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STUDIES ON SUPPLEMENTAL ORGANIC MANURE FOR ENHANCING SEED GERMINATION AND SEEDLING PERFORMANCES IN PAPAYA (*CARICA PAPAYA* L.)

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ABSTRACT

This study investigated the effect of adding different organic manures on seed germination and seedling growth of papaya (*Carica papaya*) cv. Red Lady-786.The research was conducted during 2023 at Experimental Unit-1, Department of Agriculture, Integral Institute of Agricultural Science and Technology (IIAST), Integral University, Kursi Road, Lucknow (U.P.). The experiment consisted of seven treatment combinations; each replicated three times and laid out in a Completely Randomized Design. Among all the treatments, T_7 comprising (Soil + Vermicompost + FYM (1:1:1) + 3cm Cocopeat) exhibited the most favourable results, indicating their potential for use in sustainable and efficient papaya seedling growth. This treatment (T_7) exhibited the earliest germination (3.67 days), the highest germination percentage (95.5%) and the highest emergence rate (410.67%), along with the highest germination index (5.53) and germination value (68.45). It produced the maximum root length (6.15 cm) and the highest seedling survival percentage (95.37%), while also requiring the fewest days to reach transplanting size (38.27 days). In addition, T_7 significantly enhanced seedling growth giving the greatest seedling height at 30 and 45 DAS (16.77 & 18.89 cm, respectively), the highest number of leaves per plant at 30 and 45 DAS (8.93 and 14.87), the maximum shoot fresh weight (3.96g), root fresh weight (0.84 g), shoot dry weight (1.05 g), root dry weight (0.12g) and the chlorophyll content (61.63). The maximum and significantly higher root-to-shoot ratio (0.10) was recorded under treatment T_2. Whereas the highest seedling vigour (91.07%) was observed under T_7, indicating improved overall seedling performance in that treatment.

Key words : Vermicompost, FYM, Cocopeat, Seedling growth.

Introduction

Papaya (*Carica papaya* L.) is a significant tropical fruit crop, often referred to as a “wonder fruit” due to its rich nutritional profile and numerous health-promoting bioactive compounds. “Papaya is also called papaw or pawpaw, an ideal fruit for growing in kitchen gardens, backyards of homes as well as in fields, especially near the cities or big towns. It is also grown extensively as a filler plant in orchards. It is a quick-growing, typically single-stemmed, short-lived, large, perennial herb that starts bearing within 8-10 months of transplanting. The Caricaceae family comprises approximately 48 known species, of which only *Carica papaya* L. is cultivated for its edible fruits (Arvind *et al*., 2015). It is a diploid, dicotyledonous, polygamous plant with nine pairs of chromosomes and a short genome (372 Mbp/1C5). Although, papaya is believed to have originated in the tropical regions of Central and South America, it is now cultivated widely across most warm and subtropical parts of the world. In India, it is grown extensively in various states, with Maharashtra, Bihar, Tamil Nadu, Andhra Pradesh, Assam, Uttar-Pradesh and Punjab, Gujarat, West-Bengal and Madhya Pradesh, Karnataka being prominent producers. The area and production of

cultivation in India is 1.44lakh/ha and 57.80MT respectively (Anonymous,2023). Its rapid growth rate, year-round production, low input requirement, and high nutritional value make papaya an economically significant fruit crop.

