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EVALUATION OF DIFFERENT GROWTH MEDIA FOR SEED GERMINATION AND SEEDLING GROWTH IN PAPAYA (*CARICA PAPAYA* L.) CV. RED LADY-786

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ABSTRACT

This study was carried out to explore the effect of growing media on seed germination and seedling growth of papaya (*Carrica papaya*) cv. Red Lady-786. The research was conducted at nuresury of Dr. B.R. Choudhary Agriculture Research Station Mandor, Jodhpur during *Kharif*, 2022-2023 and 2023-2024. This research was arranged in a complete randomized design with sixteen treatment combinations and three replications. The treatments were combination between types of media with level of cocopeat and vermicompost. Each treatment has 100 poly bags. The results showed that the medium Vermicompost + Pond soil + Sand (1:1:1) with 2 cm cocopeat in top of the poly bags (T_{13}) found most effective for germination, seedling growth and development compared to other treatments. This medium gave the highest parameters in term of germination parameters like imbibition period, germination percentage, germination period, seedling vigour and seedling growth parameters like seedling height, seedling stem girth, number of leaves, number of roots, root length, fresh weight of shoot, fresh weight of root, fresh weight of plant and Root: Shoot ratio. This treatment achieved highest net profit (Rs. 7,533.75 per 1000 seedlings) with most favourable B:C ratio (1.73).

Keywords **:** Germination, vermicompost, pond soil, sand and FYM.

Introduction

Papaya (*Carica papaya* L.) is an important tropical fruit crop of India. The fruit is widely grown in various states of India, mainly in Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, West Bengal, Chhattisgarh, Tamil Nadu, Assam and Kerala. Papaya belongs to Caricaceae family. The Caricaceae family comprises approximately 48 known species, of which only *Carica papaya* L. is cultivated for its edible fruits (Arvind *et al.*, 2015). Seed germination in papaya is reported to be erratic, slow and is also incomplete. 'Red Lady' is the choicest variety of papaya growers due to its hermaphrodite flowering nature and prolonged shelf-life of fruits. However, the cost of seeds for this variety is relatively high. Therefore, increasing germination per cent and producing more number of healthy seedlings is a challenge for papaya growers. Papaya seeds of cv. Red Lady face some problems in germination and have high seedling mortality due to damping-off disease in the nursery. Papaya seedling survival rates are lower due to incomplete germination and early mortality. Growth media composition influences seed germination and quality of the seedlings (Bhardwaj, 2013).

Growing media refers to a substrate that supplies essential nutrients and physical support for plant growth. Not all soils are ideal for seed germination and

the healthy development of seedlings. Therefore, the growing medium must possess good water-holding capacity, proper drainage, and favourable physical and chemical properties. It is important to use a soil medium or mixture that meets these criteria to ensure optimal seed germination and better seedling growth (Desai *et al*., 2017).

Fruit crop seedling media typically consist of soil, organic matter and sand. Soil is commonly used as the base component due to its low cost and easy availability. Sand is added to improve porosity while organic matter enriches the medium with essential nutrients. Cocopeat is regarded as an excellent component of growing media because it has a suitable pH, electrical conductivity and favourable chemical properties. It also offers beneficial physical characteristics such as high total pore space, high water retention, low shrinkage, low bulk density and slow decomposition (Sajana *et al*., 2018). Vermicompost as a growing medium provides sufficient oxygen to plant roots and ensures adequate retention of water and nutrients. The presence of various humic substances in vermicompost significantly enhances nutrient availability, which positively influences plant growth, yield and overall quality. (Voruganti *et al*., 2022). In view of these facts, the present experiment was undertaken to identify a suitable growing medium for seed germination and seedling growth of papaya.

Material and Methods

The experiment was conducted during *Kharif*, 2022-2023 and 2023-2024 at nursery of Dr. B.R. Choudhary Agricultural Research Station Mandor, Jodhpur. Experimental treatments comprised of sixteen treatment combinations which consisting of different combination of growing media and cocopeat filling at the top of seedling polybags namely, T_1-Soil + Sand (1:1) without cocopeat, T_2-Soil + Sand (1:1) with 1cm cocopeat, T_3-Soil + Sand (1:1) with 2 cm cocopeat, T_4-Soil + Sand (1:1) with 1 cm cocopeat + Vermicompost (1:1), T_5-Soil + Sand (1:1) with 2 cm cocopeat + Vermicompost (1:1), T_6-FYM + Soil + Sand (1:1:1) without cocopeat, T_7-FYM + Soil + Sand (1:1:1) with 1cm cocopeat, T_8-(FYM + Soil + Sand (1:1:1) with 2 cm cocopeat, T_9-FYM + Soil + Sand (1:1:1) with 1cm cocopeat + Vermicompost (1:1), T_{10}-FYM + Soil + Sand (1:1:1) with 2 cm cocopeat + Vermicompost (1:1), T_{11}-Vermicompost + Soil + Sand (1:1:1) without cocopeat, T_{12}-Vermicompost + Soil + Sand (1:1:1) with 1cm cocopeat, T_{13}-Vermicompost + Soil + Sand (1:1:1) with 2 cm cocopeat, T_{14}-Vermicompost + Soil + Sand (1:1:1) with 1cm cocopeat + Vermicompost (1:1), T_{15}-Vermicompost + Soil + Sand (1:1:1) with 2 cm cocopeat + Vermicompost (1:1) and T_{16}-Control. Seed sowing was carried out in July, with seeds placed approximately 1 cm deep in various media according to the treatment specifications. The poly bags were irrigated immediately after sowing and then watered daily until seed emergence was complete. Following full germination, irrigation was continued every two days.

