



HORTICULTURE

EFFECT OF DIFFERENT NURSERY GROWING MEDIA ON SEED GERMINATION AND SEEDLING GROWTH OF PAPAYA (*CARICA PAPAYA* L.)

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ABSTRACT

The current experiment was conducted at fruit plant nursery of Horticultural Research Institute, (HRI), Ayub Agricultural Research Institute, (AARI), Faisalabad during 2023-24 to evaluate the impact of different growing nursery materials and their combinations on emergence and growth of papaya seedling. Seven treatments were applied viz., T₁ [Pond soil: sand (1:1)]; T₂ (Pond soil: sand (1:1) and 1 cm coco peat on top); T₃ (Pond soil: leaf manure 1:1); T₄ (Pond soil: leaf manure 1:1 and 1 cm coco peat on top), T₅ (Pond soil: vermicompost 1:1), T₆ (Pond soil: vermicompost 1:1, and 1 cm coco peat on top), and T₇ (peat moss alone). The experiment was laid out according to Randomized Complete Block Design (RCBD) having four replications. The treatments exhibited significant variations. Among them T₂ produced the best results showing the highest germination rate (94.37 %), vigor index (1819.7), root number (24.75), and root length (18.48 cm), while T₇ showed the poorest performance. The results suggested that incorporation of cocopeat into soil-based nursery material improves substrate quality and root development. Therefore, it is recommended that for successful raising of papaya nursery the growing media composed of Pond soil: sand (1:1) and 1 cm coco peat on top can be used effectively for producing vigorous papaya seedlings suitable for transplanting.

KEYWORDS: *Carica papaya*; emergence; coco peat; growth; soil-less material; survival percentage; Pakistan

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INTRODUCTION

Papaya (*Carica papaya* L.), widely referred to as the “wonder fruit of the tropics,” is an economically and nutritionally important fruit crop belonging to the family Caricaceae. In Pakistan, papaya is cultivated on approximately 1,667 hectares with an annual production of 12,258 tonnes in year 2022-23 (FV & CS 2023). The Sindh province serves as a leading papaya growing region due to its favorable climatic conditions. Major districts where papaya is grown extensively include Karachi, Thatta, Badin, Hyderabad, Mirpurkhas, Tando Allayar, Sanghar and Nawabshah. In Southern Punjab, papaya is cultivated on limited scale in Multan, Bahawalpur and Rahim Yar Khan (FV & CS 2023).

Papaya fruits are valued not only for their sweet flavor but also for their nutritional content, providing carbohydrates, vitamin A, minerals, and ascorbic acid. They are widely used for preparing jams, jellies,

marmalades, nectars, wines, syrups, dehydrated flakes, and baby foods (Sharma *et al.*, 2021). Beyond its nutritional importance, papaya is also a source of papain, a proteolytic enzyme obtained from the latex of unripe fruits. Papain has extensive industrial applications, particularly in pharmaceuticals, brewing, meat processing, dairy, textiles, tanning, cosmetics, detergents, and food industries, which has led to increasing demand worldwide.

Besides its nutritional value the cultivation of papaya has gained wide importance because of its profitability and economical net returns. (Sharma *et al.*, 2010; Guzmán-Ramón *et al.*, 2010). Propagation of Papaya is generally carried out through seeds, which are covered by a gelatinous sarcotesta. Germination is often slow, erratic, and incomplete, typically requiring 3–5 weeks, and high seedling mortality remains a challenge (Desai *et al.*, 2017). Seed treatments and the use of suitable nursery material are therefore

necessary to enhance germination, reduce germination time, and promote healthy seedling development. Growing nursery material not only provide anchorage for seedling growth but also serve as a source of essential nutrients, required for optimum development of seedling (Bhardwaj, 2014). An ideal nursery material provides mechanical support, holds adequate nutrients and water, facilitates diffusion of oxygen, and enables exchange of gasses around the roots (Shrivastava *et al.*, 2021).

