



## **Effects of Growing Media and Biocapsules on Germination and Growth of Papaya (*Carica papaya*) cv. Pusa Nanha**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

The study, was carried out during March – June 2022 at Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj. The experiment was carried out to see the performance of the most suitable soil media for growth and establishment of Papaya seedlings. There were nine treatments including control viz, M0 Control (Garden soil), M1(Soil + FYM), M2 (Soil+FYM+biocapsules), M3 (Soil+FYM+Neemcake), M4 (Soil + FYM + Neemcake + biocapsules), M5 (Soil +FYM + Vermicompost), M6 (Soil + Sand + Vermicompost + biocapsules), M7 (Soil + FYM + Sand) M8 (Soil+FYM+Sand+Biocapsules) replicated three times with 10 seeds per replication. Growth medium significantly affected the growth, biomass, and root morphological indexes of papaya seedlings. The results reveal that the treatment M6 (Soil+Sand+Vermicompost+biocapsules) was the most suitable treatment over all the other treatments in relation to germination and growth parameters.

**Keywords:** *FYM; vermicompost; biocapsule; neemcake.*

## 1. INTRODUCTION

Papaya is a very wholesome, refreshing and delicious fruit and rich source of vitamins. Immature papaya fruit is a rich source of papain, whereas mature fruit is rich source of carbohydrates (7.2%), minerals, Vitamin A (2020 IU/100g) and Vitamin C (85mg/100g) [1]. It has high medicinal value. Papain prepared from dried latex of its immature fruits is used in meat tenderizing, manufacture of chewing gum, cosmetics, degumming of natural silk and to give shrink resistance to wool. Papaya has an in vitro antiproliferative effect in liver cancer cells, possibly due to lycopene [2]. Its fruits are consumed fresh as well as processed commercially into jam, jelly, nectar, squash, cheese, puree, etc. papaya is highly remunerative due to high yield potential and good filler fruit crop that provide extra income to the orchardist. By adopting proper management practices and selection of suitable varieties a gross income of Rs 1.90 lac can be obtained within a year of planting from papaya crop [3].

Papaya is a quick growing, continuous fruiting, evergreen plant and requires a good fertile soil or growing media for both growth, development and quality of fruits [3-6]. The use of suitable growing media or substrates for sowing of seeds directly affects the germination, development and functional rooting system. A good growing medium provides sufficient anchorage or support to the plant, serves as reservoir for nutrients and water, allow oxygen diffusion to the roots and permit gaseous exchange between the root and atmosphere outside the root substratum [7-10]. The quality of seedlings is very much influenced by growing media under nursery. The quality of seedlings obtained from a nursery influences re-establishment in the field and the eventual productivity of an orchard [11].

Since papaya is commonly propagated by seeds, the various factors like type of potting media used, water, oxygen, temperature, light, plant species etc. are the most important for successful production of the crop [12]. The germination of papaya seeds was reported slow, erratic and incomplete. Germination of papaya seed faces certain problems of seedling mortality due to damping off diseases in nursery stage. Initial mortality and improper germination is one of the major causes of reduced survival per cent of papaya plants. The development of root system is suppressed and plants are more susceptible to soil borne diseases in heavy soils

without drainage. The papaya seeds are endorsed within a gelatinous sarcotesta (aril or outer seed coat which is formed from the outer integument). Growing media are an integral part of most horticultural production systems. Generally, media for fruit crop seedlings are composed of soil and different organic matters [13-26]. The soil is generally used as a basic medium because it is cheapest and easy to procure supplementing of the soil which is aimed to make media more porous while the organic matter vermicompost, Farmyard Manure (FYM), Neemcake are added so as to enrich adequate nutrients for the seedlings. A growing medium is a substance through which roots grow to extract water and nutrients. The growing medium also plays an important role in seed germination not only it does act as a support, but also a source of key nutrients for plant growth. The composition of the medium influences the quality of the seedlings [17]. The important media used to raise nursery plants along with their characters are Soil, vermicopost, FYM, neemcake, sand, biocapsules are included in the present study. Soil having good texture should be preferred for using a propagation media.

Sand is used as a rooting media for adding the coarse texture needed to induce proper drainage and aeration. Sand is the heaviest of all the rooting media. Therefore it should be a combination with some other organic material.

Farmyard Manure (FYM) is primarily made from cow dung, cow urine, waste grass, and other dairy waste. Properties of FYM are, FYM is nutrient-rich. A small portion of N is available directly to the plants, while a greater portion is made available when FYM decomposes. Farmyard manure has been the main source of organic matter for the supply of essential minerals needed by the plants. Heavy applications of organic matter are required for successful production of fruits and vegetables.