The seed germination and seedling growth experiment were conducted using a completely randomized design (CRD) with three replications for each treatment. Each treatment consisted of 100 poly bag seedlings. Observations on germination parameters like Imbibition period, germination Percentage, germination period and seed vigour were recorded during the germination, based on all sown seeds. Data collection began with the appearance of the first germinated seed and continued at two-day intervals until no further germination occurred. Seeds exhibiting a protruding radicle and plumule were considered germinated. The imbibition period was determined by counting the number of days from sowing until the start of germination. Germination percentage was calculated as the proportion of seeds that germinated over the observation period, using the formula:

Germination Percentage (%) = (Number of Germinated Seeds / Total Number of Seeds Sown) × 100.

The germination index was calculated using formula: GI = $\sum$ (Gt / Dt), where Gt represents the number of germinated seeds on day t, and Dt represents the time in days corresponding to Gt. The seedling growth parameters like seedling height, seedling stem girth, number of leaves, number of roots, root length, days required for gaining transplanting size of seedling, fresh weight of shoot, fresh weight of root, fresh weight of plant and Root: Shoot ratio recorded at 45 Days after sowing.

Ten seedlings were randomly selected from each treatment to record growth parameters. The data collected in the present study were statistically analyzed using the method described by Panse and Sukhatme (1989).

Results and Discussion

Germination parameters

The results indicated that the growing media particularly those containing cocopeat had a beneficial effect on germination of papaya seeds. The imbibition period ranged from 11.98 Days in T_{13} to 20.87 Days in T_{16}. The shorter imbibition period observed in T_{13}, T_{12} (11.98 & 12.70 Days) and T_{15} (13.48 Days) indicate more efficient water absorption by seeds likely due to improved aeration and moisture retention properties of

the media. The prolonged imbibition period in T_{16} suggests limited water availability or suboptimal physical properties of the growing medium. These findings are close conformity with Bhardwaj (2013) and Pant and Verma (2022).

The highest germination percentage was observed in T_{13} (91.30%) followed by at par performance of T_{12} (88.13%) and T_{15} (86.06%). T_{16} (57.81%) recorded lowest germination rate. The germination period exhibited an inverse trend with T_{13} achieving germination in just 5.48 days and T_{12} in 5.89 days indicating faster and more uniform seedling establishment. While T_{16} recorded the longest germination period (13.70 days) reflecting delayed and inconsistent germination likely caused by unfavourable growing conditions. These results are in agreement with those of Bhardwaj (2014) and Sajana *et al*. (2018).

Maximum seed vigour was recorded in T_{13} (98.29) followed by at par performance of T_{12} (96.45) and T_{15} (96.33). T_{13} also recorded the highest germination index (8.67) which integrates both speed and uniformity of germination. These parameters clearly illustrate the superiority of media compositions in T_{13}, T_{12} and T_{15} which likely include well-balanced proportions of cocopeat that enhancing aeration, water retention and nutrient availability. T_{16} had the lowest seed vigour (68.88) and germination index (2.00) reinforcing the impact of poor media formulation. These findings are close to results of Desai *et al*. (2017).

Table 1 : Effect of growth media mixture and cocopeat on germination parameters of papaya

Treatment	Imbibition Period	Germination %	Germination period	Seed vigour	Germination index
T_1	20.13	60.61	13.02	73.96	2.38
T_2	18.72	68.89	11.63	81.99	4.57
T_3	15.59	79.26	9.09	89.94	5.90
T_4	19.13	68.46	12.22	79.42	4.05
T_5	16.52	77.81	9.37	87.66	5.57
T_6	19.72	66.43	12.46	78.20	3.81
T_7	17.37	75.47	10.06	87.40	5.40
T_8	13.74	84.17	7.41	92.62	6.76
T_9	17.89	74.19	10.57	87.19	5.19
T_{10}	14.80	80.59	8.85	90.28	6.24
T_{11}	18.41	70.00	11.05	84.66	4.90
T_{12}	12.70	88.13	5.89	96.45	7.48
T_{13}	11.98	91.30	5.48	98.29	8.67
T_{14}	14.19	82.71	8.13	90.53	6.48
T_{15}	13.48	86.06	6.87	96.33	7.24
T_{16}	20.87	57.81	13.70	68.88	2.00
SEm+	0.62	1.30	0.41	0.61	0.14
CD (5%)	1.78	3.75	1.18	1.75	0.42
CV (%)	6.46	2.98	7.28	1.22	4.61