Papaya is a profitable crop that increases farmers' income and supports cottage industries, offering a favourable cost-benefit ratio (Sharma and Zote, 2010). In orchards, it is also widely grown as a filler plant. In comparison to bananas, it requires less space for trees, bears fruit in a year, is simple to grow and yields a higher yield per hectare. It has been suggested that because papaya juice contains lycopene and carotenoids, it also has anti-proliferative properties against liver cancer cells in vitro (Meena and others, 2017). Although papaya fruit is typically eaten as a dessert, it can also be used to make a variety of processed foods, including pickles, preserves, jam, candies, and purees (Chaudhary *et al*., 2020). Products such as jelly, tutty fruity, marmalade, nectar, wines, syrup, dehydrated flakes, and baby meals can be made using the fruits. Rather than mature fruits, unripe fruits are the primary source of papain. The fruit and other plant components contain the milky latex papain, which has been used as a meat tenderizer and beer clarifying agent (Ayoola and Adeyeye, 2010). Papaya fruit, leaves, seeds, and latex contain a variety of essential nutrients such as vitamin C, provitamin A, folate, minerals, the digestive enzyme papain, phenolic compounds, and flavonoids. These constituents contribute to its classification as a nutraceutical-rich fruit, offering not only basic nutrition but also multiple health benefits. Previous research indicates that papaya exhibits strong antioxidant, anti-inflammatory, digestive, hepatoprotective, antidiabetic, and antimicrobial properties.

The papaya cultivar 'Red Lady (Taiwan)' is widely preferred by growers in India and abroad due to its hermaphrodite flowering habit, early bearing, high productivity, superior fruit quality, extended shelf life and tolerant to papaya ring spot virus. The variety has a productive lifespan of about two years and is capable of yielding approximately 50 tonnes per acre, with individual plant producing 50-120 fruits weighing 1.5-2.0kg each. The fruits are highly valued for their thick, firm red flesh, pleasant aroma, high sweetness and sugar content of 13-14% making them suitable for both domestic and export markets. Harvesting generally commences 8-9 months after sowing (2,4). Despite these advantages, the high cost of red lady seeds poses a major constraint for papaya growers, emphasizing the need for maximum germination and higher production of healthy seedlings. Germination of papaya seeds is often slow, uneven and incomplete, and seedling frequently suffer from high mortality due to Damping-off disease resulting in poor nursery survival. The success of papaya cultivation largely depends on the quality of seedlings, which is influenced by factors such as seed quality, suitable growing media and favorable nursery conditions (Albano *et al*., 2014). High quality seedlings are characterized by uniform growth, a strong and well-developed root system, balanced root-to-shoot biomass, and improved survivability which ultimately determine field establishment and crop performances (Costa *et al*., 2015; Sanches *et al*., 2017).

Growth media composition influences seed germination and quality of the seedlings (Bhardwaj,2013; Wilson *et al*., 2001). 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). The different growing media used in the present study include Perlite, soil, vermiculite, vermicompost, and cocopeat, among others. The soil is customarily used as a basic medium because it is the cheapest and easiest to procure. Supplementing the soil makes the media more porous, while the addition of organic matter (vermiculite, vermicompost, cocopeat, perlite) enriches it with adequate 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, used as a growing medium, provides sufficient oxygen to plant roots and ensures the 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). FYM is prepared using cow dung, cow urine, and crop waste, as well as other organic wastes, and is a rich source of nutrients. It contains 0.5% N, 0.2% P, 0.5% K and about 60-70% moisture at the initial stage.

Materials and Methods

The experiment was carried out under Experimental Unit-1 at the Department of Agriculture, Integral Institute of Agricultural Science and Technology (IIAST), Kursi

Road, Lucknow (U.P.), India. Geographically, the experimental field is situated at IIAST at 26.95°N latitude and 80.99°E longitude, with an elevation of 123m above the mean sea level (MSL). The Experimental treatments comprised twenty one treatment combinations consisting of different combination of growing media and cocopeat filling at the top of seedling polybags namely, T_1-Soil(control), T_2-Soil + Vermicompost (1:1), T_3-Soil + Vermicompost (1:1) + 1.5cm Cocopeat, T_4-Soil + Vermicompost (1:1) + 3cm Cocopeat, T_5-Soil + Vermicompost + FYM (1:1:1), T_6-Soil + Vermicompost + FYM (1:1:1) + 1.5cm Cocopeat, T_7-Soil + Vermicompost + FYM (1:1:1) + 3cm Cocopeat. On 02-09-2023, one to two seeds were sown in each polybag at a depth of approximately 10-15 mm/5cm. Various growing media were used for the sowing. The polybags were irrigated immediately after sowing with light irrigation repeated daily for each polybag until seedling emergence occurred. After the germination was complete, the polybags were lightly irrigated once every two days. The seed germination and seedling growth experiments were conducted using a completely randomized design (CRD) with three replications for each treatment. The experiment consisted of 315 polybags. Data collection began with the appearance of the first germinated seed and continued at two days interval until no further germination was recorded. Germination percentage was calculated by the number of germinated seeds divided by the total number of seeds sown in polybags and multiplied by 100. The germination period (d) was calculated as the period between the initial and the final emergence of seedlings.

