Plant Archives Vol. 25, Supplement 2, 2025 pp. 502-514 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

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

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.060

EFFECT OF GROWING MEDIA AND LIGHT INTENSITY ON GERMINATION AND GROWTH OF *PROSOPIS CINERARIA* (L.) DRUCE SEEDLINGS

Suruchi Kumari[1*], S.B.S. Pandey[1], Prahlad V.C.[1], Kanica Upadhyay[2] and Rahul Chopra[3]

[1]Department of Silviculture and Agroforestry, College of Horticulture and Forestry, Jhalawar, Rajasthan, India-326023

[2]Department of Forest Products and Utilization, College of Horticulture and Forestry, Jhalawar, Rajasthan, India-326023

[3]Department of Natural Resource and Management, College of Horticulture and Forestry, Jhalawar, Rajasthan, India-326023

*Corresponding author E-mail: suruchi13sep@gmail.com

(Date of Receiving : 01-03-2025; Date of Acceptance : 10-05-2025)

ABSTRACT

A current research work titled "Effect of growing media and light intensity on germination and growth of (*Prosopis cineraria* (L.) Druce) seedlings" was conducted from July 2023 to March 2024 at the College of Horticulture and Forestry, Jhalawar, Rajasthan. The study laid out in a completely randomized design (factorial) to evaluate the effects of 15 different compositions of growing media (soil, sand, vermicompost) and light intensity (100% or open condition, ~50%, ~25%) on germination and seedling growth of *P. cineraria*. The treatment P_{13}[Soil: Sand: Vermicompost (1:2:2)] exhibited the earliest seed emergence, short germination span, and highest overall germination percentage and recorded maximum height, taproot diameter, biomass accumulation and survival %. The length of the tap root was maximum in P_{11} [Soil: Sand: Vermicompost (1:2:1)]. The media of Soil: Sand: Vermicompost in the ratio of 1: 1: 2 (P_9) excelled in collar diameter, root-shoot ratio and chlorophyll content. In various light intensities, ~50% light intensity (L_1) optimized germination, and seedling quality (shoot growth, taproot diameter, survival, biomass), while open conditions (L_0) maximized root development (length, root: shoot ratio, seedling quality). Among the interactions, L_1P_{13} recorded significant seedling height, biomass accumulation and L_1P_9 obtained maximum collar diameter. A strong correlation was found between total dry weight and seedling quality (r = 0.964). The results of the study elucidate the morphological responses of species during early developmental stages under nutrient and light stress conditions, thereby informing optimized nursery practices aimed at accelerating seedling production with minimized resource input.

***Keywords*:** Growing media, Light intensity, *Prosopis cineraria,* Germination, Seedlings

Introduction

In the arid zone areas of Rajasthan, Punjab, and Haryana, poor soil nutrients, a dearth of water, and frequent droughts are major constraints. In such areas, introducing woody perennials like Prosopis cineraria on farmland, wastelands or degraded ravine lands could offer a great advantage by providing food, fuel and fodder and conserving natural resources. It is a deeply-rooted, N_2-fixing, multipurpose tree native to the hot deserts of the country. The tree is recognised by various local names such as Khejri, Sangari and Shami in India and Ghaf in Arabic. In the northwest part of the Indian subcontinent, it plays an integral part in the rural economy. The genus *Prosopis* belongs to subfamily Mimosaceae of the family Leguminosae. In parts of its natural distribution, the climate is characterised by extreme temperatures, dry to arid conditions and a wide range of annual rainfall, from 100 to 600 millimetres with a prolonged dry season (Khatri *et al.*, 2010). It is tolerant of dry, arid conditions and resistant to drought hence described as an aridity-loving tree. It grows well in a variety of soils but cannot stand in pure sands and extremely saline soils. However, it can withstand higher alkalinity and is also found in black cotton soils.

A small to moderate-sized evergreen thorny tree of *Prosopis cineraria* has light bluish-green foliage and thin branches adorned with conical thorns. The *P. cineraria* is a common species in tropical dry deciduous forests of India and is nearly evergreen as it never remains leafless. Before summer, it produces a fresh flush of leaves however, the young plants shed all their leaves in both hot weather and cold seasons. The flowering occurs in February and continues up to April. The pods ripen in April- May. The plants initiate flowering at the age of four years and coppice shoots of 5-10 years old start yielding fertile seeds.

Due to its deep penetrating nature of the tap root makes it highly tolerant to drought. But the young seedlings are somewhat sensitive to drought and frost. It coppices well up to a moderate age and also sustains pollarding even after heavy browsing. Due to heavy mortality in dry conditions, its natural regeneration is scanty. The seedlings require repeatedly pruning for the straight growth of the stem. The growth is slow in the initial few years but fairly rapid up to an age of 40-50 years.

P. cineraria is a highly valuable tree for agroforestry systems and most commonly grown tree in the arid region of India. Owing to its deep root development makes it a suitable species for agroforestry systems as it avoids competition with annual crops. The leaves and fruits provide fodder and food of high value respectively. According to Singh *et al.* (2007), the trees of *P. cineraria* on agricultural land enhance the productivity of annual crops grown in its vicinity at optimum density The ecological, social, and economic advancement of the population has been greatly supported by the Khejri-based agroforestry systems, as the species has not only increased the green cover but also given the people security for a better life without causing degradation of the land or other natural resources (Kaushik *et al.*, 2020). Aiding to it, the tree has also secured a sacred place in the Bishnoi community of Rajasthan. It is protected and grown for religious purpose by the community.

To introduce the species in farmlands whether for agroforestry purpose or plantation, quality seedlings play a key role. Factors like light requirement of species in nursery stage, potting media plays a key role. Therefore, the present study has been conducted to analyse the light and media requirement for germination and seedling growth of *Prosopis cineraria* under various light conditions and organic media constituting soil, sand and vermicompost in different proportions.

Material and Methods

Study site and experimental design

The study was carried out at a nursery block in the College of Horticulture and Forestry, Jhalrapatan, in the Jhalawar district at 24°53’ N-Latitude and 76°14’ E-Longitude in the South-Eastern region of Rajasthan from July 2023 to March 2024. The site falls in the agroclimatic zone V, Humid South Eastern Plain, characterized by a sub-tropical and sub-humid climate with hot summer and moderate winter. The experiment was carried out using Completely Randomized Design (Factorial) comprising two factors, light condition and growing media. The light factor consists three levels of different light conditions i.e., open condition or 100% light intensity (Control), ~50% light intensity and ~25% light intensity was maintained with treatment notations L_0, L_1 and L_2 respectively. The growing media comprised of soil, sand and vermicompost constitutes 15 treatments, i.e., P_0 (Soil), P_1 [Soil: Sand (1:1)], P_2 [Soil: Vermicompost (1:1)], P_3 [Soil: Sand(1:2)], P_4 [Soil: Vermicompost (1:2)], P_5 [Sand: Vermicompost (1:1)], P_6 [Sand: Vermicompost (2:1)], P_7 [Sand: Vermicompost (1:2)], P_8 [Soil: Sand: Vermicompost (1:1:1)], P_9 [Soil: Sand: Vermicompost (1:1:2)], P_{10} [Soil: Sand: Vermicompost (2:1:1)], P_{11} [Soil: Sand: FYM (1:2:1)], P_{12} [Soil: Sand: FYM (2:1:2)], P_{13} [Soil: Sand: FYM (1:2:2)] and P_{14} [Soil: Sand: FYM (2:2:1)]. Thus, a total of 45 treatment combinations formed and each combination were replicated thrice. Twenty polybags were used in each replication. The treatment differences were analysed using an 'F' test of significance based on the null hypothesis. In each case, the appropriate standard error (S. Em ±) was calculated, and the critical difference (C.D.) at a 5% significance level was determined to compare the treatments when the treatment effects were significant.

