mean (9.64). Potting mixtures also had a significant effect; T_1 (Soil + Vermicompost + FYM) consistently produced the most branches and recorded the highest mean (11.17), while T_4 (Control) was lowest. The interaction was non-significant, though MT_1 showed the maximum branches (23.25) and DT_4 the minimum (11.05). The research findings in the present investigation are in agreement with Okunlola and Adegeye (2023) [12] observed that organic media combinations significantly increased branching and vegetative growth in *Acacia* seedlings,

highlighting the positive impact of nutrient-rich organic substrates on shoot and branch development

Root length

Seed sources significantly affected root length, with T_1 (Mohla-Manpur) recording the maximum (21.44 cm), followed by T_2 and T_3. Potting mixtures also showed significant effects; T_1 (Soil + Vermicompost + FYM) produced the longest roots (22.33 cm), while T_4 (Control) was lowest. The interaction was significant, with MT_1 showing the maximum root length (28.06 cm) and DT_4 the minimum (12.10 cm). The superior root length in T_1 seed source and MT_1 potting mixture is mainly due to the genetic vigour of the Mohla-Manpur seeds combined with the improved soil structure, aeration, and nutrient availability provided by vermicompost and FYM. These organic amendments enhance root penetration, nutrient uptake, and microbial activity resulting in significantly longer and healthier root systems. Similar findings were reported by Hossain (1995) [6], who observed that *Dalbergia sissoo* seedlings grown in cow dung-soil mixtures showed greater root diameter, higher nodule counts per root, and increased oven-dry root weight compared to control and fertilizer treatments, highlighting the positive impact of organic amendments on root development.

Fresh shoot weight

Seed sources significantly influenced shoot fresh weight, with T_1 (Mohla-Manpur) highest (3.85 g), followed by T_2 and T_3. Potting mixtures also showed significant effects; T_1 (Soil + Vermicompost + FYM) produced the maximum fresh shoot weight (13.70 g), while T_4 (Control) was lowest. The interaction was significant, with MT_1 recording the highest value (16.03 g) and DT_4 the minimum (7.97 g). The present investigation are similar with Ghising *et al.* (2022) [4], Choudhary *et al.* (2021) [1], and Venkatesh *et al.* (2009) [19] emphasize that seed quality, media composition, and nutrient enrichment significantly influence seedling growth, root-to-shoot ratio, and biomass production in forest and medicinal trees

Dry shoot weight

Seed sources significantly affected shoot dry weight, with T_1 (Mohla-Manpur) recording the maximum (2.92 g), followed by T_2 and T_3. Potting mixtures also showed significant influence; T_1 (Soil + Vermicompost + FYM) produced the highest dry shoot weight (2.97 g), while T_4 (Control) was lowest. The interaction effect was significant, with MT_1 showing the maximum dry weight (3.178 g) and minimum (1.64 g) was found in DT_4 The superior shoot dry weight in T_1 and MT_1 is attributed to the genetically vigorous seed source (Mohla-Manpur) and the nutrient-rich combination of Soil + Vermicompost + FYM, which enhances nutrient uptake, photosynthetic efficiency, and biomass accumulation resulting in significantly higher shoot dry matter.

Fresh root weight

Seed sources significantly influenced root fresh weight, with T_1 (Mohla-Manpur) showing the highest value (3.85 g), followed by T_2 and T_3. Potting mixtures also had a significant effect; T_1 (Soil + Vermicompost + FYM) recorded the maximum fresh root weight (4.53 g), while T_4 (Control) was lowest. The interaction was non-significant, though MT_1 showed the highest fresh root weight (5.20 g) and DT_4 the minimum (1.60 g). The research findings in the present investigation are similar with Sharma *et al.* (2019) [14], Singh and Yadav (2021) [18], and Kumar & Venkatesh *et al.* (2009) [19] highlight that media composition, organic amendments, and seed size play key roles in enhancing root growth, biomass, and overall seedling performance

Dry root weight

Seed sources significantly affected dry root weight, with T_1 (Mohla-Manpur) recording the highest value (0.148 g), followed by T_2 and T_3. Potting mixtures also showed significant influence; T_1 (Soil + Vermicompost + FYM) produced the maximum dry root weight (0.143 g), while T_4 (Control) was lowest. The interaction was significant, with MT_1 showing the highest dry root weight (0.175 g) and DT_4 the minimum (0.104 g). The research findings in the present investigation are similar with Sajana *et al.*, Venkatesh *et al.* (2009) [19], Choudhary *et al.* (2021) [1], and Deshmukh *et al.* (2019) [2] highlight that media, seed size, and seed source strongly affect seedling growth, biomass, and root development.

