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Influence of organic waste and growing media on seed germination and seedling growth of Papaya (*Carica papaya* L.) under polyhouse conditions

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Abstract

A field experiment was conducted to study the "Effect of organic wastes and growing media on seed germination and seedling growth of papaya (*Carica papaya* L.*)* under polyhouse condition" was taken up at the instructional farm of Department of Horticulture, College of Agriculture, Rewa (M.P.) during October to November 2022. There were thirteen treatments combinations of organic wastes and growing media *viz.* T_1- Control, T_2- Cow dung 12 hours + Soil + FYM + Vermicompost T_3- Cow dung 12 hours + Soil + FYM + Cocopeat T_4- Cow dung 24 hours + Soil + FYM + Vermicompost T_5- Cow dung 24 hours + Soil + FYM + Cocopeat T_6- Cow dung slurry 12 hours + FYM + Vermicompost T_7- Cow dung slurry 12 hours +Soil + FYM + Cocopeat T_8- Cow dung slurry 24 hours + Soil + FYM + Vermicompost T_9- Cow dung slurry 24 hours + Soil + FYM + Cocopeat T_{10}- Cow urine 12 hours + Soil + FYM + Vermicompost T_{11}- Cow urine 12 hours + Soil + FYM + Cocopeat T_{12}- Cow urine 24 hours + Soil + FYM + Vermicompost T_{13}- Cow urine 24 hours + Soil + FYM + Cocopeat. Which were laid out in randomized block design with three replications.

Key words: Papaya, organic waste, germination percentage, fresh weight.

Introduction

Papaya (*Carica papaya* L.), often referred to as the "wonder fruit of the tropics," belongs to the family *Caricaceae* and is believed to have originated in Tropical America. It was introduced to India from Malacca during the 16th century and is now cultivated across all tropical and subtropical regions worldwide. In India, papaya is cultivated on approximately 144 thousand hectares, producing a total of 5,951 thousand metric tons (MT) (NHB, 2019–20). In Madhya Pradesh, papaya covers about 10.98 thousand hectares, contributing 435.91 thousand MT to the state's annual fruit production, with an average productivity of 39.68 MT/ha (NHB, 2019–20). Compared to traditional field crops, papaya is highly remunerative, offering significantly higher returns to growers. Within Madhya Pradesh, major papaya-producing districts include Dhar, Barwani, Khargone, Khandwa, Ratlam, and Guna.

Papaya is also an important source of papain, a commercially valuable proteolytic enzyme obtained from the latex of unripe green fruits (Silva *et al*., 2018; Auxcilia *et al*., 2020). On the other hand, growing media play a crucial role in seed germination and quality seedling production (Agbo and Omaliko, 2006). It serves as a vital component in both container-grown and bare-root nursery systems (Rose and Haase, 2000). Different types of

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growing media provide essential nutrients for plant growth (Khan *et al.,* 2006). An ideal growing medium should be free from harmful microorganisms, exhibit good drainage, have adequate water-holding capacity, suitable porosity, and allow proper aeration to support healthy seedling development.A well-balanced growing medium fulfills three primary functions: it anchors the plant, retains and supplies water and nutrients, and provides adequate oxygen to the roots (Ingram *et al*., 2003). One of the most efficient media components is cocopeat, which is characterized by high total pore space, high water retention capacity, low shrinkage, low bulk density, and moderate biodegradability (Thiruppathi and Mullaimaran, 2020, Khan *et al*., 2023).

The use of organic wastes in appropriate concentrationsalong with scarificationcan significantly influence the growth behavior of many fruit crops. Pre-sowing treatments using organic wastes like cow dung and cow urine have shown promising effects in improving seed germination and seedling vigor. Cow urine, in particular, is a cost-effective and readily available organic input. Though its effects may vary, it contains beneficial compounds such as iron, urea, uric acid, estrogen, and progesterone, which can influence seed germination, shoot elongation, and overall seedling development (Dilrukshi, 2009). An effective growing medium not only provides mechanical support but also acts as a reservoir for water and nutrients, facilitates oxygen availability to roots, and ensures proper gaseous exchange. Media used for raising fruit crop seedlings typically comprise pond soil, sand, and organic matter such as farmyard manure (FYM) and vermicompost. Pond soil is commonly used as a base medium due to its availability and cost-effectiveness. Sand is incorporated to improve porosity, while organic matter enriches the medium with essential nutrients. Among these, cocopeat stands out as a superior component due to its balanced pH, acceptable electrical conductivity, and favorable physical and chemical properties (Abad *et al*., 2002). Therefore, the present study was conducted to investigate the effect of various combinations of organic wastes and growing media on seed germination and seedling growth of papaya (*Carica papaya* L.) under polyhouse conditions.