Growth parameters

The growth of papaya seedlings under different treatments showed significant differences between all measured parameters indicating the effect of growing media and cocopeat on plant development. Seedling height ranged from 12.13 cm (T_{16}) to 41.42 cm (T_{13}). T_{13} exhibited the maximum height, followed by T_{12} (40.62 cm) and T_{15} (36.23 cm) indicating the positive impact of optimized media composition in these treatments. T_{16} likely representing a control or less favourable medium showed the poorest growth. The promising results in seedling growth and development may be attributed to the favourable effects of the growing media composition which enhances water-holding capacity, porosity and soil aeration while also provide essential nutrients particularly nitrogen and micronutrients that support vigorous seedling growth. These similar findings were obtained by Meena *et al*. (2017) and Pant and Verma (2022).

Stem girth followed a similar trend, with T_{13} (6.36 mm) and T_{12} (6.03 mm) showing superior performance compared to other treatments. In contrast, T_{16} recorded the smallest stem girth (3.19 mm) further emphasizing the importance of an appropriately formulated growing medium. Similar results were obtained by Bhardwaj (2014) and Rakibuzzaman *et al*. (2019).

The number of leaves varied significantly among treatments, with T_{13} (13.10) producing the highest number of leaves followed by T_{12} (11.40) and T_{15} (10.33). These results highlight the importance of nutrient availability and water retention in promoting vegetative growth. T_{16} recorded the lowest number of leaves (6.53) indicating suboptimal growing conditions. These results were also found by Pant and Verma (2022).

T_{13} (35.89) was observed highest number of root per seedling followed by T_{12} (33.47) and T_{15} (30.78). These findings suggest improved root establishment in media enriched with cocopeat or similar amendments. Conversely T_{16} recorded the lowest roots (15.73) indicating less favourable growing media. Similar results have also been reported by Meena et al. (2017). Maximum root length was measured in T_{13} (22.11 cm) and T_{12} (20.27 cm) significantly surpassing the control (11.99 cm in T_{16}). Treatments with cocopeat layer contributed to enhanced aeration in rooting zone and promote root elongation. Similar results for number of roots and root length have been reported by Meena *et al*. (2017) and Gawankar *et al*. (2019).

Minimum number of days for gaining transplanting size of seedling was observed in T_{13} (28.37 days) and T_{15} (30.78 days) indicating accelerated early development under these media combinations. On the other hand, T_{16} required longest time (54.16 days) for transplanting. This result is in line with findings of Bhardwaj (2013).

Table 2 : Effect of growth media mixture and cocopeat on growth of papaya at 45 days after seed sowing.

Treatment	Seeding height (cm)	Stem girth (mm)	Number of leaves/plant	Number of roots/plant	Root length (cm)	Day required for gaining transplanting size of seedling
T_1	20.42	3.91	7.37	16.74	12.64	45.29
T_2	24.14	4.35	8.00	18.91	14.77	42.58
T_3	32.25	4.95	8.90	24.18	17.38	35.42
T_4	23.88	4.08	8.00	18.41	14.34	43.25
T_5	29.94	4.79	8.63	22.35	16.71	36.60
T_6	20.95	3.99	7.80	17.42	13.49	44.71
T_7	29.26	4.64	8.53	20.72	16.53	37.67
T_8	35.22	5.26	9.83	28.70	19.19	32.13
T_9	27.56	4.51	8.27	20.08	16.25	39.81
T_{10}	32.77	5.09	9.20	26.31	18.20	34.17
T_{11}	26.55	4.41	8.10	19.53	14.90	41.18
T_{12}	40.62	6.03	11.40	33.47	20.27	29.76
T_{13}	41.42	6.36	13.10	35.89	22.11	28.37
T_{14}	33.16	5.20	9.53	27.41	18.44	33.01
T_{15}	36.23	6.08	10.33	30.78	19.61	30.78
T_{16}	12.13	3.19	6.53	15.73	11.99	54.16
SEm+	1.32	0.18	0.37	0.92	0.73	1.41
CD (5%)	3.79	0.53	1.08	2.65	2.09	4.06
CV (%)	7.82	6.64	7.22	6.77	7.54	6.41

Fresh weight of seedling was found highest in T_{13} (17.58 g) followed by T_{12} (15.10 g) and T_{15} (11.85 g). These results align with other growth parameters, indicating enhanced biomass accumulation under these media combinations. In contrast, T_{16} recorded the lowest fresh weight (3.27 g). The fresh weight of seedling observed in this study is consistent with previous findings of Jitendrabhai *et al*. (2025).