Neem Cake is the de-oiled residue that can be used after Neem kernels are crushed for their oil. In this seed kernel are nutrients like nitrogen-phosphorus-potassium (NPK). These nutrients are nematicidal in nature so the seed cake ends up with these properties [18,19]. Neem Cake is used in agriculture, horticulture, floriculture and the turf industry as an organic fertilizer as well as a natural nematicide. Neem Cake is used as an organic fertilizer because of the various micro and macro nutrients which it is composed of. It will control, at the same time, soil based

pathogens as well as nematodes. It will also inhibit nitrification of the soil plus enhance the efficiency of nitrogen providing fertilizer [20-22].

Vermicompost refers to a mixture of worm casting, organic material, humus, living earthworms their cocoons and other organisms. Earthworm reduces C:N ratio, increases humic acid content, cation exchange capacity and water soluble carbohydrates. Vermicompost is a rich source of nutrients with good water holding capacity.

Biocapsules is a revolutionary technology that ensures the successful delivery of biologically competent beneficial microbes. Biocapsule, a biofertiliser technology developed by - Indian Institute of Spices Research, has started gaining acceptance among the farming community. Recently, Indian Council of Agricultural Research (ICAR) scientists have developed the technology to pack bio-fertilizers in tiny capsules. This eliminates the need for farmers to carry the sacks of biofertilizers.

- It is being called the **one-gram capsule, which have many advantages:**
  - One-gram capsules are very efficient as it contains the microbial population equivalent to what is present in a one-kg pack of powder-based biofertilizer or a one-litre bottle.
  - Also, as these microbial strains are retained in the dormant stage, there is no issue of their viable loss in room temperatures as is the case with many liquid-based bio formulations.

#### Unique Benefits of biocapsule

- Each capsule contain  $10^9$  propagule.
- Enhance seed germination & suppress diseases.
- Low cost, ecologically safe micro for all agriculture and horticulture crop.
- Promote crop growth & increase in yield.
- Long lasting viability up to 2 yrs.
- Easy to use & handling (Drench, seed treatment & use in compost)

Recently numerous complaints have been received from papaya growers regarding poor seed germination, high mortality percentage of seedlings and seed viability. So, increasing germination percentage percent and producing more seedlings is a challenge for papaya

growers. The papaya seed (*Carica papaya L.*) cv. Pusa Nanha faces certain problems in germination and has high seedlings mortality due to damping off disease in nursery. Initial mortality and incomplete germination is also one of the causes of reduced survival percent of papaya seedlings. Hence keeping in view the influence of media in germination and seedling growth of papaya, the present research was carried out

1. To study the effects of different potting media on seed germination and seedling growth of papaya seedlings.
2. To study the survival percentage of seedlings on transplanting.

## 2. MATERIALS AND METHODS

The experiment entitled was carried out at Department Nursery and Horticulture Research Farm, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh during the month of March-June 2022. The site is situated between the North latitude  $25^{\circ}42'$  and at the East longitude  $85^{\circ}55'$  with an altitude of 98 meter above mean sea level on northern aspect. The climate is characterized by hot summers with maximum temperature  $47^{\circ}\text{C}$  during May and June and least being i.e.,  $1^{\circ}\text{C}$  in January. On an average the area receives an annual rainfall of 850 to 1000 mm. Most of which is concentrated during monsoon season.

There were nine treatment combination including control viz,  $T_0$  Control (Garden soil),  $T_1$  (Soil + FYM),  $T_2$  (Soil + FYM + biocapsules),  $T_3$  (Soil + FYM + Neemcake),  $T_4$  (Soil + FYM + Neemcake + biocapsules),  $T_5$  (Soil + FYM + Vermicompost),  $T_6$  (Soil + Sand + Vermicompost + biocapsules),  $T_7$  (Soil + FYM + Sand)  $T_8$  (Soil + FYM + Sand + Biocapsules) replicated three times with 10 seeds per replication. Seeds were sown in the month of march. The polybags were irrigated after sowing and repeated everyday until emergence and in alternate days after germination.

### 2.1 Experimental Design and Measured Parameters

The experiment was carried out in a complete random block design with 30 polybags per treatment. All the germination and growth parameters were recorded at the time of germination till transplanting (60 days after sowing).