Materials and Methods

The experiment has been carried out in poly house conditions from October to November 2022 at Department of Horticulture's Instructional Farm, College of Agriculture, Rewa (M.P.) Rewa is located in North Eastern region of Madhya Pradesh at latitude 24°30′ North latitude, longitude 81°15′ East longitude, and elevation 360.0 meters above mean sea level. The subtropical climate of Rewa, with hot and dry summers and cold winters, is the region's key characteristic. In general, the maximum and minimum temperatures are higher than 43.3°C lower than 5°C, respectively. The average rainfall ranges from 900 mm to 1150mm, which is received mainly in rainy season (July-September).

Germination Percentage: The germination in each treatment was recorded at 30 days after sowing number of seedlings were recorded and expressed as percentage germination.

$$\text{Germination \%} = \frac{\text{Total No. of germinated seed of a treatment}}{\text{Total No. of seed sown in the treatment}} \times 100$$

Results and Discussion

Days taken to start germination

The results illustrated in (Table 1) the average number of days taken for papaya seed germination varied significantly comparing to different treatments. The minimum average number of days required for papaya seed germination is begin recorded in treatment T_5 *i.e.* Cow dung 24 hours + Soil + FYM + Cocopeat (9.17 days). which was significantly superior to other treatments, followed by T_4 *i.e.* Cow dung 24 hours + Soil + FYM + Vermicompost (10.5 days) and T_3 *i.e.* Cow dung 12 hours + Soil + FYM + Cocopeat (11.5 days), while, the maximum number of days recorded for papaya seed germination was found in treatment T_1 *i.e.* control (15 days).

Days taken to complete germination

The results illustrated in (Table 1) the average number of days taken for complete germination of papaya seed varied significantly comparing to different treatments. The minimum average number of days required for complete germination of papaya seed is begin recorded in treatment T_5 *i.e.* Cow dung 24 hours + Soil + FYM + Cocopeat (15.0 days) which was significantly superior to other treatments, followed by T_4 *i.e.* Cow dung 24 hours + Soil + FYM + Vermicompost (15.8 days) and T_3 *i.e.* Cow dung 12 hours + Soil + FYM + Cocopeat (16.2 days), while the maximum number of days recorded for complete germination of papaya seed was found in treatment T_1 *i.e.* control (23.0 days).

Germination percentage

Various seed soaking treatment affected the rate of papaya seed germination. The results illustrated in (Table 1) the average germination percentage for papaya seed germination varied significantly comparing to different treatments. The maximum germination rate of seeds (80.0%) resulted in treatment T_5 *i.e.* Cow dung 24 hours + Soil + FYM + Cocopeat, which was significantly superior to other treatments, followed by T_4 *i.e.* Cow dung 24 hours + Soil + FYM + Vermicompost (77.0%) and T_3 *i.e.* Cow dung 12 hours + Soil + FYM + Cocopeat (72.0%) while, the minimum germination rate recorded in treatment T_1 *i.e.* control (50%). These outcomes could be linked to the retention of more air and moisture, therefore facilitated in rapid and early enzymatic activity for production of compounds which result cell proliferation, as well as accelerated seed coat dissolution, leading in the embryo's changeover into a seedling at initial stages. These outcomes could be linked to the retention of more air and moisture, therefore facilitated in rapid and early enzymatic activity for production of compounds which result cell proliferation, as well as accelerated seed coat dissolution, leading in the embryo's changeover into a seedling at initial stages.

Among the different treatments, T_5 (Cow dung 24 hours + Soil + FYM + Cocopeat) was found most effective, recording the earliest initiation of germination (9.17 days) and completion of germination (15.0 days), along with the highest germination percentage (80.0%). This improvement can be attributed to the synergistic effect of cow dung soaking, which may help in breaking seed dormancy by softening the seed coat and initiating enzymatic activity essential for germination. Additionally, the growing media combination in T_5 provided an ideal balance of aeration, mois-

Table 1. Germination (%), Seedling vigour index, Length of root (cm), Fresh weight (gm) and Dry weight (gm) of papaya seeds as influenced by different doses of bio-wastes and growing media