Root fresh weight varied from 1.10 g in T_{16} to a maximum of 2.97 g in T_{13} while shoot fresh weight ranged from 2.16 g (T_{16}) to 14.61 g (T_{13}). Treatments T_{13}, T_{12} and T_{15} consistently exhibited higher values for both parameters indicating superior media conditions that enhanced nutrient availability, water retention and overall seedling vigour. The outstanding performance of T_{13} (2.97 g root and 14.61 g shoot) is likely due to improved aeration, optimal moisture levels and an adequate supply of essential nutrients particularly nitrogen and micronutrients. The lowest biomass accumulation observed in T_{16} highlights the inadequacy of its growing medium in supporting healthy seedling development. These results are closely related to Bhardwaj (2013) and Sajana *et al*. (2018). The root: shoot ratio ranged from 0.20 in T_{13} to 0.64 in T_{16}. Lower ratios observed in treatments T_{13}, T_{12} and T_{15} reflect proportionally greater shoot development while higher ratio recorded in T_{16} suggests restricted shoot elongation.

Table 3 : Effect of growth media mixture and cocopeat on biomass production, net returns and B:C ratio of papaya at 45 days after sowing.

Treatment	Fresh weight of plant (g)	Fresh weight of root (g)	Fresh weight of shoot (g)	Root : shoot ratio	Gross Retrun (Rs/1000 seedlings)	Net return (Rs/1000 seedlings)	B : C ratio
T_1	5.14	1.45	3.68	0.43	10085.42	1235.42	1.14
T_2	6.45	1.52	4.93	0.34	11716.67	2366.67	1.25
T_3	9.27	1.95	7.32	0.29	14114.58	4264.58	1.44
T_4	6.08	1.57	4.51	0.38	11173.00	1573.00	1.16
T_5	8.24	1.85	6.39	0.31	13691.67	3341.67	1.33
T_6	5.45	1.29	4.15	0.36	10733.33	1673.33	1.19
T_7	7.63	1.76	5.87	0.32	13166.67	3606.67	1.38
T_8	11.24	2.18	9.06	0.25	15431.25	5371.25	1.54
T_9	7.24	1.68	5.56	0.33	12754.17	2944.17	1.30
T_{10}	9.66	2.01	7.65	0.28	14504.17	3944.17	1.38
T_{11}	6.97	1.62	5.35	0.33	12072.92	2712.92	1.29
T_{12}	15.10	2.68	12.42	0.22	16568.75	6708.75	1.68
T_{13}	17.58	2.97	14.61	0.20	17893.75	7533.75	1.73
T_{14}	10.43	2.10	8.34	0.27	15083.33	4973.33	1.49
T_{15}	11.85	2.23	9.62	0.24	16128.75	5268.75	1.49
T_{16}	3.27	1.10	2.16	0.64	9479.17	899.17	1.11
SEm+	0.39	0.09	0.38	0.03	-	-	0.04
CD (5%)	1.13	0.27	1.08	0.07	-	-	0.11
CV (%)	7.68	8.59	9.33	13.85	-	-	5.05

Economics

The economic evaluation indicated that Vermicompost + Soil + Sand (1:1:1) with 2 cm cocopeat (T_{13} media) was found the highest gross return (Rs. 17,893.75 per 1000 seedlings) and net return (Rs. 7,533.75 per 1000 seedlings) along with the most favourable benefit-cost (B:C) ratio of 1.73. Treatments T_{12} and T_{15} also exhibited strong economic performance reflecting their suitability for profitable seedling production.

Conclusion

In conclusion, the results of this study demonstrate that vermicompost and cocopeat due to their favourable physical, chemical and biological properties can be effectively used in the preparation of papaya seedlings. The findings clearly show that the type of growing media significantly influenced germination, growth and developmental parameters. Among the various media tested the combination of vermicompost + pond soil + sand (1:1:1) with a 2 cm cocopeat top layer in poly bags proved to be the most effective. This medium resulted in the highest values for germination, seedling growth and development compared to other treatments.

Overall, media supplemented with cocopeat consistently outperformed those without it, indicating that cocopeat enhances germination and seedling performance. Therefore, a growing medium composed of vermicompost, soil and sand in equal proportions supplemented with cocopeat is recommended for achieving higher germination rates and improved growth of papaya seedlings.

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