Observation parameters

To monitor the light intensity in three different light conditions, light intensity was measured by a digital luxmeter at 8:00, 13:00 and 16:00 hours throughout the study period at fortnight interval. The data regarding germination attributes *i.e.*, number of days taken for germination, days required for 50% germination, span of germination, germination percentage and peak period of germination was recorded by constant monitoring the number of seeds emerged on daily basis. Shoot parameters, such as seedling height and collar diameter, were recorded by randomly selecting six seedlings from each treatment combinations at an interval of 30 days up to 240 DAS. Root growth measurements (length and diameter of tap root) and total fresh and dry biomass and root shoot ratio was recorded at the end of study period from three seedlings out of six randomly selected seedlings. Survival percentage of the seedling was calculated by number of seedlings survived at the end of study period upon number of total seedlings germinated. The chlorophyll a, chlorophyll b and total chlorophyll content in the leaves was determined by following the method given by Sadasivam and Manickam (1997). The quality of seedlings was assessed by Dixon Quality Index (DQI) calculated by using the following formula (Dickson *et al.*, 1960):

$$\text{Dickson Quality Index} = \frac{\text{Dry weight of seedlings (g)}}{\frac{\text{Seedling height (cm)}}{\text{Collar diameter (mm)}} + \frac{\text{Dry weight of shoot (g)}}{\text{Dry weight of root (g)}}}$$

Results and Discussion

Light intensity (k Lux)

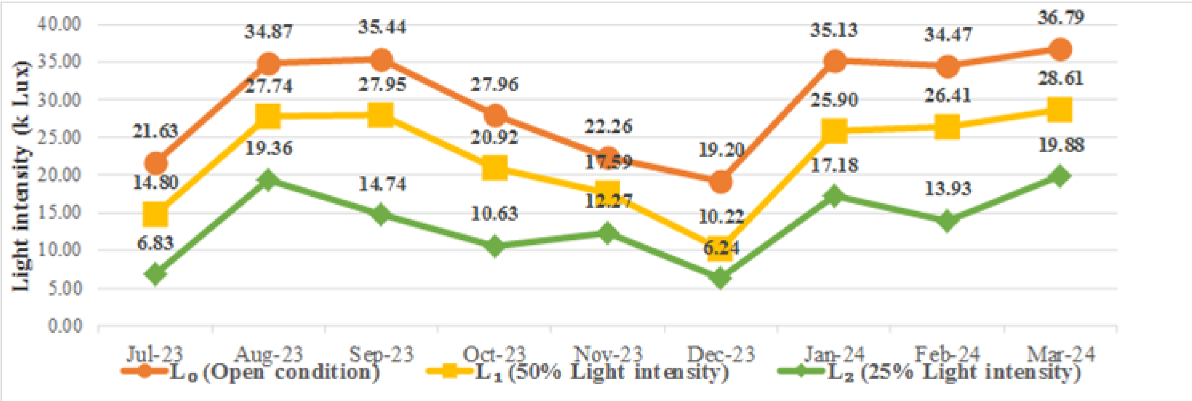

Fig. 1 : Light intensity (k Lux) measurement in different light conditions.

The recorded data revealed that the expressed value of light intensity (in k Lux) in different growing conditions viz., L_0 (open condition), L_1 (50% light intensity) and L_2 (25% light intensity) remained significantly distinct from each other from July 2023 to March 2024. In comparison to full sunlight or an open environment (L_0), the shade net house with around 50% light (L_1) inhibited 20 to 47% of the light intensity. In contrast to the open condition (L_0), a light reduction of 44 to 68% was seen in the shade net house with around 25% light intensity (L_2). However, light intensity remains non-significant among various growing media factors and the interactions among light conditions and growing media. Figure 1 presents a graphic summary of the variations in light intensity measurements across the various light situations.

Effect of growing media (P)

Germination attributes

The data presented in the Table 1 revealed that among the different growing media treatments, P_6 [Sand: Vermicompost (2:1)], P_{11} [Soil: Sand: Vermicompost (1:2:1)] and P_{13} [Soil: Sand: Vermicompost (1:2:2)] exhibited the lowest time for germination, averaging 2.78 days. P_{13} [Soil: Sand: Vermicompost (1:2:2)] exhibited a significantly shorter span for 50% germination with 6.89 days, statistically at the same bar as P_6, P_{11} and P_{14}. The minimum days taken for completion of germination was recorded in P_{13} [Soil: Sand: Vermicompost (1:2:2)] (17.22 days), remained at par with P_6, P_{11} and P_{14}. However, the longest time was taken by control (soil) which was 23.44 days. P_{11} [Soil: Sand: Vermicompost (1:2:1)] has achieved significantly the earliest germination peak within 7.44 days after sowing, remained at par with the P_7, P_9 and P_{13}. Regarding the germination percentage, P_{13} [Soil: Sand: Vermicompost (1:2:2)] and P_7 [Sand: Vermicompost (1:2)] significantly showed the highest mean germination percentage (71.11%) among other growing media treatments which remained statistically at the same bar with P_5, P_6, P_{11} and P_{14} (Table 2). The lowest germination was found in control P_0 (soil) with a value of 56.67%. The significant values of the treatments show the optimum composition of mixtures in the media that could have resulted in the early and highest germination in the treatments. The higher proportion of sand and vermicompost provided good aeration, drainage and mineral mobilisation making a balanced mixture in the media favouring the early germination of seeds. Verma *et. al* (2018) recorded the highest germination of *Prosopis cineraria* in media consisting of sand and FYM in a 5:1 ratio. The addition of vermicompost in the mixture of growing media results in the early emergence of germination and a significant increment in the germination percentage due to high porosity and available nutrients (Kumar *et al.* (2018) in *Albizzia lebbeck*).

Growth attributes

In the present study, growing media imparted a significant influence on shoot growth parameters. The perusal of the statistical data in Table 3 found that among the growing media treatments, P_9 [Soil: Sand: Vermicompost (1:1:2)] recorded significantly the highest value of 21.48 cm and 45.52 cm at 30 and 90 DAS respectively. Subsequently, P_{13} [Soil: Sand: Vermicompost (1:2:2)] showed notably the highest values of 50.98 cm and 52.06 cm at 180 and 240 DAS respectively. At the end of 240 DAS, the significant value was found statistically at par with P_9 and P_{11}. Among all the growing media, the lowest seedling height was recorded by control (P_0). The highest growth in P_{13} is likely due to the ideal soil mixture as required by the plant for growth which also favoured the early germination. It might also be due to the application of a higher proportion of vermicompost in media which is a rich source of macro and micronutrients, enzymes and vitamins that would encourage the seedling growth. Regarding the collar diameter, P_{12} [Soil: Sand: Vermicompost (2:1:2)] has recorded significantly maximum collar diameter of 1.60 mm at 30 DAS. Further, P_9 [Soil: Sand: Vermicompost (1:1:2)] registered highest collar diameter of 3.59 mm, 3.97 mm and 4.09 mm at 90, 180 and 240 DAS respectively (Table 4). The treatment of $P_{10,}$ P_{12} and P_{13} remained at par with the highest significant value at the end of 240 DAS. The maximum growth of collar diameter in P_9 indicates the effectiveness of soil mixture in promoting robust seedling growth. The findings are analogous to the study of Verma *et. al.* (2018) on *Prosopis cineraria* seedlings, Kaur (2017) on seedlings of *Mangifera indica* cultivars and Attri *et al.* (2024) on *Ailanthus excelsa* seedlings. The application of a higher proportion of vermicompost in growing media mixtures enhances the seedling height of *Artocarpous heterophyllus* (Chaudhary *et al.*, 2024).