Treatment	Days taken to start Germination	Days taken to complete Germination	Germination percentage	SVI	Length of root (cm)	Fresh weight (gm)	Dry weight (gm)
Control (T_1)	15.0	23.0	50.0	480.1	9.8	1.2	0.11
Cow dung 12 hours + Soil + FYM + Vermicompost (T_2)	11.5	16.5	68.0	1226	17.7	2.6	0.27
Cow dung 12 hours + Soil + FYM + Cocopeat (T_3)	11.2	16.2	72.0	1315	18.1	2.7	0.34
Cow dung 24 hours + Soil + FYM + Vermicompost (T_4)	10.5	15.8	77.0	1400	18.5	3.0	0.37
Cow dung 24 hours + Soil + FYM + Cocopeat (T_5)	9.17	15.0	80.0	1500	19.0	3.3	0.42
Cow dung slurry 12 hours + Soil + FYM + Vermicompost (T_6)	13.9	19.0	55.0	850	15.1	2.0	0.17
Cow dung slurry 12 hours +Soil + FYM + Cocopeat (T_7)	13.0	18.5	58.0	900.1	15.7	1.9	0.17
Cow dung slurry 24 hours + Soil + FYM + Vermicompost (T_8)	12.2	18.0	60.0	1009.3	16.1	2.1	0.19
Cow dung slurry 24 hours + Soil + FYM + Cocopeat (T_9)	12.0	17.4	65.0	1100.3	16.5	2.4	0.22
Cow urine 12 hours + Soil + FYM + Vermicompost (T_{10})	13.9	21.7	51.0	520	11.1	1.4	0.12
Cow urine 12 hours + Soil + FYM + Cocopeat (T_{11})	13.7	21.5	52.0	610	12.0	1.5	0.12
Cow urine 24 hours + Soil + FYM + Vermicompost (T_{12})	13.3	19.9	53.0	750	13.2	1.7	0.15
Cow urine 24 hours + Soil + FYM + Cocopeat (T_{13})	13.0	19.4	54.0	800	14.7	1.9	0.16
S. Em$\pm$	0.26	0.132	1.14	0.30	0.035	0.046	0.004
C.D. at 5%	0.76	0.384	3.33	0.88	0.10	0.13	0.011

ture retention, and nutrients, all crucial for early seedling development. These results are consistent with the findings of Paikra *et al*. (2021), who reported that organic seed treatments significantly improve seed germination and seedling vigor in papaya by enhancing water uptake and enzymatic activation. Similarly, Rana *et al.* (2020) observed that media enriched with FYM and cocopeat enhanced the physical environment around the seed, promoting faster and more uniform germination. The treatments T4 (Cow dung 24 hours + Soil + FYM + Vermicompost) and T_3 (Cow dung 12 hours + Soil + FYM + Cocopeat) also performed well, showing significantly better results compared to the control. These treatments highlight the importance of both the soaking duration and the composition of the growing media. The presence of organic matter like FYM, vermicompost, and cocopeat not only provides essential nutrients but also improves the physical structure of the soil, which is favourable for seed germination.In contrast, the control treatment (T_1), which lacked both cow dung soaking and media amendments, showed delayed germination (15 to 23 days) and lowest germination percentage (50%), emphasizing the necessity of pre-sowing seed treatment and appropriate growing conditions. The enhancement in germination could be further explained by the fact that cow dung contains beneficial microbial populations and growth-promoting substances that may have stimulated early enzymatic activities, thereby promoting cell division and embryo growth. Moreover, the improved air and moisture retention properties of cocopeat and vermicompost likely facilitated early seed coat breakdown and enhanced oxygen availability, both critical factors in the germination process (Singh *et al*., 2019; Kumawat *et al*., 2018).

Seedling vigour index

The effect of organic waste and growing media combination was found significant for variation in seedling vigour index. The maximum seedling vigour index in treatment T_5 *i.e.* Cow dung 24 hours + Soil + FYM + Cocopeat (1500) at 45 DAS. Which was significantly superior to other treatments, followed by T_4 *i.e.* Cow dung 24 hours + Soil + FYM + Vermicompost(1400) at 45 DAS. and T_3 *i.e.* Cow dung 12 hours + Soil + FYM + Cocopeat (1315). At 45 DAS. while, the minimum seedling vigour index recorded in treatment T_1*i.e.* control (480.1).

