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Research Article

Seed germination and seedling growth as pretentious by various growing media in Red Lady-786 papaya

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Abstract

Carica papaya is a significant fruit crop solely grown from seeds for commercial purposes. Atmosphere, temperature, water, light, and substrate utilized are some of the variables that might affect a seed's ability to germinate. Papaya seed germination is frequently described as unpredictable, sluggish and partial. For papaya growers, increasing the degree of germination to enhance the production of healthier seedlings is a challenge owing to the higher seed cost. The present experiment aimed to determine the effect of various growing media combinations in Red Lady-786 using a completely randomized design (CRD). The experiment comprised nine treatment combinations. Four different growing media: soil, vermicompost, coco peat and perlite were used in different treatment combinations *viz.* T_1: control; T_2: soil + vermicompost (80% + 20%); T_3: soil + vermicompost (60% + 40%); T_4: soil + vermicompost + cocopeat (80%+10%+10%); T_5: soil + vermicompost + cocopeat (60%+20%+20%); T_6: soil + vermicompost + perlite (80%+10%+10%); T_7: soil + vermicompost + perlite (60%+20%+20%); T_8: soil + vermicompost + cocopeat + perlite (70%+10%+10%+10%+10%) and T_9: soil + vermicompost + cocopeat + perlite (40%+20%+20%+20%). T9 was the most significant combination for early germination among all the treatment combinations. The application of T_9 recorded maximum root length (7.70 cm), maximum shoot length (13.35 cm), maximum per cent initiation of germination (92.5%), high seed vigour (1947.75) and maximum height of the seedlings (21.05). The study revealed that for better germination and seedling growth, the application of treatment combination $T_{9,}$ which influenced the germination properties of papaya seedlings, can be exploited commercially.

Keywords: *Carica papaya*, Germination, Growing media, Growth, Vigour

INTRODUCTION

The papaya (*Carica papaya* L.) is a tropical fruit which belongs to the family Caricacaeae. It is grown across 1,44,000 hectares of land and produces 59,51,000 MT of fruit in India (Anonymous 2021). It grows well in well-drained soil, rich in organic matter, and has a pH range of 5.5–6.7. Trees with waterlogged soils usually perish in 3–4 days, and the best conditions for growth are 22–26°C and 100–150 cm of evenly distributed rainfall. Commercial papayas are propagated by seeds that require three to five weeks to germinate and are covered with a gelatinous sarcotesta. The germination of papaya seeds is slow and frequently partial (Sharma *et al.,* 2021). The atmosphere (O_2), temperature, water, light and kind of substrate utilized are just a few variables that might affect a seed's germination ability. For papaya growers, increasing the degree of germination to enhance the production of healthier seedlings is a challenge owing to the higher seed cost (Nguyen *et al.,* 2022).

Papaya is a tropical fruit that is perfect for growing in kitchen gardens. It is a good source of minerals, potassium, vitamin C, A and other vitamins. The crop may bring in a good income for farmers and is generally easy to cultivate and maintain (Lal and Urvashi, 2015). It has a longer fruiting period. Papaya trees are quickly growing to resemble trees. The fruit has an oval or pear shape. Dioecious papaya plants are distinguished by having distinct male and female blooms that develop on separate plants. For them to produce fruit, insect pollination is crucial. Certain papayas are hermaphrodites, meaning they can self-pollinate by producing both male and female flowers on the same plant. In commercial production, these hermaphrodite papaya varieties are more widely utilized (Rimberia *et al.*, 2018).

One of the key components of horticultural production systems worldwide is growing media. It serves as a reservoir for water, minerals and nutrients, oxygen to permeate the roots, and gaseous exchange between the roots and the surrounding atmosphere. A healthy growing medium gives the plant the support it needs. It is also crucial for the germination of seeds. The growth media's composition affects the quality of the seedlings (Choudhary and Wilson, 2020). Most of the propagation media used in nurseries to grow horticultural plants are organic and inorganic. Sand, vermiculite, and perlite are inorganic materials, while vermicompost, coco peat, sphagnum moss, and other similar materials are organic. Numerous organic media are quickly broken down and compacted, reducing pore space and aeration in soil. It has been established that adding some coarse mineral components helps with drainage and aeration. In this context, sand, vermiculite, and perlite are helpful (Gupta *et al*., 2023).