soil, is the most common nursery material used for propagation due to its availability and low cost, its physical and chemical properties are often improved by adding organic amendments such as vermicompost, peat moss, silt, farmyard manure (FYM), or cocopeat. These amendments enhance soil porosity, improve aeration, and enrich nutrient availability, resulting in more vigorous seedling growth (Bhat *et al.*, 2013; Awang *et al.*, 2009). Cocopeat, a renewable byproduct of the coconut industry, has gained popularity due to its high water-holding capacity, good aeration, neutral pH, and eco-friendly nature (Sahu *et al.*, 2022). Sand, depending on its texture, may either improve drainage or restrict aeration, with finer sands being less favorable (Shrivastava *et al.*, 2021). Peat moss is also commonly used because of its ability to retain moisture and create aeration pockets, which help root respiration and reduce the risk of waterlogging (Cantliffe *et al.*, 2007). Vermicompost, unlike traditional compost, provides readily available macro- and micronutrients, particularly nitrogen, phosphorus, and potassium, and has long-term nutrient release capacity (Sinha *et al.*, 2009).

Selecting an appropriate growing nursery material and maintaining optimal nursery conditions are therefore essential for producing vigorous seedlings. In prelude, it may observed that a growing media for raising papaya nursery is needed to be standardized. The current research was carried out to find standardized nursery media that will economical, ensures uniform growth, disease free healthy seedlings and early transplanting that will shortens the nursery period for successful papaya cultivation.

MATERIALS AND METHODS

Experimental site: This experiment was conducted during 2023–2024 at fruit plant nursery of the Horticultural Research Institute (HRI), Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan. Hybrid seeds of papaya cv. Red lady were sown in different growing medias (listed below).

Treatments: Seven growing nursery material combinations were tested:

T₁: Pond soil: sand 1:1

T₂: Pond soil: sand 1:1 and 1 cm coco peat on top

T₃: Pond soil: leaf manure 1:1

T₄: Pond soil: leaf manure 1:1 and 1 cm coco peat on top

T₅: Pond soil: vermicompost 1:1

T₆: Pond soil: vermicompost 1:1, and 1 cm coco peat on top

T₇: peat moss alone

Experimental design: The experiment was arranged in a Randomized Complete Block Design (RCBD) with four replications. In each replication 15 seedlings were studied. The cultural practices were followed as routine. Plants were irrigated at an interval of 1 or 2 days or as per requirement. The samples were studied after 10 and 30 days of germination, respectively.

Sowing procedure: Papaya seeds were sown on first week of February in 42-cell plug tray. Each cell measured 5.5 cm in diameter and 6.5 cm in depth was filled with the respective growing nursery material according to the treatments. Seeds were placed at a depth of 2 cm. After sowing, trays were stacked and covered with black plastic sheets for seven days to maintain favorable conditions for uniform germination.

Parameters recorded: Germination percentage (%) i.e., number of seeds germinated relative to total seeds sown.

Seedling height (cm) was measured from the base of the stem to the tip of the shoot using regular measuring scale. Root length (cm) was measured from the base of the stem to the tip of the longest root using regular scale. Number of roots per seedling was counted manually at sampling. Fresh and dry weight (g): (determined for both shoots and roots after harvesting), Survival percentage (%): (Proportion of seedlings that survived until the end of the nursery period).

Vigour index was estimated using the formula proposed by Abdul-Baki and Anderson (1973).

Vigour Index = Germination % × Total Seedling Length (cm) after an interval of ten days and thirty days of germination, respectively.

STATISTICAL ANALYSIS: Data was analyzed using analysis of variance (ANOVA) to assess treatment effects. Treatment means were compared using the Least Significant Difference (LSD) test at a 5% probability level ($p < 0.05$). Statistix 8.1 software was used for statistical analyses (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Nursery material composition influences the quality of seedlings. The growing nursery material is of vital importance in nursery as it promotes water absorption, nutrient availability, oxygen supply and prevent incidence of disease for the germination of seeds and

seedlings (Raviv, Wallach & Blom, 2004).