The germination index was calculated by the method as described by the Association of Official Seed Analysis (AOSA, 1983) as follows.

$$\text{Germination Index} = \frac{\text{No. of germinated seed}}{\text{Date of first count 15 DAS}} + \frac{\text{No. of germinated seed}}{\text{Date of last count 25 DAS}}$$

The rate of emergence (RE) was calculated through the technique suggested by the Islam *et al.* (2009) using the following formula

$$\text{RE} = \frac{\text{No. of seedlings emerged 5 days after sowing}}{\text{No. of seedlings emerged 15 days after sowing}} \times 100$$

Seedling growth parameters such as height, number of leaves per seedling, and seedling girth were recorded at 30 and 45 days after sowing in ten randomly selected seedlings of each treatment. Seedling vigour will be evaluated by dividing the total number of healthy seedlings by the total number of seedlings and multiplying by 100.

Additionally, measurements of leaf area, fresh weight of shoot, fresh weight of root, number of roots, and root length were taken once at the time of transplanting in the field, i.e., 45 days after sowing. Leaf area of selected ten seedlings at the time of transplanting (45 DAS) was measured with tracings on graph paper and the average leaf area per sq. cm was observed. The root-to-shoot ratio will be calculated by separating and weighing stems and roots to record their fresh weights (FWs), as well as their root-to-shoot FW ratio. This ratio will be compared to the total FW of each seedling at the time of transplanting. The leaf chlorophyll content of five physiologically active leaves from tagged plants was measured with the help of a spade meter and averaged at 30 and 45 days after sowing.

Results and Discussion

The findings of the experiment titled "Studies on Supplemental Organic Manure for Enhancing Germination and Seedling Performance in Papaya (*Carica papaya* L.)" conducted in 2023 at Unit-1, Department of Agriculture, Integral Institute of Agricultural Science and Technology, Integral University, Lucknow, are presented in this chapter. The effect of different treatments on imbibition period, seed germination, seedling growth and survival percentage of papaya was statistically analyzed using standard methods to determine their significance. The result is organised and discussed under the following headings in the subsequent pages.

Seed Germination parameters

Seed germination parameters in papaya as affected by supplemental organic manure (FYM, vermicompost, cocopeat) are presented in Table 1. Treatment T_7 was found to be the best, followed by T_6, for germination parameters. These media had suitable physical properties and a good water-holding capacity to support papaya seed germination (Table 1). In the given year, maximum rate of emergence (410.67), highest germination% (95.53%), highest seedling vigour (91.07%), highest germination index (5.53), best germination value (68.45), minimum germination period (3.67 days) were obtained in Soil + vermicompost + FYM (1:1:1) + 3cm cocopeat (T_7) of the polybags in the given year.T_1 treatment comprised Soil(control) showed least values for all the parameters compared to other treatments.

The minimum days required to reach transplanting size 38.27 were recorded under treatment T_7, which was found significantly higher than treatment T_6, T_5, T_4, T_3 and T_2. However, the maximum days required to reach transplanting size 49.13 was noted under the treatment

Table 1 : Effect of different Growing Media on Germination Parameters of Papaya seedlings.