Due to the damping off disease in the nursery stage, papaya seeds have trouble germinating and have a high seedling death rate. Papaya plant survival rates are also influenced by germination and initial mortality. Plants are more vulnerable to soil-borne illnesses, and their root systems are inhibited by heavy soil and inadequate drainage. A gelatinous sarcotesta, also known as the outer seed coat or aril generated from the outer integument, encloses the papaya seed. Growing media is essential for the germination of seeds. Growing media serves as a space for plants to grow as well as a supply of nutrients. The type of media utilized affects the seedlings' quality. Media for fruit crop seedlings often consist of sand, pond soil, organic matter, and dirt. Since pond soil is inexpensive and simple to obtain, it is typically utilized as a basic medium. Sand is supplemented to increase the media's porosity, and organic matter (Farmyard manure and vermicompost) is added to replenish the soil with sufficient nutrients for the seedlings. Compared to a traditional soil mix, there is a better interaction between manure and roots, and the seedlings are less vulnerable to diseases and pests carried by the soil (Bhardwaj, 2014).

The present study examined the effects of various media, including sand, pond soil, FYM, vermicompost, and cocopeat, on papaya (Red Lady-786) seed germination, seedling growth, and vigour.

MATERIALS AND METHODS

Study area

An experiment regarding seed germination aspect of Red Lady-786 papaya in different growing media was conducted at the Agriculture Farm at Lovely Professional University in Phagwara, Punjab in open field conditions in 2021–2022.

Treatment details

Three replications and nine treatment combinations, composed of four growing mediums: soil, vermicompost, cocopeat, and perlite, in various combinations: T_1 = control; T_2 = soil + vermicompost (80% + 20%); T_3 = soil + vermicompost (60% + 40%); T_4 = soil + vermicompost + cocopeat (80%+10%+10%); T_5 = soil + vermicompost + cocopeat (60%+20%+20%); T_6 = soil + vermicompost + perlite (80%+10%+10%); T_7 = soil+vermicompost+perlite (60%+20%+20%); T_8 = soil + vermicompost + cocopeat + perlite (70%+10%+10% +10%+10%); T_9 = soil + vermicompost + cocopeat + perlite (40%+20%+20%+20%). According to treatments, seeds were sown approximately one centimetre thick in various media in July. Soon after seeds were sown, the poly bags were irrigated again each day until the last emergence. The bags received one irrigation every two days once germination was complete. The details of various field operations for transplanting seedlings are mentioned in Fig.1.

Germination and growth parameters

To record germination percentage, sprouted seeds in each treatment were counted at an interval of two days and after completion of germination. The total number of germinated seeds was subtracted from the total number of seeds sown and the percentage of germination was calculated. Then, the number of days required for the first germination was calculated based on the days taken for the initiation of germination. It was averaged out, and the mean was reported from each repetition based on the days taken to initiate germination for the given treatment (Scott *et al*. 1984).

Mean germination time (MGT) was calculated by using the equation: $\sum (n \times d)$. Eq.1

Where n = number of seeds germinated on each day, d = number of days from the beginning of the test N = total number of seeds germinated at the termination of the experiment. The total shoot length per plant and root length were determined in the line-measured approach by measuring the number of orthogonally and diagonally linked pairs of pixels. The length of roots of randomly selected five seedlings was measured at 60 days after sowing by metric scale from the base of the shoot to the tip of the roots and its average value was calculated. The tree's diameter was estimated in reticle scale units, and an optical scaling factor for the monocular reticle can be derived using the tree's diameter at that moment. The stem diameter of five randomly selected seedlings was measured 60 days after sowing with the help of Vernier calliper at a height of 1 cm above ground level and its average value was calculated.

Shoot diameter (mm) = (Reticle scale × distance to target)/ optical factor Eq.2

Crown area was calculated by determining the estimated diameter of the tree crown under investigation. Multiply the crown area by the number of leaves per unit area to get the total area. The total number of fully grown leaves of all tagged plants in each treatment in each replication was calculated 60 days after sowing, and their average was calculated. Leaf area (A) was calculated by multiplying the product of leaf length (L) and width (W) by a constant. Seedling length (cm) was noted by measuring from the plant's base to its tallest point with a ruler or measuring tape. It was measured for all the five plants that were tagged and, later on, averaged. Fresh weight of shoot (g) was measured immediately after removal. The shoot of all tagged plants was selected in each treatment, and fresh weight was measured 60 days after sowing using an electronic balance. The average weight was calculated.

Fresh Weight [g] = Dry Weight [g] + Lost water Content [g] Eq.3

Fresh weight of root was measured immediately. To note dry weight of shoots (SDW), tissue was taken and dried. The dry weight of shoot of five seedlings was calculated at 60 days after sowing by drying uprooted seedlings under shade for two days and drying in an oven at 60oC for 48 hours. After drying, seedlings' dry weight was measured using an electronic balance and the average weight was calculated. To observe the dry weight of the root, overnight, dry the roots in a low-heat oven (100° F). Allow the plants to cool in a dry Ziploc bag. To record the above-mentioned observations, established procedures and standards were established, and the observations about germination and vegetative growth characteristics were documented. Based on these observations, a concrete conclusion was made (after sixty days).