In the present study, different growing nursery material significantly influence the growth and development of papaya seedlings. The data showed the significant effect of growing nursery material on observations viz, days taken to sprout, number of seedlings germinated, germination percentage, survival percentage and vigor index were found to be highest in the combination of (T₂) Pond soil + Sand (1:1) with 1 cm Cocopeat followed by T₄ (Pond soil + Leaf manure with 1 cm Cocopeat) (Table 1).

Days taken to sprout: Seeds of papaya sown in treatment T₂ taken almost 13.5 days to sprout i.e., significantly faster and earlier than all other treatments, while T₆ (16.0 days) and T₇ (16.1 days) recorded the longest germination time (Table 1). Early sprouting in T₂ suggests that its growing nursery material provided optimal conditions such as favorable moisture and aeration for rapid germination. It might be due to the combination of cocopeat with organic manure, that it improved the overall physical properties of the growing nursery material, which likely contributes to the increase in germination (Debnath *et al.*, 2025).

Germination and survival percentage: Treatment T₂ (Pond soil: sand 1+1 and 1 cm coco peat on top) recorded highest germination (94.38%) and survival rate after 10 days (92.38%), which were statistically significant than all other treatments. In contrast, T₅ (Pond soil: vermicompost 1+1) exhibited the lowest germination (68.25%) and survival percentage

(66.25%) (Table 1). These results indicate that the combination of sand and pond soil supplemented with a thin layer of cocopeat provided favorable conditions for seed viability and establishment possibly due to improved nutrient availability, whereas T₅ might have had unfavorable physical or chemical properties, leading to poor germination and survival. T₂ (Pond soil: sand 1+1 and 1 cm coco peat on top) nursery material showed more than 90% seed germination. This is likely because the mixture improves the soil's ability to hold water, its porosity, and aeration, results in better root and shoot growth compared to using soil alone or soil mixed with vermicompost. Similar responses in papaya were reported by Bhardwaj *et al.* (2013) when cocopeat was incorporated as a component of the growing nursery material.

Seedling vigour (vigour index): Treatment T₂ (Pond soil + Sand (1:1) with 1 cm Cocopeat) recorded the highest vigour index (1819.7), indicative of superior seedling performance. In contrast, treatment T₅ showed the lowest vigour index (1007.9), which corresponded with its reduced germination and survival rates (Table 1). The elevated vigour index observed in T₂ suggests enhanced root and shoot growth potential, which is crucial for successful transplanting and field establishment. These results are consistent with earlier reports demonstrating that seed vigour is closely associated with seedling emergence and establishment under field conditions (Basu & Groot, 2023).

Plant height: Seedlings in T₂ (Pond soil + Sand (1:1)

Table 1: Effect of different growth nursery materials on germination and survival percentage of papaya seedlings

Treatments	Days taken to sprout	Number of seedlings germinated	Germination %	Survived plants after 10 days	Survival %	Vigour Index
T1	14.37bc	85.38b	85.38b	74.38c	74.38c	1467.6bc
T2	13.5c	94.38a	94.38a	92.38a	92.38a	1819.7a
T3	14.25bc	82.75b	82.75b	74.12c	74.12c	1329.6d
T4	14.75abc	85.12b	85.12b	81.38b	81.38b	1523.8b
T5	15.50ab	68.25d	68.25d	66.25e	66.25e	1007.9f
T6	16.00a	76.62c	76.62c	73.12cd	73.12cd	1364.6cd
T7	16.12a	75.62c	75.62c	68.50de	68.50de	1168.9e
LSD	1.502	4.24	4.24	4.78	4.78	136.61