Table 1 : Implications of growing media, light intensities and their interactions on various germination aspects

	No. of days taken for germination				Days required for 50% germination				No. of days taken to complete the germination				Peak period of germination (days)			
	L_0	L_1	L_2	Mean	L_0	L_1	L_2	Mean	L_0	L_1	L_2	Mean	L_0	L_1	L_2	Mean
P_0	4.33	4.33	4.67	**4.44**	10.33	10.33	11.00	**10.56**	23.33	23.33	23.67	**23.44**	11.33	11.00	11.67	**11.33**
P_1	3.33	3.00	3.33	**3.22**	8.67	8.67	9.00	**8.78**	18.67	18.67	18.33	**18.56**	9.00	8.67	9.33	**9.00**
P_2	3.67	3.67	3.33	**3.56**	9.33	9.33	10.00	**9.56**	20.00	20.33	21.33	**20.56**	9.00	9.33	10.67	**9.67**
P_3	2.67	2.33	3.00	**2.67**	7.33	8.00	9.33	**8.22**	18.00	17.67	18.33	**18.00**	9.33	8.67	9.33	**9.11**
P_4	3.33	3.33	4.00	**3.56**	9.00	9.33	10.00	**9.44**	21.33	20.67	20.00	**20.67**	9.67	9.67	10.00	**9.78**
P_5	2.67	3.00	3.67	**3.11**	8.00	7.67	9.00	**8.22**	18.00	18.67	19.33	**18.67**	8.33	7.67	9.67	**8.56**
P_6	2.67	3.00	2.67	**2.78**	6.67	6.67	7.67	**7.00**	17.33	17.00	18.00	**17.44**	8.67	7.33	8.33	**8.11**
P_7	3.33	3.00	3.33	**3.22**	8.67	7.67	8.33	**8.22**	18.00	18.00	19.33	**18.44**	7.67	8.00	8.00	**7.89**
P_8	3.67	3.33	3.33	**3.44**	8.33	8.00	8.67	**8.33**	18.67	18.33	19.33	**18.78**	8.67	9.00	10.67	**9.44**
P_9	3.33	3.00	3.33	**3.22**	7.67	7.00	8.67	**7.78**	18.33	18.67	18.67	**18.56**	7.33	8.33	8.33	**8.00**
P_{10}	3.67	3.33	3.67	**3.56**	8.67	8.67	9.67	**9.00**	19.67	19.33	21.33	**20.11**	8.67	9.33	10.00	**9.33**
P_{11}	2.67	2.67	3.00	**2.78**	6.67	6.67	7.67	**7.00**	17.33	16.67	18.00	**17.33**	7.67	7.00	7.67	**7.44**
P_{12}	3.67	3.33	3.67	**3.56**	8.67	8.33	10.33	**9.11**	20.33	19.33	21.00	**20.22**	9.33	9.33	11.00	**9.89**
P_{13}	3.00	2.67	2.67	**2.78**	7.00	6.33	7.33	**6.89**	17.33	16.33	18.00	**17.22**	7.67	7.67	7.67	**7.67**
P_{14}	3.33	3.00	3.00	**3.11**	7.33	6.67	8.00	**7.33**	17.67	17.33	18.33	**17.78**	8.67	7.67	8.00	**8.11**
	3.29	**3.13**	**3.38**		**8.16**	**7.96**	**8.98**		**18.93**	**18.69**	**19.53**		**8.73**	**8.58**	**9.36**	

	CD	SE(m)	CV		CD	SE(m)	CV		CD	SE(m)	CV		CD	SE(m)	CV
P	0.47	0.16	15.36	**P**	0.48	0.17	6.17	**P**	0.76	0.27	4.24	**P**	0.61	0.22	7.37
L	**NS**	0.07		**L**	0.22	0.08		**L**	0.34	0.12		**L**	0.27	0.10	
P×L	**NS**	0.28		**P×L**	0.84	0.30		**P×L**	**NS**	0.47		**P×L**	1.06	0.38	

Table 2 : Effect of growing media, light intensities and their interactions on the germination percentage

Light intensity (L) / Growing media (P)			Open condition (L_0)	50% Light intensity (L_1)	25% Light intensity (L_2)	Mean
P_0	Soil (control)	1	55.00	58.33	56.67	**56.67**
P_1	Soil: Sand	1:1	66.67	70.00	63.33	**66.67**
P_2	Soil: Vermicompost	1:1	63.33	68.33	63.33	**65.00**
P_3	Soil: Sand	1:2	68.33	63.33	71.67	**67.78**
P_4	Soil: Vermicompost	1:2	63.33	68.33	65.00	**65.56**
P_5	Sand: Vermicompost	1:1	68.33	70.00	68.33	**68.89**
P_6	Sand: Vermicompost	2:1	70.00	71.67	66.67	**69.44**
P_7	Sand: Vermicompost	1:2	71.67	70.00	71.67	**71.11**
P_8	Soil: Sand: Vermicompost	1:1:1	66.67	70.00	66.67	**67.78**
P_9	Soil: Sand: Vermicompost	1:1:2	66.67	70.00	66.67	**67.78**
P_{10}	Soil: Sand: Vermicompost	2:1:1	65.00	63.33	63.33	**63.89**
P_{11}	Soil: Sand: Vermicompost	1:2:1	70.00	71.67	66.67	**69.44**
P_{12}	Soil: Sand: Vermicompost	2:1:2	68.33	68.33	63.33	**66.67**
P_{13}	Soil: Sand: Vermicompost	1:2:2	71.67	70.00	71.67	**71.11**
P_{14}	Soil: Sand: Vermicompost	2:2:1	70.00	68.33	66.67	**68.33**
Mean			**67.00**	**68.11**	**66.11**	

	CD	SE(m)	CV
P	3.27	1.17	5.21
L	1.46	0.52	
P × L	**NS**	2.02	

The data regarding root dimensions showed a significant difference among various media treatments (Table 5). The long length of roots shows root coiling in polybag but that doesn't affect the quality of the seedlings. P_{11} [Soil: Sand: Vermicompost (1:2:1)] registered a maximum significant length of 49.57 cm, which remained at par with P_{13}. Compared to the control (P_0), P_{11} recorded a 27.75 percent increment in root length. P_{13} [Soil: Sand: Vermicompost (1:2:2)] recorded a maximum tap root diameter of 3.87 mm, statistically at par with P_9 and P_7. The application of vermicompost in the media has provided a synergistic effect on root growth (Asif *et al.*,2019). Similar findings were observed in the study of Verma *et al.* (2018) in *P. cineraria* and Attri *et al.* (2024) in *Ailanthus excelsa* seedlings.

Survival percentage

The data furnished in Table 6 revealed that P_{13} [Soil: Sand: Vermicompost (1:2:2)] recorded significantly the highest percentage (82.05%) of survival of the seedlings which was found at par with P_5 and P_{11}. The lowest survival was seen in control (P_0) with 50.23%. The higher survival growth in P_{13} might be the result of significantly higher seedling height and tap root diameter as well as an at par response in collar diameter and root length. Verma *et. al* (2018) concluded sand, soil and vermicompost in the ratio of 2:1:1 as a suitable medium for raising *P. cineraria* seedlings. The addition of vermicompost in media produces quality seedlings and enhances their survival (Negi *et al.,*2022).

Biomass attributes

From the Table 7, it can be seen that among all the growing media mixtures, significantly, the highest total fresh weight total dry weight of the seedlings was found in P_{13} [Soil: Sand: Vermicompost (1:2:2)] with the value of 7.26 g and 3.67 g respectively. The highest root shoot ratio of 1.36 was estimated in P_9 [Soil: Sand: Vermicompost (1:1:2)] on par with P_7, P_{11} and P_{13}. The present outcomes were also in agreement with the earlier findings of Verma *et. al* (2018) in *P. cineraria* and Kaur (2017) in *Mangifera indica* cultivar. Damtew *et. al* (2019) reported the beneficial impact of vermicompost on the growth and biomass productions in *Olea europea* subsp. Cuspidata seedlings.

Seedling quality

The data in Table 8 reflects that the effect of treatments and their interactions are significant on the seedling quality index (DQI). Among the growth media, P_{13} [Soil: Sand: Vermicompost (1:2:2)] registered a maximum DQI of 0.28 on par with P_9. whereas, the lowest (0.11) was seen in P_0 (Soil). In the same contention, *Oroxylem indicum* seedlings recorded maximum DQI of 1.18 in the media containing soil, sand and vermicompost (1:1:1) over other potting media (Sood and Ram, 2019). The higher application of vermicompost provided a higher value of DQI (0.77) in *Juniperus polycarpos* seedlings (Negi *et al.*, 2022).