The days taken for first seed germination were calculated from the date of sowing up to germination of the first seedling. Germination per cent was calculated as the number of seeds sown and the number of seeds germinated, expressed in percentage.

$$\text{Germination percent} = \frac{\text{No of seeds germinated}}{\text{Total no. of seeds sown}} \times 100$$

Height of the seedling was recorded by measuring the height of five random seedlings by metric scale from the base to the tip of the shoot of the seedling. The numbers of leaves of five seedlings were counted and average value was calculated. The stem girth of seedlings were measured with the help of vernier caliper at height 1cm above ground level. The fresh weight of seedlings was weighed on digital weighing balance expressed in gram. The primary root of seedlings were measured by metric scale from the base of the shoot to tip of root at the time of transplanting. The Root: Shoot ratio was calculated by dividing dry weight of roots by dry weight of shoots of seedlings at the time of transplanting. The chlorophyll content of the leave of the plant was measured using a Soil Plant Analysis Development (SPAD) meter. Survival percentage of papaya seedlings was observed by transplanting them in the field and was calculated using the formula:

$$\text{Survival percentage} = \frac{\text{Total number of surviving seedlings}}{\text{Total number of seedlings transplanted}} \times 100$$

### 3. RESULTS AND DISCUSSION

The results shows that growing media and biocapsule had beneficial effects on germination, seedling growth and survival percentage of papaya.

#### 3.1 Seed Germination Parameters

Effects of growing media and biocapsules on seed germination parameters are given in Table 1. The treatment T<sub>6</sub> was found best followed by treatment T<sub>2</sub> regarding germination parameters as it had the best water holding capacity, porosity and nutrients which would have enhanced the availability of water, aeration and nutrition during germination of seed.

Germination started at 11.3 days after sowing on Soil +FYM + Vermicompost (1:1:1) + Biocapsule (T<sub>6</sub>). Similar findings were found in Gawankar et al. [23] in jackfruit which took 11.8 days for initiation of germination, Kumar et al. (2015) in papaya, Kaur [24] in mango stones. Maximum germination percent 96.67 was also found in T<sub>6</sub>. This might be because of the media containing organic manures possess organic acid within them. Therefore, more available moisture and some acids may have helped in better germination percentage. Biocapsules also provide microbes that are beneficial to plants. Among the microbes, rhizobacteria, which functions as plant growth promoting rhizobacteria (PGPR) such as *Pseudomonas* spp. and *Bacillus* sp., can serve as fertilizer. These organisms have proven to accelerate germination and improve overall growth of the plant. Similar findings were found in, Kumararvind et al. [25] in papaya with germination percent (96.11%), Irsa et al. [26] in marigold.

#### 3.2 Seedling Growth Parameters

Growth increase in papaya seedling significantly affected by growing media and biocapsule is presented in the data in Table 2 and 3. Highest seedling height (23.41 cm) was recorded in T<sub>6</sub>. Maximum number of leaves (10.8) was recorded in T<sub>6</sub> which was at par with T<sub>2</sub> (10.2). Soil, vermicompost, FYM provides adequate nutrients and enhances both the physical and biological properties and the water holding capacity of soil while iocapsule provide PGPR (plant growth-promoting rhizobacteria) which results in acceleration of plant growth and protection against plant pathogens. Similar findings were found in Samir et al. [27] in Khirmi, Dayeswari et al. [28] in papaya, Kumar et al. [29] in *Albizia lebbek*.

Maximum stem girth (7.09mm), longest root length (12.83cm), highest seedling vigour (3503.33), highest chlorophyll content (38.37 μmol per m<sup>2</sup>) and highest fresh weight of seedling (14.74 g) were recorded in treatment T<sub>6</sub>. This might be due to vermicopost which contains plant growth regulations like auxis, gibberillins and cytokinins which are responsible for increase in plant growth and biocapsule which provide PGPR (plant growth-promoting rhizobacteria) which results in acceleration of plant growth. Similar findings were found in Chiranjeevi et al. [30] in aonla.