Statistical analysis

During the study of seed germination and seedling growth, a complete randomized design (CRD) was applied with three replications for each treatment. The collected data was analysed (Panse and Sukhatme, 1985). The "F" test was used to determine the significance of the difference between the means of the data, and critical difference (CD) calculations were made wherever the "F" result indicated a significant treatment impact.

RESULTS AND DISCUSSION

Growth attributes

Root length controls water and plant nutrient uptake (Xiong *et al.,* 2021). The data in Table 1 indicates that the maximum root length (7.70 cm) was observed in T_9 viz. {Soil + Vermicompost + Cocopeat + Perlite (40% + 20% + 20% + 20%)} while in control, it was minimum (3.65 cm). This may be due to the properties of vermicompost, perlite and cocopeat. Further, the combined application of vermicompost and cocopeat with perlite in T_9 showed much better and encouraging results in germination rate, shoot and root growth shoot and root length, and seed vigour, probably due to the synergistic combinations of these factors improving the physical conditions of the media and nutritional factors. Bhardwaj (2014) experimented with papaya using different combinations and concluded that the best treatment (vermicompost, pond soil and sand, i.e., 1:1:1) had maximum germination percentage and root and shoot growth. Maximum shoot length (13.35 cm) resulted from T_9 followed by T_8 (Table 1). Probable reasons may be that the media (T_9) created sufficient porous space to let the excess water drain out and pertaining adequate aeration and increased physiological activities of seed, essential for cell division, cell enlargement or both or might be absorbed more nutrients from the soil media, which resulted in better seedling growth. The present investigation conforms with the results of Verma *et al.* (2019) in Indian gooseberry seedlings.

Growing media in T_9 recorded significantly higher seedling height at 60 days (21.05 cm), as compared to the other treatments (Table 1), but control, on the other hand, resulted in lowest seedling height (10.65 cm). Seedling height might be due to the conductive effect of such media composition, water holding capacity, porosity, soil aeration, and the supply of substantial amounts of nutrients, especially nitrogen and micronutrients, for good root and shoot growth. Vermicompost is a microbiologically active, nutrient-rich material. When added to the plant growing media, it may influence plant growth directly or indirectly through different chemical, physical, and biological mechanisms. Due to the availability of more nitrogen in the media, more

Table 1. Effect of different growing media on time taken for different attributes of papaya

Treat-ment	Particular	Initiation of germination	50% Ger-mination	Seed vigour	Root length (cm)	Shoot length (cm)	Height of the seed-ling (cm)	No of leaves	Stem di-ameter (mm)	Fresh wt. of seed-ling (gm)	Dry wt. of seedling (gm)	Dry wt. of shoot (gm)	Dry wt. of root (gm)
T_1	Control	52.50	26.50	560.00	3.65	7.00	10.65	4.50	0.31	2.50	0.23	0.12	0.01
T_2	Soil+vermicompost (80%+20%)	60.50	25.50	690.45	4.05	7.35	11.40	5.50	0.47	3.00	0.29	0.16	0.01
T_3	Soil+vermicompost (60%+40%)	67.50	24.50	837.75	4.40	8.00	12.40	6.00	0.47	4.00	0.32	0.24	0.01
T_4	soil+vermicompost + cocopeat (80%+10% +10%)	76.50	24.00	1163.25	5.55	9.65	15.20	6.50	0.78	5.50	0.39	0.33	0.02
T_5	Soil+vermicompost+ cocopeat (60%+20% +20%)	86.50	23.00	1592.05	6.40	12.00	18.40	8.50	1.09	7.00	0.51	0.43	0.03
T_6	Soil+vermicompost+ perlite (80%+10% +10%)	73.50	24.50	1000.05	4.95	8.65	13.60	7.50	0.62	4.00	0.35	0.23	0.02
T_7	Soil+vermicompost+ perlite (60%+20% +20%)	81.50	23.50	1398.10	6.15	11.00	17.15	8.00	0.94	6.50	0.44	0.34	0.03
T_8	Soil+vermicompost + cocopeat + perlite (70%+10%+10% +10%)	90.50	21.50	1788.00	6.80	12.95	19.75	9.50	1.25	8.00	0.55	0.43	0.04
T_9	Soil+vermicompost + cocopeat + perlite (40%+20%+20% +20%)	92.50	20.50	1947.75	7.70	13.35	21.05	10.50	1.41	8.50	0.70	0.53	0.05
SE(m)		2.11	0.64	54.40	0.12	0.17	0.29	0.44	0.11	0.57	0.01	0.01	0.01
C.D.		6.86	2.09	176.50	0.39	0.56	0.94	1.43	0.38	1.87	0.05	0.05	0.00
CV		3.95	3.84	6.30	3.11	2.46	2.64	8.44	20.18	14.99	6.00	7.19	20.78

vegetative growth was observed. Cocopeat helps increase water availability, whereas perlite helps promote proper porosity and drainage. Though similar findings were reported by Ramteke *et al.* (2015) and Hossain *et al.* (2023) for papaya conducted under Punjab conditions (Jalandhar, Doaba region).