Treatments having same letter are non-significant at $P \leq 0.05$

T₁: Pond soil: sand 1:1, T₂: Pond soil: sand 1:1 and 1 cm coco peat on top, T₃: Pond soil: leaf manure 1:1, T₄: Pond soil: leaf manure 1:1 and 1 cm coco peat on top, T₅: Pond soil: vermicompost 1:1, T₆: Pond soil: vermicompost 1:1, and 1 cm coco peat on top, T₇: peat moss alone

with 1 cm Cocopeat) attained the greatest height (19.27 cm), which was significantly higher than all other treatments. T_4 (17.88 cm) and T_6 (17.82 cm) are at par regarding seedling height, while T_5 (14.77 cm) and T_7 (15.49 cm) recorded the shortest plants (Table 2). The enhanced plant height under T_2 suggests optimal nutrient and moisture availability in its growing nursery material, which supported vigorous stem elongation. The positive effect may be attributed to the ability of

cocopeat to supply essential nutrients simultaneously improving the physical and biological properties of the soil, particularly its water-holding capacity. These findings are in agreement with the results of Kumawat *et al.*, (2014), who reported similar responses in papaya when cocopeat was incorporated as a component of the growing nursery material.

Number of leaves: Maximum number of leaves were reported in treatment T_4 (10.63 leaves) and T_2 (10.38

Table 2: Effect of different growth nursery materials on vegetative characteristics of papaya seedlings

Treatments	Plant height (cm) after 30 days	Number of leaves	Leaf length (cm)	Leaf width (cm)	Leaf area (cm ²)
T1	17.20bc	8.25b	5.98c	5.58b	33.38bc
T2	19.27a	10.38a	7.76a	6.89a	53.81a
T3	16.06cd	7.00c	5.98c	4.98c	29.76cd
T4	17.88b	10.63a	7.05b	5.04c	35.67b
T5	14.77d	7.63bc	5.98c	4.80c	28.67cde
T6	17.82b	8.25b	5.60c	4.61cd	25.81de
T7	15.49d	5.25d	5.42c	4.28d	23.39e
LSD	1.39	1.11	0.623	0.46	5.54

Treatments having same letter are non-significant at $P \leq 0.05$

T_1 : Pond soil: sand 1:1, T_2 : Pond soil: sand 1:1 and 1 cm coco peat on top, T_3 : Pond soil: leaf manure 1:1, T_4 : Pond soil: leaf manure 1:1 and 1 cm coco peat on top, T_5 : Pond soil: vermicompost 1:1, T_6 : Pond soil: vermicompost 1:1, and 1 cm coco peat on top, T_7 : peat moss alone

Table 3: Effect of different growth nursery materials on root development and biomass accumulation of papaya seedlings

Treatments	Number of roots	Root length (cm)	Seedling fresh weight (g)	Seedling dry weight (g)	Root fresh weight (g)	Root dry weight (g)
T1	20.00b	15.41c	3.50d	0.36e	0.60f	0.13d
T2	24.75a	18.48a	6.66a	0.97a	2.58a	0.30a
T3	15.38d	14.62c	5.65b	0.82b	1.69d	0.18c
T4	21.38b	16.70b	4.98c	0.48d	2.09b	0.18c
T5	16.00cd	15.38c	5.45b	0.55c	1.41e	0.25b
T6	17.50c	15.10c	4.67c	0.49d	1.70cd	0.22b
T7	14.50d	13.36d	5.57b	0.80b	1.87c	0.14 d
LSD	1.55	0.85	0.06	0.06	0.18	0.02

Treatments having same letter are non-significant at $P \leq 0.05$

T_1 : Pond soil + Sand (1:1) without Cocopeat; T_2 : Pond soil + Sand (1:1) with 1 cm Cocopeat; T_3 : Pond soil + Leaf manure (1:1) without Cocopeat; T_4 : Pond soil+ Leaf manure (1:1) with 1 cm Cocopeat; T_5 : Pond soil + Vermicompost (1:1) without Cocopeat; T_6 : Pond soil + Vermicompost (1:1) with 1 cm Cocopeat; T_7 : Peatmoss (1)

leaves) (Table 2). T_7 exhibited the lowest leaf count (5.25 leaves) (Table). An increased leaf number is associated with enhanced photosynthetic capacity and better early plant establishment as leaves serve as the primary sites for light interception and carbohydrate assimilation (Chen *et al.*, 2022). Combining this nursery material likely created optimal conditions, such as improved aeration and porosity, which supported the proper growth and development of seedlings and led to an increase in the number of leaves. These results are similar with findings reported by Ramteke *et al.*, 2015 in papaya.