Length of root (cm)

The effect of organic waste and growing media combination was found significant for variation in length of root. The maximum length of root in treatment T_5 *i.e.* Cow dung 24 hours + Soil + FYM + Cocopeat (19.0cm) at 45 DAS. Which was significantly superior to other treatments, followed by T_4 *i.e.* Cow dung 24 hours + Soil + FYM + Vermicompost(18.5cm) at 45 DAS. and T_3 *i.e.* Cow dung 12 hours + Soil + FYM + Cocopeat (18.1cm). at 45 DAS. while the minimum length of root recorded in treatment T_1*i.e.* control (9.8cm).

Table 2. Effect of organic waste and growing media on total gross income, total expenditure, net income and B:C ratio

Treatment	Gross income (Rs)	Net income (Rs)	B:C Ratio
Control (T_1)	180	81	0.83
Cow dung 12 hours + Soil + FYM + Vermicompost (T_2)	230	132	1.34
Cow dung 12 hours + Soil + FYM + Cocopeat (T_3)	235	135	1.35
Cow dung 24 hours + Soil + FYM + Vermicompost (T_4)	240	142	1.45
Cow dung 24 hours + Soil + FYM + Cocopeat (T_5)	250	152	1.55
Cow dung slurry 12 hours + FYM + Vermicompost (T_6)	215	115	1.15
Cow dung slurry 12 hours +Soil + FYM + Cocopeat (T_7)	220	122	1.24
Cow dung slurry 24 hours + Soil + FYM +Vermicompost (T_8)	225	125	1.25
Cow dung slurry 24 hours + Soil + FYM + Cocopeat(T_9)	228	130	1.32
Cow urine 12 hours + Soil + FYM + Vermicompost (T_{10})	208	110	1.12
Cow urine 12 hours + Soil + FYM + Cocopeat (T_{11})	210	112	1.14
Cow urine 24 hours + Soil + FYM + Vermicompost (T_{12})	210	113	1.16
Cow urine 24 hours + Soil + FYM + Cocopeat (T_{13})	215	115	1.15

Fresh weight of root (gm)

The effect of organic waste and growing media combination was found significant for variation in fresh weight of root. The maximum fresh weight of root in treatment T_5 *i.e.* Cow dung 24 hours + Soil + FYM + Cocopeat (3.3gm) at 45 DAS. Which was significantly superior to other treatments, followed by T_4 *i.e.* Cow dung 24 hours + Soil + FYM + Vermicompost(3.0gm) at 45 DAS. and T_3 *i.e.* Cow dung 12 hours + Soil + FYM + Cocopeat (2.7gm) at 45 DAS. While, the minimum fresh weight of root recorded in treatment T_1 *i.e.* control (1.2 gm).

Dry weight of root (gm)

The effect of organic waste and growing media combination was found significant for variation in dry weight of root. The maximum dry weight of root in treatment T_5 *i.e.* Cow dung 24 hours + Soil + FYM + Cocopeat (0.42 gm) at 45 DAS. Which was significantly superior to other treatments, followed by T_4 *i.e.* Cow dung 24 hours + Soil + FYM + Vermicompost (0.37gm) at 45 DAS. and T_3 *i.e.* Cow dung 12 hours + Soil + FYM + Cocopeat (0.34gm). at 45 DAS. While, the minimum dry weight of root recorded in treatment T_1 *i.e.* control (0.11gm). The outcome from present research were accordance another's Palepad *et al*. (2016) and Desai *et al*. (2017). The maximal seedling vigour index (SVI) was acquired by multiplying the percent germination to the length of root. It was maximal responded in T_5 Cow dung 24 hours + Soil + FYM + Cocopeat (1500) and minimum in T_1 control (480.1).

The maximum root length (19.0 cm) was observed in T5 (Cow dung 24 hours + Soil + FYM + Cocopeat) at 45 DAS, followed closely by T_4 (18.5 cm) and T_3 (18.1 cm). In contrast, the minimum root length (9.8 cm) was recorded in the control treatment (T_1). These findings suggest that the enhanced physical environment and nutrient supply in the amended media likely promoted deeper and healthier root development. Cocopeat and FYM, being porous and nutrient-rich, provide optimal aeration and water retention conditions, which are critical for root elongation and function. These results are consistent with those reported by Palepad *et al*. (2016) and Desai *et al*. (2017), who observed that the use of organic manures and soil amendments significantly improved the root length and overall seedling growth in papaya and other fruit crops.Similarly, significant variation was recorded in the fresh weight of roots, with T_5 exhibiting the highest fresh root weight (3.3 g), followed by T_4 (3.0 g) and T_3 (2.7 g), while the lowest (1.2 g) was in T_1. This enhanced biomass accumulation is a direct consequence of better nutrient availability and improved root physiological activity. The pres-