Treatment	Germination %	Germination period	Germination index	Germination value	Seedling Vigour	Rate of Emergence
T_1	62.20	8.33	2.43	17.81	51.07	144.43
T_2	64.40	8.00	2.49	19.66	53.30	144.43
T_3	68.83	8.00	2.52	20.13	57.77	152.73
T_4	77.77	7.00	3.35	31.98	66.63	161.10
T_5	88.83	7.00	3.70	41.36	75.53	283.33
T_6	91.07	4.67	4.67	55.72	84.40	405.33
T_7	95.53	3.67	5.53	68.45	91.07	410.67
SEM ±	2.224	0.488	0.161	1.764	2.790	18.480
CD	6.811	1.494	0.494	5.402	8.545	56.595

Table 2 : Effect of different Growing Media on Growth Parameters of Papaya Seedlings.

Treatment	Seedling height (cm)		Number of leaves		Stem girth (mm)		Leaf area (cm^2)		Chlorophyll content	Number of roots
	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS		
T_1	6.78	8.88	4.10	5.03	1.13	1.47	15.12	17.99	27.48	5.53
T_2	8.90	11.04	4.87	6.63	1.15	2.22	17.99	27.61	28.35	7.07
T_3	10.22	12.49	5.70	8.22	1.25	2.40	20.84	32.19	29.15	8.06
T_4	11.57	13.82	6.80	10.43	1.51	2.62	23.66	47.61	35.21	9.80
T_5	13.37	16.19	7.83	11.97	2.03	2.78	30.50	89.55	51.65	11.20
T_6	15.64	17.65	8.90	12.90	2.28	3.32	47.61	138.41	59.46	12.40
T_7	16.77	18.89	8.93	14.30	2.35	3.46	89.55	187.53	61.63	14.30
SEm±	0.311	0.430	0.204	0.305	0.064	0.130	1.041	2.441	0.589	0.334
CD at 5%	0.952	1.318	0.626	0.933	0.197	0.398	3.189	7.477	1.804	1.022

T_1. Vermicompost is reported as having bioactive principles considered to be beneficial for root growth, root initiation, germination and growth of the plant (Bachman and Metzger, 2008), as well as having a balanced composition of nutrients (Zaller, 2007). All these factors are favourable for seed germination and, ultimately, increase seed germination %, speed of emergence, seed vigour, germination index, germination value, and reduce the imbibition period. Combined application of T_7 (Soil + vermicompost + FYM(1:1:1) + 3cm cocopeat) showed a significant positive effect on germination, seedling growth and plant biomass, probably owing to a synergistic combination of both these factors in improving the physical condition of the media and providing nutritional factors (Sahni *et al*., 2008).

Seedling Growth and Development

The results presented in Table 2 indicated that the seedling height of papaya seedlings was significantly affected by different propagating media at both 30 and 40 days after sowing (DAS).

Among the treatments, growing medium T_7 [Soil+Vermicompost+FYM(1:1:1)+ 3cm cocopeat] produced the tallest seedlings at 30 and 45 DAS, recording heights of 16.77cm and 18.89cm, respectively. This treatment showed statistically superior performances over all other treatments except T_6, with which it remained at par. In contrast, the lowest seedling height at 30 and 45DAS (6.78cm and 8.88cm, respectively) was observed under T_1 (control). 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 providing 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_7 (2.35mm and 3.46mm) showing superior performance compared to other treatments. Similar results were obtained by Bhardwaj (2014) and Rakibuzzaman *et al*. (2019). Similarly, the highest number of leaves per plant at 30 and 45 DAS (8.93 and 14.87, respectively)was recorded in treatment T_7, which was statistically comparable with

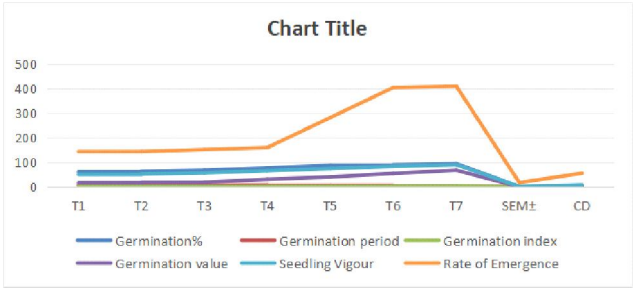

Fig. 1 : Effect of different Growing Media on Germination Parameters of Papaya seedlings.