Seedling vigour index

Seed sources and potting mixtures showed a significant effect on the seedling vigour index. MT_1 (Soil + Vermicompost + FYM) recorded the highest vigour index (1818.7), followed by MT_2 and KT_1, while the lowest value was observed in DT_4 (Control) (603.3). MT_1 (Soil + Vermicompost + FYM) recorded the highest seedling vigour index because the combination of organic amendments improves soil fertility, nutrient availability, and microbial activity, leading to enhanced germination, stronger root-shoot growth, and overall better physiological performance. In contrast, the control lacked these benefits, resulting in the lowest vigour index.

Table 1: Germination behaviour and growth performance of kutaja seedlings

Area	Germination %	Seedling height (cm)	Collar diameter (mm)	Number of leaves	Root length (cm)	Fresh shoot weight (g)	Dry shoot weight (g)	Fresh root weight (g)	Dry root weight (g)
T_1 Mohla-Manpur-Ambagarh Chowki	71.616	19.353	3.164	17.028	21.449	13.211	2.923	3.85	0.148
T_2 Kanker	69.204	17.917	2.41	14	17.909	11.094	2.56	3.2	0.121
T_3 Dantewada	64.781	16.201	2.124	12.938	16.707	9.225	2.155	2.75	0.111
CD@0.05%	1.205	1.035	0.217	1.217	0.742	0.611	0.049	0.514	0.005
SE(d)	0.596	0.506	0.106	0.595	0.367	0.302	0.024	0.254	0.003
Sem±	0.421	0.358	0.075	0.421	0.259	0.214	0.017	0.18	0.002

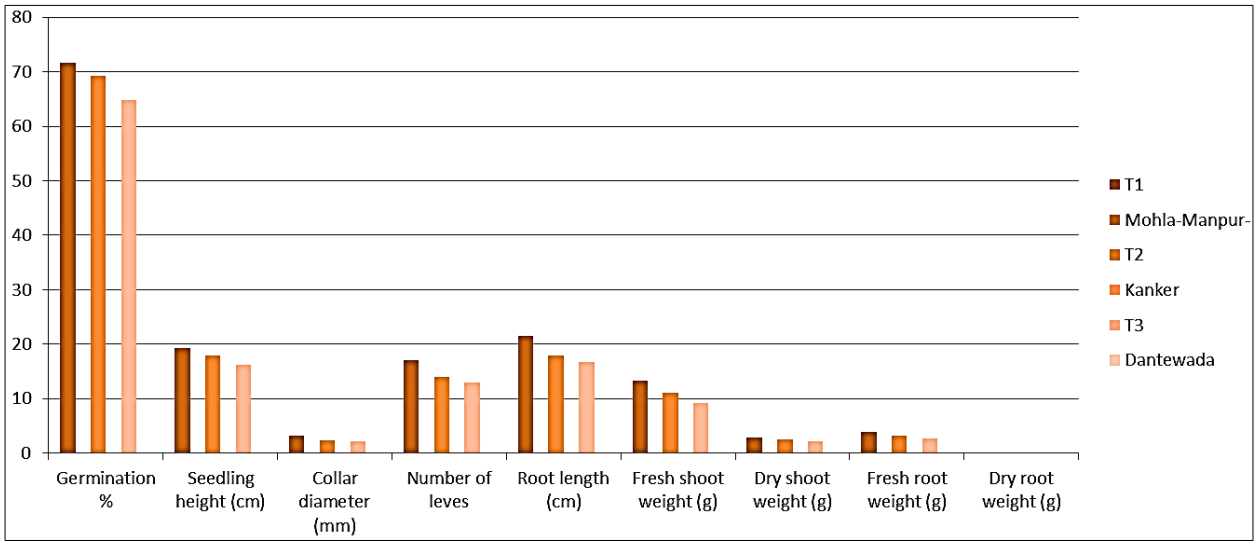

Fig 1: Effect of potting mixture on growth performance of kutaja seedlings

Table 1: Effect of different potting mixtures on germination and seedling growth parameters.