Table 3 : Effect of growing media, light intensities and their interactions on seedling height (cm)

	30 DAS				90 DAS				180 DAS				240 DAS			
	L_0	**L_1**	**L_2**	**Mean**	**L_0**	**L_1**	**L_2**	**Mean**	**L_0**	**L_1**	**L_2**	**Mean**	**L_0**	**L_1**	**L_2**	**Mean**
P_0	16.02	16.58	16.35	**16.32**	29.09	32.15	31.67	**30.97**	34.98	38.03	35.87	**36.29**	35.32	38.58	35.99	**36.63**
P_1	18.07	17.79	17.60	**17.82**	35.85	39.42	37.43	**37.57**	40.12	41.78	41.64	**41.18**	40.93	42.77	42.01	**41.90**
P_2	18.81	18.50	17.82	**18.38**	36.78	39.53	38.83	**38.38**	41.27	43.46	43.42	**42.72**	41.77	44.37	44.07	**43.40**
P_3	17.51	18.14	18.00	**17.88**	36.32	38.15	37.59	**37.35**	39.05	41.98	41.55	**40.86**	39.39	42.42	42.07	**41.29**
P_4	18.67	20.54	19.50	**19.57**	37.10	39.77	39.73	**38.87**	43.81	47.58	43.10	**44.83**	45.03	48.88	43.60	**45.84**
P_5	19.58	20.98	20.44	**20.33**	39.06	41.22	40.58	**40.29**	44.74	45.69	43.96	**44.80**	45.86	46.41	44.31	**45.53**
P_6	17.59	17.62	17.69	**17.64**	35.93	39.30	37.69	**37.64**	39.75	43.11	41.79	**41.55**	40.47	43.97	42.21	**42.21**
P_7	21.17	21.12	21.45	**21.25**	40.64	44.40	45.50	**43.52**	45.54	49.73	48.32	**47.86**	46.73	50.87	49.52	**49.04**
P_8	20.18	20.12	20.44	**20.25**	42.12	44.04	45.15	**43.77**	44.77	49.33	47.99	**47.36**	45.80	49.77	48.86	**48.14**
P_9	22.09	21.31	21.03	**21.48**	42.02	47.30	46.72	**45.52**	46.37	53.44	52.19	**50.66**	47.81	53.79	53.07	**51.56**
P_{10}	21.13	21.11	21.50	**21.25**	42.64	46.85	45.55	**45.02**	45.74	52.48	48.40	**48.88**	46.73	53.41	48.87	**49.67**
P_{11}	21.40	20.31	19.57	**20.43**	42.43	45.70	45.24	**44.46**	46.81	52.84	50.28	**49.98**	47.72	53.61	51.69	**51.01**
P_{12}	19.81	21.25	21.46	**20.84**	42.34	43.63	45.52	**43.83**	45.78	51.87	49.57	**49.07**	46.69	52.59	50.63	**49.97**
P_{13}	21.58	21.38	21.39	**21.45**	43.70	47.24	45.61	**45.35**	47.57	54.28	51.09	**50.98**	48.84	55.44	51.91	**52.06**
P_{14}	21.52	21.61	21.14	**21.42**	43.02	45.79	44.23	**44.35**	47.20	52.13	49.68	**49.67**	48.55	53.49	50.40	**50.81**
Mean	**19.67**	**19.89**	**19.69**		**39.27**	**42.30**	**41.80**		**43.57**	**47.85**	**45.92**		**44.51**	**48.69**	**46.61**	

	CD	**SE(m)**	**CV**		**CD**	**SE(m)**	**CV**		**CD**	**SE(m)**	**CV**		**CD**	**SE(m)**	**CV**
P	0.56	0.20	3.05	**P**	1.00	0.35	2.59	**P**	1.00	0.35	2.33	**P**	1.15	0.41	2.64
L	**NS**	0.09		**L**	0.45	0.16		**L**	0.45	0.16		**L**	0.52	0.18	
P×L	**NS**	0.35		**P×L**	1.72	0.61		**P×L**	1.73	0.61		**P×L**	1.99	0.71	

Table 4 : Effect of growing media, light intensities and their interaction on collar diameter (mm)

	30 DAS				90 DAS				180 DAS				240 DAS			
	L_0	**L_1**	**L_2**	**Mean**	**L_0**	**L_1**	**L_2**	**Mean**	**L_0**	**L_1**	**L_2**	**Mean**	**L_0**	**L_1**	**L_2**	**Mean**
P_0	0.88	0.86	0.84	**0.86**	1.88	1.74	1.63	**1.75**	2.25	2.20	2.04	**2.16**	2.42	2.41	2.23	**2.35**
P_1	1.22	1.24	1.26	**1.24**	3.10	2.98	2.97	**3.02**	3.41	3.38	3.43	**3.41**	3.56	3.49	3.58	**3.54**
P_2	1.26	1.27	1.29	**1.27**	3.07	3.06	3.06	**3.06**	3.55	3.65	3.44	**3.55**	3.64	3.76	3.59	**3.67**
P_3	0.89	0.91	0.86	**0.89**	1.95	2.17	2.16	**2.09**	2.48	2.53	2.36	**2.46**	2.80	2.64	2.48	**2.64**
P_4	1.44	1.45	1.41	**1.44**	3.33	3.25	3.28	**3.28**	3.73	3.87	3.64	**3.75**	3.86	4.04	3.77	**3.89**
P_5	1.41	1.42	1.43	**1.42**	3.38	3.34	3.21	**3.31**	3.73	3.73	3.67	**3.71**	3.85	3.97	3.75	**3.86**
P_6	1.28	1.26	1.20	**1.25**	2.15	2.31	2.22	**2.23**	2.63	2.88	2.68	**2.73**	3.03	3.16	2.81	**3.00**
P_7	1.55	1.57	1.55	**1.56**	3.34	3.41	3.39	**3.38**	3.79	3.87	3.91	**3.86**	3.88	4.03	3.96	**3.96**
P_8	1.57	1.56	1.54	**1.56**	3.32	3.51	3.51	**3.45**	3.67	3.67	3.80	**3.71**	3.77	3.79	3.84	**3.80**
P_9	1.54	1.53	1.54	**1.54**	3.61	3.64	3.51	**3.59**	3.95	3.97	3.99	**3.97**	4.06	4.11	4.09	**4.09**
P_{10}	1.55	1.53	1.54	**1.54**	3.61	3.54	3.48	**3.54**	3.94	3.87	3.89	**3.90**	4.04	4.03	3.96	**4.01**
P_{11}	1.49	1.46	1.45	**1.47**	3.28	3.48	3.36	**3.37**	3.84	3.80	3.87	**3.84**	3.91	3.88	3.91	**3.90**
P_{12}	1.59	1.61	1.58	**1.60**	3.51	3.53	3.50	**3.51**	3.92	3.94	3.87	**3.91**	3.99	4.03	3.97	**4.00**
P_{13}	1.57	1.60	1.57	**1.58**	3.50	3.63	3.43	**3.52**	3.93	3.94	3.88	**3.91**	3.98	4.07	3.93	**3.99**
P_{14}	1.53	1.50	1.53	**1.52**	3.30	3.25	3.35	**3.30**	3.51	3.76	3.69	**3.65**	3.68	3.82	3.78	**3.76**
Mean	**1.39**	**1.39**	**1.37**		**3.09**	**3.12**	**3.07**		**3.49**	**3.54**	**3.48**		**3.63**	**3.68**	**3.58**	

	CD	**SE(m)**	**CV**		**CD**	**SE(m)**	**CV**		**CD**	**SE(m)**	**CV**		**CD**	**SE(m)**	**CV**
P	0.03	0.02	2.01	**P**	0.07	0.02	2.39	**P**	0.12	0.04	3.03	**P**	0.10	0.04	2.89
L	0.01	0.01		**L**	0.03	0.01		**L**	0.05	0.02		**L**	0.05	0.02	
P×L	**NS**	0.04		**P×L**	0.12	0.04		**P×L**	0.21	0.07		**P×L**	0.17	0.06	

Table 5 : Effect of growing media, light intensities and their interactions on the length of tap root (cm) and diameter of tap root (mm) at 240 DAS

