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# EFFECT OF GROWING MEDIA ON SEED GERMINATION AND SEEDLING GROWTH OF PAPAYA CV. 'RED LADY'

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## ABSTRACT

**The study was carried out to study the effect of growing media on seed germination and seedling growth of papaya (*Carrica papaya*). For germination and seedling growth three types of media and three levels of cocopeat were studied. This experimented was conducted in a complete randomized design with nine treatment combinations and replicated thrice. The results showed that the medium of vermicompost + sand + pond soil (1: 1:1) with 2 cm cocopeat on top of the polybags (T9) gave maximum speed of emergence (493.34), highest germination percent (92.71%), highest seed vigour (89.33), maximum germination index (7.18), germination value (25.58), least time required for imbibtion (9.37 days) and minimum germination period (3.22 days). This medium was also found to be the best medium for the growth of papaya seedlings as it gave the highest value of growth parameters of seedling growth like, seedling height (23.05 cm), leaf area (339.26 cm2), number of leaves (9.84), stem diameter (3.32 mm), number of roots (16.68), root length (9.93 cm), production of total biomass (4.89 g/plant) and least root/shoot ratio (0.21). This treatment significantly reduced the seedling mortality and produced maximum healthy seedlings (92.69%) in minimum days (35.24) with highest net profit (Rs. 3470.65/1000 seedling) and B: C ratio (1.84) of seedlings.**

**Key word**- B:C ratio, Cocopeat, Plant growth, Pond soil, Seedling, Vermicompost.

## INTRODUCTION

Growing medium directly affects the development and later maintenance of the extensive functional rooting system. A good growing medium would 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 roots and atmosphere outside the root substrate (Abad *et al.*2002). Nursery potting media influence quality of seedlings produced (Agbo and Omaliko 2006). The quality seedling established well in field increase the productivity of an orchard (Baiyeri 2006). Papaya is an important fruit crop which is propagated by seeds only. The germination of papaya seed is reported to be slow, erratic and is incomplete (Chako and Singh Lange 1966). Red lady is choicest variety of papaya grower due to hermaphrodite nature and prolonged self life of fruits. But the seed cost of this variety is very high (Rs. 2.0 lakh/kg). So, increasing germination per cent and producing more healthy seedling is a challenge for papaya growers. The papaya seeds (*Carica papaya*) cv. Red lady faces certain problems in germination and has high seedling mortality due to damping off disease in nursery. Initial mortality and incomplete germination is also one of the causes of reduced survival per cent of papaya seedlings. In heavy soil, without enough drainage, the development of root system is suppressed and plants are more susceptible to soil borne diseases (Beattie and White 1992). The papaya seed is endosed within a gelatinous sarcotesta (aril or outer seed coat which is formed from the outer integument). While this sarcotesta can prevent germination and dormancy is also observed in seeds from which the sarcotesta has removed (Yahira 1979). The pond soil is usually used as a basic medium because it is cheapest and easy to procure. Supplementing of the sand is aimed

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to make media more porous. While the organic matter (FYM and vermicompost) is added so as to enrich adequate nutrients for the seedling. There is better relationship between the manure and rooting rather than conventional soil mix and less susceptibility of the seedling to soil borne pests and diseases (Akanbi *et al.* 2002). Humic acids (vermicompost) applied in the medium increased plant height, leaf area and dry weight of peppers, tomatoes and marigold (Arancon *et al.* 2004). As a growing medium, cocopeat can be used to produce a number of crop species with acceptable quality in the tropics (Pickering 1997; Yau and Murphy 2000). Cocopeat is considered as a good growing media component with acceptable pH, electrical conductivity and other chemical attributes (Abad *et al.* 2002). Cocopeat has good physical properties, high total pore space, high water content, low shrinkage, low bulk density and slow biodegradation. The results of many experiments revealed that cocopeat used alone, or as a component of soil medium, is suitable for roses, gerbera, many potted plants (De Kreij and Leeuven 2001; Pickering 1997) and also for vegetables.

Keeping in view the influence of media in germination and seedling growth of papaya, the present investigation was carried out to study the effect of different media viz. sand, pond soil, FYM, vermicompost and cocopeat on seed germination, seedling growth and vigour of papaya seedlings.

## MATERIALS AND METHODS

Seed germination and seedling growth experiments of papaya were carried out at NHM Model nursery of Krishi Vigyan Kendra-Sirohi (Rajasthan) during two successive season from July to August 2009 and 2010 under agronet (75%) house conditions. There were nine treatments consist of different combination of growth media with or without cocopeat in poly bag (10 x 12 cm) namely, T1 – Sand + pond soil (1:1) without cocopeat, T2- Sand + pond soil (1:1) with 1 cm cocopeat, T3- Sand + pond soil (1:1) with 2 cm cocopeat, T4- FYM + sand + pond soil (1:1:1) without cocopeat, T5- FYM + sand + pond soil (1:1:1) with 1 cm cocopeat, T6- FYM + sand + pond soil (1:1:1) with 2 cm cocopeat, T7- Vermicompost + sand + pond soil (1:1:1) without cocopeat, T8- Vermicompost + sand + pond soil (1:1:1) with 1 cm cocopeat, T9- Vermicompost + sand + pond soil (1:1:1) with 2 cm cocopeat. The seed sowing was done in month of July about 1 cm depth in different media as per treatments. The experiment was laid out in Complete Randomized Design and replicated thrice. Each treatment was composed of 100 polybags seedlings. The polybags were irrigated immediately after seed sowing and repeated every day till the final emergence. After the completion of germination the bags were irrigated once in 2 days.