Potting mixture	Germination %	Seedling height (cm)	Collar diameter (mm)	Number of leaves	Root length (cm)	Fresh shoot weight (g)	Dry shoot weight (g)	Fresh root weight (g)	Dry root weight (g)
T_1	78.362	20.615	3.081	17.917	25.339	13.7	2.977	4.533	0.143
T_2	73.535	18.998	2.703	15.583	18.587	11.464	2.822	3.667	0.132
T_3	68.651	17.814	2.428	13.528	16.332	10.493	2.381	3.067	0.121
T_4	53.586	13.868	2.039	11.593	14.494	9.049	2.003	1.8	0.11
CD@0.05%.	1.391	1.195	0.251	1.405	0.856	0.705	0.056	0.593	0.006
SE(d)	0.688	0.585	0.123	0.687	0.423	0.349	0.028	0.293	0.003
Sem±	0.486	0.413	0.087	0.486	0.299	0.247	0.02	0.207	0.002

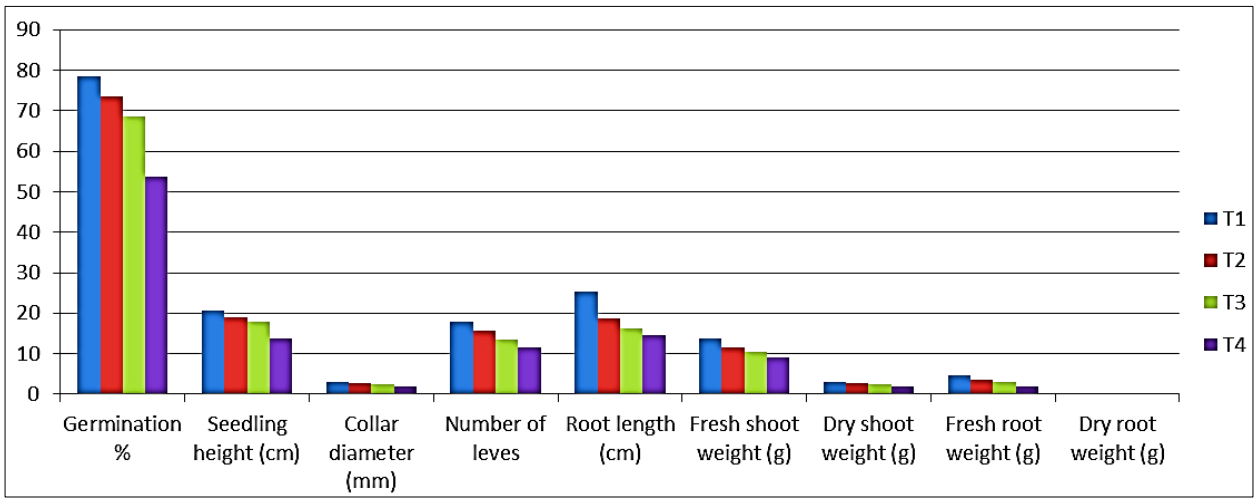

Fig 2: Effect of seed source and potting mixture interaction on growth performance of kutaja seedlings.

Table 2: Interaction effect of media and potting mixtures on germination and seedling growth parameters.

interaction	Germination %	Seedling height (cm)	Collar diameter (mm)	Number of leaves	Root length (cm)	Fresh shoot weight (g)	Dry shoot weight (g)	Fresh root weight (g)	Dry root weight (g)
$M1T_1$	81.158	22.41	3.703	19.25	28.026	16.034	3.178	5.2	0.175
$M1T_2$	76.974	20.38	3.485	18	19.964	14.22	3.092	4.4	0.156
$M1T_3$	71.192	19.053	3.22	16.583	19.976	12.278	3.02	3.6	0.137
$M1T_4$	57.138	15.57	2.248	14.28	17.828	10.312	2.4	2.2	0.122
$K1T_1$	78.348	20.693	3.058	18.25	24.646	13.712	3.092	4.6	0.137
$K1T_2$	74.314	19.06	2.48	14.5	17.968	10.758	2.966	3.6	0.124
$K1T_3$	70.028	18.073	2.125	12.75	15.474	11.042	2.216	3	0.117
$K1T_4$	54.124	13.843	1.938	10.5	13.546	8.862	1.966	1.6	0.103
$D1T_1$	75.58	18.743	2.483	16.25	23.346	11.354	2.662	3.8	0.117
$D1T_2$	69.316	17.555	2.143	14.25	17.828	9.414	2.408	3	0.117
$D1T_3$	64.732	16.318	1.94	11.25	13.546	8.16	1.906	2.6	0.108
$D1T_4$	49.496	12.19	1.933	10	12.108	7.972	1.644	1.6	0.104
CD@0.05%	NS	NS	0.435	NS	1.483	1.222	0.098	NS	0.011
SE(d)	1.191	1.013	0.213	1.191	0.733	0.604	0.048	0.508	0.005
Sem±	0.842	0.716	0.15	0.842	0.519	0.427	0.034	0.359	0.004