Light intensity (L)			Length of tap root (cm)				Diameter of tap root (mm)			
Growing media (P)			**L_0**	**L_1**	**L_2**	**Mean**	**L_0**	**L_1**	**L_2**	**Mean**
P_0	Soil (control)	1	36.59	37.36	33.48	**35.81**	2.12	2.32	1.27	**1.90**
P_1	Soil: Sand	1:1	44.88	41.97	38.77	**41.87**	3.34	3.33	2.53	**3.07**
P_2	Soil: Vermicompost	1:1	42.91	38.66	35.06	**38.88**	3.39	3.44	3.25	**3.36**
P_3	Soil: Sand	1:2	44.89	46.54	41.70	**44.38**	2.66	2.58	1.40	**2.21**
P_4	Soil: Vermicompost	1:2	42.19	39.45	35.83	**39.16**	3.43	3.79	3.35	**3.52**
P_5	Sand: Vermicompost	1:1	46.01	45.05	39.38	**43.48**	2.70	3.78	2.83	**3.10**
P_6	Sand: Vermicompost	2:1	45.12	46.79	42.36	**44.76**	2.02	3.17	2.46	**2.55**
P_7	Sand: Vermicompost	1:2	46.01	42.95	43.54	**44.17**	3.90	3.96	3.58	**3.81**
P_8	Soil: Sand: Vermicompost	1:1:1	45.77	43.70	42.25	**43.91**	3.75	3.92	3.38	**3.68**
P_9	Soil: Sand: Vermicompost	1:1:2	47.36	44.98	42.98	**45.11**	3.90	3.99	3.69	**3.86**
P_{10}	Soil: Sand: Vermicompost	2:1:1	43.13	42.21	38.13	**41.15**	3.77	3.79	3.58	**3.71**
P_{11}	Soil: Sand: Vermicompost	1:2:1	52.36	49.79	46.56	**49.57**	3.36	3.69	3.51	**3.52**
P_{12}	Soil: Sand: Vermicompost	2:1:2	42.45	42.24	37.46	**40.72**	3.63	3.52	3.25	**3.47**
P_{13}	Soil: Sand: Vermicompost	1:2:2	51.22	48.96	45.58	**48.58**	3.94	3.99	3.68	**3.87**
P_{14}	Soil: Sand: Vermicompost	2:2:1	49.84	47.21	46.21	**47.75**	3.41	3.60	3.09	**3.37**
Mean			**45.38**	**43.86**	**40.62**		**3.29**	**3.53**	**2.99**	

	CD	SE(m)	CV
P	1.16	0.41	2.85
L	0.52	0.18	
P × L	2.01	0.72	

	CD	SE(m)	CV
P	0.06	0.02	2.04
L	0.03	0.01	
P × L	0.11	0.04	

Table 6 : Effect of growing media, light intensities and their interactions on survival percentage at 240 DAS

Light intensity (L) Growing media (P)			Open condition (L_0)	50% Light intensity (L_1)	25% Light intensity (L_2)	Mean
P_0	Soil (control)	1	57.58	62.88	61.87	**60.77**
P_1	Soil: Sand	1:1	67.58	76.28	73.81	**72.56**
P_2	Soil: Vermicompost	1:1	65.81	73.26	76.59	**71.89**
P_3	Soil: Sand	1:2	63.37	76.19	69.84	**69.80**
P_4	Soil: Vermicompost	1:2	76.50	73.26	71.79	**73.85**
P_5	Sand: Vermicompost	1:1	75.64	78.57	78.29	**77.50**
P_6	Sand: Vermicompost	2:1	73.81	79.21	77.47	**76.83**
P_7	Sand: Vermicompost	1:2	74.44	78.84	76.83	**76.70**
P_8	Soil: Sand: Vermicompost	1:1:1	70.15	73.89	72.53	**72.19**
P_9	Soil: Sand: Vermicompost	1:1:2	67.40	78.84	80.04	**75.43**
P_{10}	Soil: Sand: Vermicompost	2:1:1	67.12	71.15	68.59	**68.96**
P_{11}	Soil: Sand: Vermicompost	1:2:1	76.19	81.59	80.22	**79.33**
P_{12}	Soil: Sand: Vermicompost	2:1:2	73.26	73.44	73.72	**73.47**
P_{13}	Soil: Sand: Vermicompost	1:2:2	81.43	85.67	79.05	**82.05**
P_{14}	Soil: Sand: Vermicompost	2:2:1	69.05	80.17	75.09	**74.77**
Mean			**70.62**	**76.22**	**74.22**	

	CD	SE(m)	CV
P	4.64	1.65	6.72
L	2.07	0.74	
P × L	**NS**	2.86	

Table 7 : Effect of growing media, light intensities and their interactions on biomass parameters at 240 DAS

Light intensity (L)			Total fresh weight (g)				Total dry weight (g)				Root: Shoot ratio			
Growing media (P)			L_0	L_1	L_2	Mean	L_0	L_1	L_2	Mean	L_0	L_1	L_2	Mean
P_0	Soil (control)	1	2.98	3.10	3.00	**3.03**	2.41	1.93	1.41	**1.92**	1.07	1.01	0.95	**1.01**
P_1	Soil: Sand	1:1	3.98	4.27	4.14	**4.13**	2.67	2.88	2.21	**2.59**	1.13	1.03	1.12	**1.09**
P_2	Soil: Vermicompost	1:1	4.33	4.95	4.54	**4.61**	2.96	3.15	2.39	**2.83**	1.35	1.10	1.12	**1.19**
P_3	Soil: Sand	1:2	2.83	3.63	3.63	**3.36**	2.19	2.18	1.68	**2.01**	1.15	1.08	1.02	**1.09**
P_4	Soil: Vermicompost	1:2	5.07	6.05	5.48	**5.54**	2.90	3.26	2.69	**2.95**	1.30	1.15	1.19	**1.21**
P_5	Sand: Vermicompost	1:1	5.40	5.19	5.51	**5.37**	2.75	3.15	2.03	**2.64**	1.20	1.12	1.23	**1.18**
P_6	Sand: Vermicompost	2:1	3.93	4.53	4.33	**4.26**	2.49	2.49	1.72	**2.23**	1.23	1.10	1.12	**1.15**
P_7	Sand: Vermicompost	1:2	6.45	6.87	6.21	**6.51**	3.26	3.51	3.23	**3.34**	1.39	1.23	1.25	**1.29**
P_8	Soil: Sand: Vermicompost	1:1:1	6.57	6.40	5.96	**6.31**	3.09	3.27	2.74	**3.03**	1.17	1.17	1.24	**1.19**
P_9	Soil: Sand: Vermicompost	1:1:2	6.75	7.12	6.40	**6.76**	3.75	3.81	3.26	**3.60**	1.53	1.28	1.29	**1.36**
P_{10}	Soil: Sand: Vermicompost	2:1:1	5.19	5.71	4.60	**5.16**	2.92	2.87	2.59	**2.79**	1.32	1.28	1.20	**1.27**
P_{11}	Soil: Sand: Vermicompost	1:2:1	6.47	6.68	6.62	**6.59**	3.29	3.13	3.00	**3.14**	1.28	1.45	1.22	**1.32**
P_{12}	Soil: Sand: Vermicompost	2:1:2	5.14	5.48	4.88	**5.17**	2.84	3.06	2.57	**2.82**	1.29	1.28	1.27	**1.28**
P_{13}	Soil: Sand: Vermicompost	1:2:2	6.72	7.54	7.52	**7.26**	3.76	3.96	3.30	**3.67**	1.40	1.34	1.24	**1.33**
P_{14}	Soil: Sand: Vermicompost	2:2:1	5.89	6.18	6.12	**6.06**	3.49	3.32	2.87	**3.23**	1.10	1.33	1.19	**1.21**
Mean			**5.12**	**5.58**	**5.32**		**2.99**	**3.06**	**2.49**		**1.26**	**1.19**	**1.18**	

	CD	SE(m)	CV		CD	SE(m)	CV		CD	SE(m)	CV
P	0.15	0.05	3.06	**P**	0.08	0.03	3.07	**P**	0.07	0.02	6.05
L	0.07	0.02		**L**	0.04	0.01		**L**	0.03	0.01	
P × L	0.26	0.09		**P × L**	0.14	0.05		**P × L**	0.13	0.04	