**Table 1. Effects of different growing media and biocapsule on germination parameters of papaya plant**

Treatments	Initiation period	Germination percent %
T <sub>0</sub>	18.8	56.67
T <sub>1</sub>	18.4	63.33
T <sub>2</sub>	11.6	93.33
T <sub>3</sub>	15.6	73.33
T <sub>4</sub>	13.8	83.33
T <sub>5</sub>	12.7	86.67
T <sub>6</sub>	11.3	96.67
T <sub>7</sub>	16.23	66.67
T <sub>8</sub>	15.4	80.00
C.D.(P=0.05)	0.68	17.90
C.V	2.64	13.30

**Table 2. Effects of different growing media and biocapsule on growth of papaya seedlings.**

Treatments	Seedling height (cm)	No. of leaves	Stem girth (cm)	Root length(cm)	Seedling vigour index	Chlorophyll content (µmol per m <sup>2</sup> )	Fresh weight of seedling (g)
T <sub>0</sub>	11.71	5.7	5.21	6.35	1023.8	29.24	4.24
T <sub>1</sub>	11.93	6.2	5.40	7.88	1255.33	31.41	4.71
T <sub>2</sub>	22.05	10.2	6.15	12.73	3338.6	37.88	14.18
T <sub>3</sub>	19.23	8.8	5.72	10.06	2149.57	30.34	9.72
T <sub>4</sub>	21.09	9.4	6.21	12.38	2789.67	33.05	13.58
T <sub>5</sub>	22.19	10.03	6.44	12.52	3007.60	34.16	13.77
T <sub>6</sub>	23.41	10.8	7.09	12.83	3503.33	38.37	14.74
T <sub>7</sub>	12.93	7.8	5.57	8.871	1454.43	30.23	8.95
T <sub>8</sub>	19.81	9.2	6.06	10.75	2445.20	33.77	13.75
C.D.(P=0.05)	0.30	0.18	0.31	1.36	669.35	8.77	0.33
C.V	0.94	1.21	3.04	13.30	12.05	5.04	1.80

**Table 3. Effects of different growing media and biocapsule on biomass production and survival per cent of papaya plant.**

Treatments	Fresh weight of shoot (g)	Fresh weight of root(g)	Dry weight of shoot (g)	Dry weight of root(g)	Root:Shoot ratio	Total biomass (g)	Survival percentage%
T <sub>0</sub>	3.1	1.32	0.8	0.21	0.24	1.03	58.67
T <sub>1</sub>	3.42	1.29	1.6	0.26	0.17	1.86	61.33
T <sub>2</sub>	10.04	4.09	3.88	0.72	0.18	4.6	81.33
T <sub>3</sub>	7.69	2.48	2.4	0.32	0.12	2.8	69.33
T <sub>4</sub>	9.62	3.61	3.26	0.46	0.14	3.72	74.7
T <sub>5</sub>	10.03	3.78	3.60	0.52	0.14	4.11	77.33
T <sub>6</sub>	10.56	4.29	4.02	0.73	0.18	4.73	82.67
T <sub>7</sub>	6.59	2.24	2.11	0.26	0.13	2.36	65.33
T <sub>8</sub>	7.72	3.13	2.84	0.36	0.12	3.2	69.33
C.D.(P=0.05)	0.51	0.25	0.23	0.06	0.04	0.21	10.29
C.V	3.87	4.96	4.77	8.34	15.61	3.79	8.36

Similarly highest fresh weight of shoot (10.56 g) and root (4.29 g), highest dry weight of shoot (4.02) and root (0.73), highest total biomass (4.73 g) was recorded in treatment T<sub>6</sub>. The highest root:shoot ratio (0.18) was recorded in treatment T<sub>6</sub> and T<sub>2</sub>. This maybe attributed to general improvement in the physical and chemical properties of the rooting media which improved the fresh and dry weight of the seedling. Similar findings were found in Annapurna et al. [31] in *Santalum album*, Ascitutto et al. [32] in *Impatiens wallerana*.

The maximum survival percentage (82.67) was recorded with treatment T<sub>6</sub>, followed by T<sub>2</sub> (81.33) while minimum was observed under T<sub>0</sub> (control) (58.67). Better survival percentage might be due to the reason that the media combination was helpful in reducing damping off diseases in seedling due to preparation in root zone. Good physical and biological conditions in FYM and vermicompost along with biocapsules had positive effect on root and shoot growth which helps in better survival. Similar findings were found in Bhardwaj [33] in papaya, Ritesh et al. [34] in papaya, Chiranjeevi et al. [30] in aonla, Irsa et al. [26] in marigold.

#### 4. CONCLUSION

On the basis of present investigation, it is concluded that the treatment T<sub>6</sub> (Soil+FYM+Vermicompost+Biocapsule) was found to be the most suitable over all the other treatments in relation to germination and seedling growth parameters (seedling height, no. of leaves, stem girth, fresh and dry weight of seedling) of Papaya.

The treatment T<sub>6</sub> (Soil+ FYM+ Vermicompost+ Biocapsule) also recorded the maximum survival percentage after transplanting.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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