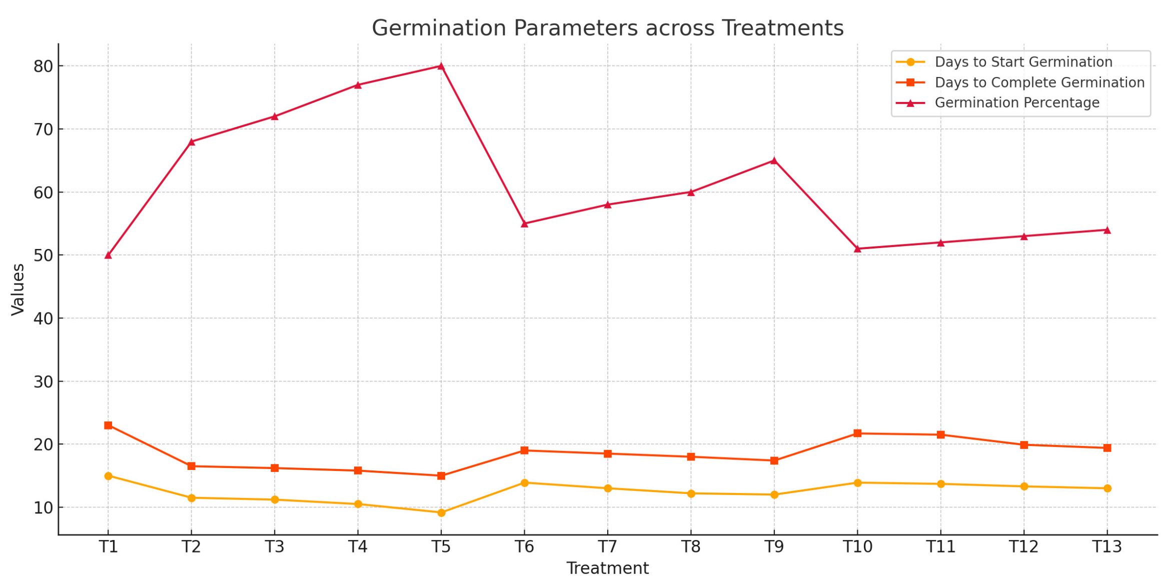

Fig. 1. Germination (%) of papaya seeds as influenced by different doses of bio-wastes and growing media

ence of well-decomposed cow dung in combination with cocopeat and FYM may have contributed to better microbial activity and enhanced nutrient uptake, as supported by previous findings (Palepad *et al*., 2016; Desai *et al*., 2017). For dry root weight, the trend remained consistent. T_5 again showed the highest dry weight (0.42 g), while T_1 was the lowest (0.11 g). This again points to the superior efficiency of the organic media combinations in facilitating not just water absorption but also nutrient assimilation, leading to greater structural development of the root system. Dry weight is a reliable indicator of assimilate accumulation, and higher values in enriched treatments signify robust metabolic activity during early growth stages. The Seedling Vigour Index (SVI), calculated by multiplying germination percentage with root length, was highest in T_5 (1500) and lowest in T_1 (480.1). This further confirms the positive influence of soaking treatment and enriched substrates on seedling vigor. A higher SVI denotes healthier and more vigorous seedlings, which is crucial for successful transplant establishment and subsequent field performance. These findings align with earlier studies conducted by Palepad *et al*. (2016) and Desai *et al*. (2017), who emphasized that combinations of organic amendments like cow dung, FYM, vermicompost, and cocopeat significantly improve root growth, biomass, and seedling quality due to better nutrient and moisture management.

Economics

The maximum gross returns (250/ha), net returns (152/ha) and benefit cost ratio was recorded in treatment T_5- Cow dung 24 hours + Soil + FYM + Cocopeat (1.55), whereas the minimum gross returns (180/ha), net returns (81/ha) and benefit cost ratio was observed in treatment T1 Control (0.83).

Conclusion

Result concluded that the seeds soaked with organic waste and growing media of cow dung for 24 hours in combination with Soil + FYM + cocopeat treatment was superior over all other treatments in relation to germinationand physiological parameters as well as root characters and minimum values found in control. However, these results are only indicative and require further experimentation to arrive at more consistent and final conclusion to be passed on to growers.

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