Table 8 : Impact of growing media, light intensity and their interactions on Dickson Quality Index (DQI)

Light intensity (L) / Growing media (P)			Open condition (L_0)	50% Light intensity (L_1)	25% Light intensity (L_2)	Mean
P_0	Soil (control)	1	0.16	0.10	0.07	**0.11**
P_1	Soil: Sand	1:1	0.22	0.22	0.17	**0.20**
P_2	Soil: Vermicompost	1:1	0.24	0.25	0.18	**0.22**
P_3	Soil: Sand	1:2	0.15	0.14	0.09	**0.13**
P_4	Soil: Vermicompost	1:2	0.23	0.25	0.22	**0.23**
P_5	Sand: Vermicompost	1:1	0.22	0.26	0.16	**0.21**
P_6	Sand: Vermicompost	2:1	0.18	0.17	0.11	**0.15**
P_7	Sand: Vermicompost	1:2	0.27	0.22	0.23	**0.24**
P_8	Soil: Sand: Vermicompost	1:1:1	0.24	0.23	0.20	**0.22**
P_9	Soil: Sand: Vermicompost	1:1:2	0.30	0.27	0.24	**0.27**
P_{10}	Soil: Sand: Vermicompost	2:1:1	0.21	0.21	0.19	**0.20**
P_{11}	Soil: Sand: Vermicompost	1:2:1	0.26	0.26	0.25	**0.26**
P_{12}	Soil: Sand: Vermicompost	2:1:2	0.26	0.23	0.21	**0.23**
P_{13}	Soil: Sand: Vermicompost	1:2:2	0.31	0.29	0.24	**0.28**
P_{14}	Soil: Sand: Vermicompost	2:2:1	0.21	0.19	0.18	**0.19**
Mean			**0.23**	**0.22**	**0.18**	

	CD	SE(m)	CV
P	0.01	0.01	4.76
L	0.01	0.01	
P × L	0.02	0.01	

Table 9 : Effect of growing media, light intensities and their interactions on the presence of chlorophyll content (mg/g tissue).

Light intensity (L)			Chlorophyll-a (mg/g tissue)				Chlorophyll-b (mg/g tissue)				Total chlorophyll (mg/g tissue)			
Growing media (P)			L_0	L_1	L_2	Mean	L_0	L_1	L_2	Mean	L_0	L_1	L_2	Mean
P_0	Soil (control)	1	0.69	0.71	0.71	**0.70**	0.15	0.38	0.55	**0.36**	0.84	1.08	1.26	**1.06**
P_1	Soil: Sand	1:1	0.69	0.71	0.72	**0.71**	0.35	0.32	0.57	**0.41**	1.04	1.04	1.29	**1.12**
P_2	Soil: Vermicompost	1:1	0.68	0.72	0.72	**0.70**	0.35	0.32	0.57	**0.41**	1.03	1.03	1.29	**1.12**
P_3	Soil: Sand	1:2	0.70	0.71	0.72	**0.71**	0.42	0.30	0.51	**0.41**	1.12	1.01	1.23	**1.12**
P_4	Soil: Vermicompost	1:2	0.72	0.72	0.71	**0.72**	0.39	0.41	0.54	**0.45**	1.11	1.13	1.26	**1.17**
P_5	Sand: Vermicompost	1:1	0.72	0.72	0.70	**0.71**	0.30	0.37	0.61	**0.43**	1.02	1.09	1.30	**1.14**
P_6	Sand: Vermicompost	2:1	0.72	0.71	0.71	**0.71**	0.30	0.35	0.57	**0.41**	1.13	1.04	1.24	**1.13**
P_7	Sand: Vermicompost	1:2	0.71	0.71	0.70	**0.70**	0.41	0.39	0.59	**0.47**	1.12	1.10	1.29	**1.17**
P_8	Soil: Sand: Vermicompost	1:1:1	0.67	0.72	0.70	**0.70**	0.37	0.33	0.51	**0.40**	1.04	1.04	1.21	**1.10**
P_9	Soil: Sand: Vermicompost	1:1:2	0.71	0.72	0.72	**0.72**	0.46	0.39	0.59	**0.48**	1.17	1.11	1.31	**1.20**
P_{10}	Soil: Sand: Vermicompost	2:1:1	0.71	0.72	0.71	**0.71**	0.42	0.39	0.55	**0.45**	1.13	1.11	1.26	**1.17**
P_{11}	Soil: Sand: Vermicompost	1:2:1	0.69	0.72	0.71	**0.71**	0.35	0.28	0.49	**0.37**	1.04	1.00	1.20	**1.08**
P_{12}	Soil: Sand: Vermicompost	2:1:2	0.70	0.71	0.73	**0.72**	0.46	0.44	0.50	**0.47**	1.17	1.15	1.23	**1.18**
P_{13}	Soil: Sand: Vermicompost	1:2:2	0.68	0.71	0.73	**0.71**	0.42	0.42	0.48	**0.44**	1.10	1.13	1.21	**1.14**
P_{14}	Soil: Sand: Vermicompost	2:2:1	0.70	0.71	0.72	**0.71**	0.37	0.36	0.43	**0.39**	1.07	1.08	1.15	**1.10**
		Mean	**0.70**	**0.72**	**0.71**		**0.36**	**0.36**	**0.53**		**1.06**	**1.08**	**1.25**	

	CD	SE(m)	CV		CD	SE(m)	CV		CD	SE(m)	CV
P	**NS**	0.01	2.55	**P**	0.01	0.03	2.39	**P**	0.02	0.01	1.76
L	0.01	0.02		**L**	0.01	0.01		**L**	0.01	0.01	
P × L	**NS**	0.01		**P × L**	0.02	0.01		**P × L**	0.03	0.01	

Chlorophyll content

The chlorophyll-a content remained non-significant with the treatment effect of growing media. Significantly the highest chlorophyll-b content was found in P_9 [Soil: Sand: Vermicompost (1:1:2)] (0.48mg/g tissue), at par with P_7 and P_{12}. The growing media treatment of P_9 [Soil: Sand: Vermicompost (1:1:2)] reported the highest value of 1.20 mg/g tissue which remained at par with P_{12}. The highest chlorophyll content might be due to the suitable soil mixtures containing vermicompost which is a powerhouse of vital nutrients, microbial growth boosts nutrient availability, supplement plant growth regulators like auxins, cytokinins, and gibberellins, which encourages cell division and elongation, enhances photosynthetic efficiency and withstand abiotic stress collectively leading to more robust plant growth and potentially higher chlorophyll content. The insights of the present study are analogous to the studies of Attri (2024) in *Ailanthus excelsa* seedlings. The statistical analysis of data presented in Table 9.

Effect of light (L)

Germination attributes:

The light intensity showed significant differences in days taken for 50% germination, span of germination, germination peak and germination percentage (Table 1 and Table 2). Among the three different light intensities, 50% light intensity (L_1) significantly recorded early 50% germination (7.96 days), shortest germination span (18.69 days) and early germination peak in 8.58 days The significant values remained at par with L_0 and slight delay in germination was observed in L_2 (25% light condition). Similarly, the average value of germination percentage was higher in L_1 (68.11%) followed by L_0 and minimum in L_2 (66.11%). The optimum light intensity and protection from exposed adverse weather conditions could have resulted in higher and early germination in L_1 whereas, a slight delay and lower germination in L_2 could be due to lower light irradiance which may not be an optimal condition for early germination of *P. cineraria.* Similar observations regarding germination percentage were found in *Moringa oleifera* where medium shade (50%) was found most suitable for germination followed by full sunlight conditions (Ahmed *et al.*, 2014).