The number of leaves in the plant is one of the visual key traits (phenotype) describing its development and growth. A perusal of data in Table 1 reveals that different growing media significantly affected the number of leaves per plant. The maximum number of leaves per plant at 60 days was recorded to be 10.50 in T_9, while the minimum was (4.5) in control. This may be because vermicompost constitutes a source of plant macro and micronutrients. Some of these nutrients are present in inorganic forms and are readily available to plants. Cocopeat holds water efficiently, whereas perlite makes the soil porous, efficiently exchanging gases and oxygen to roots. These factors might lead to high chlorophyll synthesis and the number of leaves. Similar results of vermicompost, cocopeat and perlite were obtained by Voruganti *et al.* (2022) and Hossain *et al.,* (2023) under Punjab conditions, both in papaya. However, the present study was conducted with different varieties and under different conditions. Stem diameter is considered one the most important factors used to assess the healthy growth of the seedling. Data presented in Table 1 indicate that the maximum stem diameter was recorded (1.41cm) in T_9 followed by T_8 {(Soil + Vermicompost+ Cocopeat + perlite (70% + 10% + 10% + 10%)} while minimum (0.31) stem diameter was shown in control.This may be attributed to the improvement in the rooting medium's physical and chemical properties by incorporating vermicompost, cocopeat and perlite with soil.. The same observations were submitted by Hossain *et al.* (2023) in the case of papaya but under Bangladesh (Dhaka) conditions. Table 1 specifies that the maximum fresh weight (8.5) was recorded in T_9. It is important to mention here that the impact of vermicompost on growth and development was not merely nutritional, but also biochemical and hormonal.

Some researchers (Ashraf *et al.,* 2017) have reported that vermicompost increases the leaf area and biomass in various plants with “various plants' leaf area and biomass. It appears to be the influence of the mobilization of water and nutrients transferred at a quicker speed, favouring enhanced production of photosynthetic materials and transferring these products to other plant parts, resulting in good seedling growth and, therefore, more fresh & dry weight. The result conforms with the earlier report by Joshi *et al.* (2015) under Gujarat conditions. Above all, difference lies only in variety and field conditions. The maximum dry weight of seedlings was observed in T_9 while it was minimum in control (Table 1). It appears to be the effect of the mobilization of water and nutrients transferred at a greater rate, favouring a greater production of photosynthetic products and transferring them to different plant parts, resulting in greater seedling growth and, therefore, more fresh and dry weight. The present observations conform with conclusions submitted by Yadav *et al.* (2012) and Vishwakarma, (2013) in acid lime .

The results remained the same in the studied variety and under Punjab conditions. Maximum dry weight was significant in T_9 , whereas the minimum dry weight was in control. This may be due to organic manure initially forming a conducive environment concerning physical parameters of soil, which promote better shoot growth, including other vegetative growth, in the presence of beneficial microorganisms or biologically active plant growth-influencing substances such as phytohormones that were released by beneficial microorganisms present in the vermicompost rich soil. These substances increase the ?fresh and dry weight of the shoots. Similar results was found earlier by Mahmud *et al.* (2020) in pineapple. It is apparent from the data given in Table 1 that use of growing media significantly increased dry weight, but the maximum was recorded in T_9 . Vermicompost and soil also provide close contact between seed and media, increasing stable moisture supply and root respiration and encouraging root growth. Cocopeat and perlite improved the physical characteristics of the soil, increasing soil ventilation/porosity and thereby supporting root growth. Moreover, similar findings have been reported by Kilic *et al*. (2023) in strawberries.

Conclusion

The present study showed that the treatment T_9 viz. Soil + Vermicompost + Cocopeat + Perlite (40% + 20% + 20% + 20%) in growing media was most favourable for the successful preparation of papaya seedlings. The growing media showed a significant impact on the germination, growth, and development parameters of papaya seedlings under protected conditions of Punjab. Thus, the study showed that the growing medium for papaya seedlings should be composed of soil T_9 in a specific combination of vermicompost, cocopeat, and perlite to maximize germination percentage, accelerate seedling growth, and boost seedling sales revenue of papaya.

Conflict of interest

The authors declare that they have no conflict of interest.

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