Growth parameters were recorded at the time of transplanting. Observations on germination was recorded from the first germination untill no further germination, at two days interval. The speed of emergence (SE) was calculated according to Islam *et al.* (2009) by using the following formula;

**Speed of emergence** =

$$\left[\frac{\text{No. of seedlings emerged 5 days after sowing}}{\text{No. of seedlings emerged 15 days after sowing}}\right] \times 100$$

Germination percentage was calculated by number of germinated seeds divided by the total number of seeds sown in poly bags and multiplied by 100. The germination period was calculated as the difference between initial and final emergence (number of days) recorded. Seed vigour was calculated by dividing total number of healthy seedling by the number of total seedlings and multiplied by 100. The germination index was calculated as described in the Association of Official Seed Analysis (1983) by the following formula;

**Germination index**=

$$\left[\frac{\text{No. of germinating seeds}}{\text{Days of first count}}\right] + \ldots\ldots + \left[\frac{\text{No. of germinating seeds}}{\text{Days of final or last count}}\right]$$

The germination value (GV) was calculated according to Hossain *et al.* (2005) by the following formula; Germination value = (Ó DGs/N) X GP/ 10. Where (GP) is the germination percentage at the end of experiment, (DG) is the daily germination speed obtained by dividing the cumulative germination percentage by the number of days since sowing, (Ó DGs) is the total germination obtained by adding every DGs value obtained from the daily counts, (N) is the total number of daily counts starting from the first germination and (10) is constant. Counting of number of leaves was done at the end of experiment when the true leaves have emerged. Stem diameter was measured 1 cm above from the

base of the stem using vernier caliper. Plant height was measured from base of seedling to highest tip of plant. Leaf area was calculated by the leaves traced on a graph paper. Number of roots, root length was measured by destructive method of uprooting the plants and taking measurement by standard method. Stem and root were weighed to record stem, root fresh weight, root/shoot ratio, and total fresh and dry weight of plant (g) at time of transplanting. Survival per cent (after transplanting in main field) was recorded by using following formula;

**Survival percent=**

$$\frac{\text{Total survival of transplanted plants}}{\text{Total transplanted plants}} \times 100$$

The net return was calculated by subtracting cost of each treatment from the gross return and benefit: cost ratio = Net income/Cost of seedling production. All data was subjected to analysis of variance (ANOVA) to determine significant differences followed by Tukey's test for the comparison of means at significant level of 5 per cent.

## RESULTS AND DISCUSSION

The results showed that growing media and cocopeat had beneficial effect on seed germination and growth of papaya seedling.

### Seed germination parameters

Seed germination parameters of papaya (*Carrica papaya*) as affected by growing media and use of cocopeat are presented in Table 1. The treatment T9 was found best followed by T8 regarding to germination parameters as these media has suitable physical properties and good water holding capacity that supports the germination of papaya seeds (Table 1). Germination started at the 9.37 days after sowing on vermicompost + sand + pond soil (1:1:1) with 2 cm cocopeat (T9) for both year of experimentation. Germination continued until the 23.87 days from sowing where no further germination was noticed. For both year of experimentation the maximum speed of emergence (493.34), highest germination per cent (92.71), highest seed vigour (89.33), maximum germination index (7.18), germination value (25.58), least time required for imbibtion (9.37 days) and minimum germination period (3.22 days) were obtained in vermicompost + sand + pond soil (1:1:1) with 2 cm filling with cocopeat of seedling polybags in both years. The sand + pond soil (1:1) without cocopeat showed the least value as compared to other treatment. This is because of pond soil and vermicompost are high organic matter content which increases the water and nutrient holding capacity of the medium, which improve the water utilization capacity of plant. Vermicompost is reported to have bioactive principles which are considered to be beneficial for root growth and this has been hypothesized to result in greater root initiation, higher germination, increased biomass, enhanced growth and development (Bachman and Metzger 2008) and also balanced composition of nutrients (Zaller 2007). The higher available well decomposed organic matter (vermicompost) may preserve soil humidity, increase nutrient content and improve soil structure which increase water absorption and maintains the cell turgidity, cell elongation and increase respiration at