Growth attributes:

The different growing conditions undertaken in the present study significantly influenced the shoot growth of *Prosopis cineraria* seedlings. At 240 DAS, the 50% light intensity (L_1) recorded significantly the highest mean seedling height (48.69 cm) (Table 3). The highest collar diameter (3.68 mm) was observed in L_1 (Table 4). This might be due to the favourable microclimatic conditions maintained in the shade net house with 50% light intensity. Simultaneously, the result of the present study also revealed that at the end of the study, the average seedling height was significantly minimal in open conditions (L_0) but the mean value collar diameter was remarkably lower in L_2. The lower value of collar diameter in L_2 reflects the light demander nature of the species. Conversely, to access maximum light, plants elongate their shoots thus, increases the seedling height. In support of this contention, the findings of Sevillano *et al.* (2016) stated that the seedlings of Oak (*Quercus robur* and Beech *Fagus sylvatica*) exhibited a lower height: diameter ratio under full sunlight over the shaded conditions. Bush and Auken (1990) reported maximum leaf production and greater growth performance of *Prosopis glandulosa* under open conditions. Bhadouria (2017) reviewed that little shade benefits the seedling height due to access to soil moisture for longer. The results also agreed with the study of Abutaba *et al.* (2021) for *Acacia seyal* seedlings.

The light intensity showed significant differences in length and diameter of taproot of seedlings (Table 5). Under various light conditions, root growth in length was maximum in open conditions (L_0) (45.38 cm) followed by L_1 and lowest in L_2 (40.62 cm). In comparison to shoot length (seedling height) a reverse trend was observed where maximum shoot length was obtained in L_1 followed by L_2 and the minimum was seen in open conditions. This might be due to the higher photosynthetic activity in full sunlight which often leads to resource allocation in root growth to ensure sufficient water and nutrient uptake to support the increased photosynthetic activity. Also, in open conditions to cope with low moisture due to high evapotranspiration, plants may develop longer root lengths to access water from deeper layers. The root diameter was maximum in 50% light intensity (L_1) (3.61 mm) followed by L_0 and lowest in L_2 (3.11 mm). Higher results in L_1 could be the result of adequate presence of moisture and higher nutrient uptake over the other growing conditions which promoted the expansion of root diameter. Ahmed *et al.* (2014) concluded moderate shade (50%) mostly favoured root development in *Moringa oleifera* over other shade treatments.

Survival percentage

The maximum survival percentage was remarkably obtained under 50% light conditions (L_1) with 76.22 % followed by L_2 whereas the lowest survival of 70.62% was found in open conditions (L_0) (Table 6). The seedlings raised in L_0 were more prone to mortality due to the exposed weather conditions in cold winter followed by higher temperatures causing heat stress in the open conditions. The higher survival rate of seedlings in L_1 might be due to the improved microclimatic conditions favouring the growth of seedlings by reducing temperature and evapo-transpiration (Bhadouria *et al.*, 2017). Similar conclusions regarding the growth and survival of seedlings in moderate shade were drawn by Das (2023) in *Spondias mombin* and Ahmed *et al.* (2014) in *Moringa oleifera*.

Biomass attributes

The mean value of total fresh weight and total dry weight obtained was significantly maximum in 50% light intensity (L_1) (Table 7). This might be due to the optimal condition of L_1 which favours the efficient utilization of resources, higher net photosynthesis rate in suitable microclimate and balanced resource allocation between root and shoots leading to the overall accumulation of biomass as the open condition (L_0) favours more root growth to access deeper water and in L_2 seedlings might allocate more to shoot elongation to get more light. Similar findings were observed in Das (2023) in *Spondias mombin* and *Moringa oleifera* seedlings (Ahmed *et al.*, 2014). The highest ratio of 1.26 was recorded under open conditions (L_0) and then decreased with a reduction in light intensity which might be due to the adaptive response of the species where it invests more in root growth than shoot growth to improve stability, anchorage and moisture uptake from deeper layer of soil in the higher light intensity. Kelly *et al.* (2015) also reported the same in aspen (*Populus tremuloides*) seedlings. The findings of Ahmed *et al.* (2014) in *Moringa oleifera* seedlings drew a similar conclusion that open and moderate shade had superior root: shoot ratios than higher shaded conditions.

Seedling quality

The full sunlight in the open conditions (L_0) recorded considerably the highest DQI of 0.23 over other conditions which remained at par with L_1 (Table 8). The maximum DQI in L_0 could be the result of higher light intensity leading to a comparatively higher accumulation of biomass in L_0 which implies the ability of species to survive in higher light irradiance showing the light demander nature of the species. A similar trend was observed in the study of Das (2023) in *Spondias mombin* seedlings.

Chlorophyll content

The various light intensities exhibited a considerable difference in chlorophyll-a, chlorophyll-b and total chlorophyll (Table 9). The mean value of chlorophyll-a was obtained significantly highest in 50% light intensity (L_1) (0.72 mg/g tissue) whereas, the 25% light intensity (L_2) recorded remarkably highest values of chlorophyll-b (0.53 mg/g tissue) and total chlorophyll (1.25 mg/g tissue). The seedlings raised in low light intensity (L_2) have a higher pigment concentration due to an increase in chloroplast number, size, and chlorophyll content, as well as enhanced grana development (Boardman, 1977). This adaptation enables plants raised in shade net to compensate for low light conditions by maximizing light absorption and minimizing light loss through reflection and transmission. A similar trend was observed in the previous findings of Yang *et al.* (2009) in *Acacia auriculiformis* and *Acacia mangium.*

Effect of interactions of light and media (L× P)

From Table 1 and Table 2 the perusal of data showed that there were non-significant differences observed among the interactions of media and light conditions for the days taken for first germination, span of germination and the germination % . The treatment combinations of L_1P_{13} required a significantly minimum number of days to achieve 50% of the germination (6.33 days). The early peak of germination was observed in L_1P_{11} within 7.00 days. The significant influence of these treatment combinations could be the result of balanced mixtures of growing media required for germination and the maintenance of suitable microclimate in shade net house with 50% light conditions (L_1) (Verma *et. al* (2018) in *Prosopis cineraria* and Ahmed *et al.* in *Moringa oleifera* (2014).

The data in Tables 3 and 4 revealed the maximum significant seedling height of 55.44 cm recorded in the treatment combinations of L_1P_{13} whereas, the L_1P_9 recorded the highest collar diameter of 4.11 mm. The significantly higher values of L_1P_{13} and L_1P_9 reflect the optimal conditions required for the better shoot growth performance of the seedlings over other treatment combinations. The present outcomes partially agree with the study of Egbadzor *et al.* (2023) where the combined effect of shade and media remained insignificant but the *Adansonia digitata* seedlings raised in full sun with media containing manure and sawdust over soil media with shade conditions.

The data in Table 5 apparently shows L_0P_{11} (52.36 cm) superior over other treatment combinations concerning significantly higher root length. In terms of the diameter of tap root, the significantly highest tap root diameter of 3.99 mm was found in treatment combinations of L_1P_9 and L_1P_{13}. The considerable differences among the interactions can be rationalized with the studies of Verma *et al.* (2018).

The mean value of survival percentage among the interactions between growing media and light intensity remained non-significantly different. L_1P_{13} registered significantly maximum total fresh weight of 7.54 g and dry weight of 3.96 g. Similarly, L_0P_9 shows a significantly higher root shoot ratio of 1.53. Similar to the results reported by Tanjung *et al.* (2023) for *Switenia* seedlings, found that a combination of 70% shade and a soil-sand medium led to considerably greater fresh weight in the seedlings. The treatment combinations L_0P_{13} obtained the highest DQI of 0.31. Thus, the combined effect of media and light intensity align with the findings of Sood and Ram (2019) in *Oroxylem indicum.* Among the interactions, the chlorophyll-a content did not show significant differences. The data (in Table 9) apparently found significantly the highest chlorophyll-b (0.61 mg/g tissues) and total chlorophyll content (1.31 mg/g tissues) in the treatment combinations of L_2P_9. The result is in agreement with the study of Egbadzor *et al.* (2023) where significant interactions were obtained between shade regimes and potting media and the highest chlorophyll was recorded in the media containing soil raised in partial shade.

Correlation analysiss

The correlation of various growth measures such as height of seedlings, collar diameter, tap root length, tap root diameter, total fresh and dry biomass, seedling quality and survival percentage were analysed and presented in Table 10. The data showed a positive correlation among all the parameters (r > 0). The maximum correlation was found between total dry weight and seedling quality (r = 0.964) whereas, low correlation found between tap root length and total fresh weight of seedlings (r = 0.225).