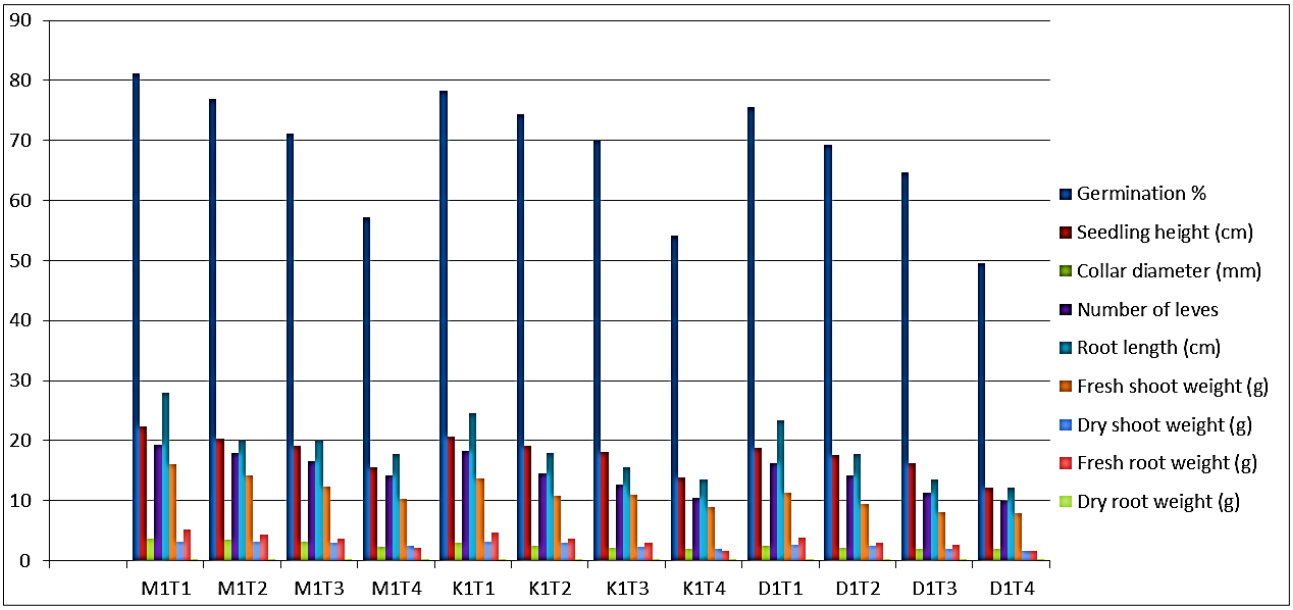

Fig 3: Interaction between seed sources and potting mixtures on the all parameters of *Holarrhena antidysenterica*

Fig 4: D_1T_4, K_1T_4, M_1T_4 D_1T_3, K_1T_3, M_1T_3 D_1T_2, K_1T_2, M_1T_2 D_1T_1, K_1T_1, M_1T_1

Where - D= Dantewada, K= Kanker, M= Manpur-Mohla-Ambagarh

Conclusion

The study demonstrated that both seed source and potting mixture significantly affect germination and seedling growth of *Kutaja* (*Holarrhena antidysenterica*). The Mohla-Manpur seed source (T_1) showed consistently superior germination and seedling performance, indicating strong genetic potential. Among the potting mixtures, MT_1 (Soil + Vermicompost + FYM) proved most effective, recording the highest germination, growth parameters, and vigour index due to its enriched nutrient status. Although most interactions were non-significant, the $T_1 \times MT_1$ combination produced the best overall results. The study recommends that the Mohla-Manpur seed source with MT_1 potting mixture is best for high-quality nursery production and large-scale planting programmes in Chhattisgarh.

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