Leaf size (length, width, and area): Leaf development followed a similar trend. T_2 exhibited the highest leaf length (7.76 cm), width (6.89 cm), and leaf area (53.81 cm²), significantly outperforming all other treatments. T_7 recorded the lowest values (leaf length 5.43 cm, width 4.28 cm, and area 23.39 cm²) (Table 2). Larger leaves with greater surface area in T_2 suggest efficient nutrient and water uptake, supporting better canopy development and photosynthesis. This can be attributed to an overall improvement in the physical and chemical properties of the rooting nursery material. These results closely align with the findings of Bishnoi *et al.*, (2024) and Ramteke *et al.*, (2015) in papaya, when they used cocopeat as an ingredient of growing nursery material.

Root development and biomass accumulation: The data reveal significant variation among treatments (T_1 – T_7) in root morphology and biomass traits.

Number of roots and root length: Seedlings grown in T_2 (Pond soil: sand 1:1 and 1 cm coco peat on top) produced the maximum number of roots (24.75) and root length (18.48 cm), both of which were significantly different from other treatments (Table 3). T_4 ranked second, with 21.38 roots and a mean root length of 16.70 cm, whereas the lowest values were recorded in T_7 (14.50 roots; 13.37 cm). An increase in root number and length is generally associated with better anchorage, enhanced soil exploration, and greater capacity for water and nutrient uptake. The superior performance of T_2 therefore indicates that its growing nursery material provided more favorable physicochemical conditions for root proliferation and elongation. These findings align with previous studies showing that nursery material contains soil + cocopeat mixtures significantly improved the root number and root length; in rosemary and geranium cuttings under soilless growing conditions (Rawat *et al.*, 2022). Similarly, New Zealand spinach seedlings exhibited greater root fresh and dry weight when grown in nursery material rich in cocopeat (Kim *et al.*, 2024).

Seedling and root biomass: Biomass accumulation showed significant difference among all treatments.

Pond soil: sand 1:1 and 1 cm coco peat on top exhibited maximum seedling fresh weight (6.66 g) and dry weight (0.97 g), as well as the highest fresh weight (root) (2.58 g) and dry weight (root) (0.30 g) respectively. These values were significantly greater compared to all other treatments. In contrast, T_1 and T_7 recorded the lowest biomass values, reflecting weaker root and shoot development (Table 3). The high organic matter content in pond soil and cocopeat is likely to enhance the growing nursery material's ability to retain water and nutrients, which are then supplied to the plant. These findings were similar with the research of Bharadwaj (2013) in papaya, who reported similar outcomes when cocopeat was used as the topping material in polybags.

CONCLUSION

The study showed that growing nursery material has a significant impact on papaya seedling germination, growth and vigour. Among various growing nursery material observed in the experiment a combination of Pond soil + sand (1:1) with 1 cm cocopeat gave better results regarding early seed germination, high vigour index, maximum number of roots, and root length of papaya cv. Red lady. Therefore, it may be suggested that adding cocopeat to soil-based nursery growing media improved the germination, growth and vigour of papaya seedlings, it is also economical and cheaper to be used on commercial basis.

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1.	Malik Mohsin Abbas	Conducted the research and collected data	
2.	M. Amna Jamil Kanwal	wrote up the manuscript and analysed data	
3.	Maryam Nasir	Reviewed the manuscript	
4.	Nida Mahreen	Analysed the data statistically	
5.	Sahar Rasheed	Proof read the manuscript	
6.	Naseem Sharif	Assisted in research work	
7.	Qamar Shahzad Anjum	Collected the data and analysed it statistically	