Table 10 : Correlation matrix of various parameters of *Prosopis cineraria* (L.) Druce. seedlings

	Seedling height	**Collar diameter**	**Root length**	**Root diameter**	**Total fresh weight**	**Total dry weight**	**Root shoot ratio**	**Seedling quality (DQI)**
Collar diameter	0.805***							
Root length	0.457**	0.331*						
Root diameter	0.753***	0.883***	0.411**					
Total fresh weight	0.828***	0.844***	0.225*	0.779***				
Total dry weight	0.679***	0.823***	0.331*	0.864***	0.821***			
Root shoot ratio	0.599***	0.68***	0.424**	0.593***	0.668***	0.664***		
Seedling quality (DQI)	0.586***	0.866***	0.299*	0.862***	0.779***	0.964***	0.666***	
Survival %	0.66***	0.528***	0.467**	0.467**	0.48***	0.287*	0.3*	0.261*

***At 0.001 level ** At 0.01 level * At 0.05 level

Conclusion

From the current research work on the species of *Prosopis cineraria* it can be concluded that the germination and growth attributes of the 8-month-old seedlings were substantially impacted by the growing media and light conditions. The species can survive a wide range of light intensities in its initial stage. The result shows an overall superior performance in the aspects of germination and growth in the treatment P_{13} constituting growing media of Soil: Sand: Vermicompost in ratio of 1:2:2 under the 50% light intensity (L_1) and therefore, the treatment combination L_1P_{13} [Soil: Sand: Vermicompost (1:2:2) in 50% light intensity] found overall best with its significant and comparable performance in terms of seedling height, collar diameter, biomass accumulation and seedling quality. Also, considering the maximum turnover from the seedlings stock, the treatment combinations L_1P_9 and L_1P_{11} could be most economically and physiologically feasible for the farmers and nursery owners due to their comparable performance in most of the growth aspects. However, more research needed to study the establishment and productivity of the raised seedlings in the field.

References

Abutaba, Y. I. M., Hammad, Z. M., Fragallah, S. A. D. A. and Ali, E. A. M. (2021). The Effects of Sowing Date and Shade on Seedling Growth of *Acacia seyal* (var. seyal) in Kordofan, Sudan. *International Journal of Agriculture, Forestry and Fisheries*, **9**(1), 8-11.

Ahmed, L. T., Warrag, E. I. and Abdelgadir, A. Y. (2014). Effect of shade on seed germination and early seedling growth of *Moringa oleifera* Lam. *Journal of Forest Products and Industries*, **3**(1), 20-6.

Asif, M., Mughal, A. H., Mehdi, Z., Malik, M. A., Masood, A., Sideeque, S., Shafi, S. and Rashid, B. (2019). Vermicompost Technology and its Application in Forest Nursery Raising. *International Journal of Current Microbiology and Applied Science,* **8**(1), 1290-1296.

Attri, M., Pandey, S. B. S., Yadav, M. and Saresh, N. V. (2024). Growing medium standardization for seedling growth of *Ailanthus excelsa* Roxb. in semi-arid region of Rajasthan. *Indian Journal of Agroforestry*, **26**(1), 97-103.

Bhadouria, R., Srivastava, P., Singh, R., Tripathi, S., Singh, H. and Raghubanshi, A. S. (2017). Tree seedling establishment in dry tropics, an urgent need of interaction studies. *Environment Systems and Decisions*, **37**, 88-100.

Boardman, N. T. (1977). Comparative photosynthesis of sun and shade plants. *Annual Review of Plant Physiology*, **28**(1), 355-377.

Bush, J. K. and Van Auken, O. W. (1990). Growth and survival of *Prosopis glandulosa* seedlings associated with shade and herbaceous competition. *Botanical Gazette*, **151**(2), 234-239.

Chaudhary, K., Topno, S. E. and Josehp, A. V. (2024). Effect of Potting Media on Seed Germination and Seedling Growth of Jackfruit (*Artocarpus heterophyllus*) under Pryagraj Agroclimatic condition. *Journal of Experimental Agriculture International*, **46**(7), 336-343.

Damtew, A., Birhane, E. and Hishe, H. (2019). Vermicomposting enhances the growth of *Olea europea* subsp. Cuspidata seedlings, nursery study from Tigray, northern Ethiopia. *Journal of the Drylands*, **9**(1), 977-985.

Das, N. (2023). Effects of light intensity on seed germination and early growth seedlings of *Spondias mombin* in Bangladesh. *Cell Biology and Development*, **7**(2), 82-88.

Dickson A, Leaf AL and Hosner JF. (1960). Quality appraisal of white spruce and white pine seedling stock in nursery. *The Forestry Chronicle*, **36**(1),10-13.

Egbadzor, K. F., Akumah, A. M., Titriku, J. K. and Akuaku, J. (2023). Effect of growth media and shade regimes on performance of baobab (*Adansonia digitata* L.) seedlings. *Forests, Trees and Livelihoods*, **32**(3), 207–217.

Kaur, S. (2017). Effect of growing media mixtures on seed germination and seedling growth of different mango (*Mangifera indica* L.) cultivars under sub mountainous conditions of Punjab. *Chemical Science Review and Letters,* **6**(23), 1599-1603.

Kaushik, N., Arya, S., Yadav, P. K., Bhardwaj, K. K. and Gaur, R. K. (2020). Khejri (*Prosopis cineraria* L. Druce) based agroforestry systems in the arid and semi-arid region, supporting ecosystem services. *Indian Journal of Agroforestry,* **23**(2), 1-9.

Kelly, J. W. G., Landhäusser, S. M. and Chow, P. S. (2015). The impact of light quality and quantity on root-to-shoot ratio and root carbon reserves in aspen seedling stock. *New Forests*, **46**,527-545.

Khatri, A., Rathore, A. and Patil, U. K. (2010). *Prosopis cineraria* (L.) Druce, a boon plant of desert—an overview. *International Journal of Biomedical and Advance Research,* **1**(5), 141-149.

Kumar, N., Handa, A. K., Dev, I., Ram, A., Uthappa, A. R., Shukla, A. and Chand, L. (2018). Effect of pre-sowing treatments and growing media on seed germination and seedling growth of *Albizia lebbeck* (L.) Benth. *Journal of Applied and Natural Science*, **10**(3), 860-863.

Negi, P.S., Sharma, S. and Thakur, N. (2022). Response of Vermicompost on Seedling Growth and Quality Parameters of *Juniperus polycarpos* C. Koch under Nursery Condition. *Annals of Arid Zone*, **61**(3-4), 181-186.

Sadasivam, S. and Manickam, A. (1997). Biochemical Method. *New Age International Publishers*, New Delhi, 187-188.

Sevillano, I., Short, I., Grant and O'Reilly, C. (2016). Effects of light availability on morphology, growth and biomass allocation of *Fagus sylvatica* and *Quercus robur* seedlings. *Forest Ecology and Management*, **374**, 11-19.

Singh, G., Mutha, S. and Bala, N. (2007). Effect of tree density on productivity of a *Prosopis cineraria* agroforestry system in North Western India. *Journal of Arid Environments*, **70**(1), 152-163.

Sood, K. K. and Ram, J. (2019). Growth and development of seedlings in relation to container size and potting media under nursery conditions in *Oroxylum indicum*-A multipurpose medicinal plant. *Indian Journal of Ecology*, **46**(1), 143-148.

Tanjung, H.U. and Tata, H.L. (2023). The growth of mahogany seedlings (*Swietenia macrophylla* King.) in various planting media and shade intensity. In *IOP Conference Series, Earth and Environmental Science*, **1271**(1), 012023.

Verma, A., Kumar, P., Rathakrishnan, P., Saresh, N. V., Kumar, S. and Kumar, P. (2018). Seedling vigour of *Prosopis cineraria* (L.) in response to different growth media and polybag sizes in arid climatic conditions. *Range Management and Agroforestry*, **39**(2), 206-214.

Yang, L., Liu, N., Ren, H. and Wang, J. (2009). Facilitation by two exotic Acacia, *Acacia auriculiformis* and *Acacia mangium* as nurse plants in South China. *Forest ecology and management*, **257**(8), 1786-1793.