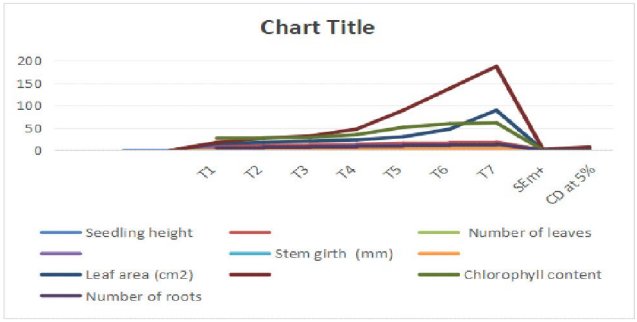

Fig. 2 : Effect of different Growing Media on the Growth Parameter of Papaya seedlings.

Fig. 3 : Effect of different Growing Media on Growth Parameters of Papaya Seedlings.

T6(8.90 and 12.90, respectively). This treatment has also recorded highest survival percentage (95.37%) and the highest chlorophyll content (61.63), the longest tap root (6.15cm), maximum number of roots (14.30). Treatments with a cocopeat layer contributed to enhanced aeration in the rooting zone and promoted root elongation. Similar results for number of roots and root length have been reported by Gawankar *et al*. (2019).

The maximum fresh weight of shoot and root (3.96g and 0.84g, respectively) was found highest in T_7 with maximum dry weight of shoot and root (1.05g and 0.12g, respectively). These results align with other growth parameters, indicating enhanced biomass accumulation under these media combinations. The fresh weight of seedling observed in this study is consistent with previous findings of Jitendra *et al*. (2025). A careful examination of the data further revealed that the application of different supplemental organic manures significantly influenced the root: shoot ratio of papaya seedlings at 45DAS. The highest and statistically superior root: shoot ratio (0.10) was recorded in treatment T_2, whereas the lowest root: shoot ratio (0.24) was noted in treatment T_6.

Conclusion

The results of the present study clearly indicated that the propagating medium consisting of Soil + Vermicompost + FYM (1:1:1) supplemented with a 3cm layer of cocopeat (T_7) proved to be the most effective for improving germination and seedling growth of papaya. This treatment significantly reduced the time required for germination and transplanting; while producing higher germination percentage, emergence rate, seedling survival and vigour compared to other media. Superior seedling attributes such as plant height, stem girth, root development and biomass circulation, leaf number, leaf

Table 3 : Effect of different Growing Media on Growth Parameters of Papaya Seedlings.

Treatment	Tap root length (cm)	Fresh weight of shoot (g)	Fresh weight of root (g)	Root shoot (FW) ratio	Dry weight of shoot (g)	Dry weight of root (g)	Survival percentage (%)	Days required to reach transplanting size
T_1	2.92	1.45	0.15	0.19	0.30	0.04	82.17	49.13
T_2	2.97	1.60	0.16	0.10	0.39	0.05	82.57	47.33
T_3	3.16	1.86	0.20	0.11	0.41	0.05	83.93	45.93
T_4	3.96	2.70	0.39	0.16	0.50	0.06	84.97	44.67
T_5	5.05	2.94	0.50	0.19	0.58	0.06	85.57	42.80
T_6	5.90	3.84	0.63	0.24	0.77	0.11	92.63	40.63
T_7	6.15	3.96	0.84	0.18	1.05	0.12	95.37	38.27
SEm±	0.155	0.109	0.016	0.012	0.022	0.003	2.673	0.814
CD at 5%	0.475	0.333	0.049	0.035	0.067	0.008	8.185	2.492

area, chlorophyll content and root to shoot ratio were also recorded under T_7. Therefore, the combined use of organic manures with cocopeat can be recommended as an ideal nursery medium for producing healthy, vigorous and high-quality papaya seedlings.

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