TABLE 1. Effect of seedling growing media and cocopeat on the germination parameters of papaya seed (pooled)

| Treatments | Imbition period | Speed of emergence | Germination % | Germination period | Seed vigour | Germination index | Germination value |
|---|---|---|---|---|---|---|---|
| $T_1$ | 15.67 | 127.37 | 59.69 | 8.20 | 55.24 | 2.37 | 1.94 |
| $T_2$ | 13.60 | 169.56 | 67.82 | 6.98 | 64.16 | 3.14 | 3.50 |
| $T_3$ | 12.05 | 226.21 | 80.33 | 5.88 | 75.74 | 4.34 | 6.83 |
| $T_4$ | 15.35 | 154.12 | 70.79 | 7.28 | 64.69 | 3.24 | 3.37 |
| $T_5$ | 13.59 | 277.13 | 81.55 | 4.88 | 76.76 | 4.51 | 7.72 |
| $T_6$ | 11.59 | 325.56 | 85.65 | 3.95 | 82.81 | 5.45 | 12.47 |
| $T_7$ | 13.84 | 252.51 | 77.62 | 6.15 | 73.76 | 3.69 | 5.02 |
| $T_8$ | 11.63 | 430.54 | 87.57 | 4.08 | 83.26 | 5.99 | 14.50 |
| $T_9$ | 9.37 | 493.34 | 92.71 | 3.22 | 89.33 | 7.18 | 25.58 |
| SEm+ | 0.500 | 9.350 | 2.000 | 0.260 | 1.830 | 0.180 | 0.280 |
| CD at 5% | 1.470 | 27.680 | 5.920 | 0.780 | 5.410 | 0.530 | 0.830 |

TABLE 2: Effect of seedling growing media and cocopeat on the growth of papaya seedlings (pooled)

| Treatments | Number of leaves | Stem girth (mm) | Seedling height (cm) | Leaf area ($cm^2$) | Number of roots | Root length (cm) | Fresh weight of plants (g) |
|---|---|---|---|---|---|---|---|
| $T_1$ | 3.54 | 1.12 | 8.27 | 16.72 | 5.80 | 3.46 | 0.62 |
| $T_2$ | 5.59 | 1.44 | 9.39 | 31.83 | 9.90 | 3.88 | 0.80 |
| $T_3$ | 7.68 | 2.08 | 11.39 | 50.80 | 12.17 | 5.74 | 1.01 |
| $T_4$ | 6.62 | 1.54 | 9.11 | 50.35 | 7.47 | 5.08 | 0.69 |
| $T_5$ | 8.20 | 2.34 | 12.19 | 91.66 | 10.41 | 6.92 | 1.00 |
| $T_6$ | 9.10 | 2.82 | 17.31 | 134.15 | 12.26 | 7.27 | 1.44 |
| $T_7$ | 7.38 | 2.05 | 14.05 | 137.65 | 12.90 | 7.67 | 2.42 |
| $T_8$ | 8.31 | 2.69 | 19.93 | 232.75 | 16.02 | 9.02 | 3.56 |
| $T_9$ | 9.84 | 3.32 | 23.05 | 339.26 | 16.68 | 9.93 | 4.89 |
| SEm+ | 0.350 | 0.100 | 0.440 | 3.460 | 0.560 | 0.210 | 0.050 |
| CD at 5% | 1.040 | 0.300 | 1.290 | 10.230 | 1.650 | 0.610 | 0.140 |

optimum level, leading to favourable for seed sprouting. Vermicompost mixed with pond soil affects properties of soil physics, chemistry and biology, since organic matter acts as glue for soil aggregate and source of soil nutrient (Soepardi 1983). Vermicompost granules may develop soil aggregate and it's granulating. Soil aggregation will improve permeability and airflow in the polybags. Vermicompost and pond soil (due to high organic matter) may decrease fluctuation of soil temperature. Organic matter may also improve nutrient availability and improve phosphorus absorption (Karama and Manwan, 1990). All these factors are favourable for seed germination and ultimate by increase seed germination per cent, speed of emergence, seed vigour, germination index, germination value and reduce imbibtion period.

**Seedling growth parameters**

Data presented in Table (2 and 3) show growth increase of papaya seedling as significantly affected by growing media and cocopeat. Maximum number of leaves was observed in $T_9$ treatment (9.84) which was at par with $T_6$ treatment (9.10). Maximum seedling diameter (3.32 mm), highest seedling height (23.05 cm), largest leaf area (339.26 cm2), longest root (9.93 cm) and highest fresh weight of plants (4.89 g) were recorded in $T_9$ treatment. Similarly maximum number of roots per plant was also higher in $T_9$ treatment (16.68) which was at par with $T_8$ treatment (16.01). Highest fresh weight of shoot (4.05 g), fresh weight of roots (0.84 g) and least root/shoot ratio (0.21) was also reported in $T_9$ treatment. Vermicompost provides adequate nutrients and enhances both the physical properties

TABLE 3. Effect of seedling growing media and cocopeat on the biomass production, survival per cent, net return and B:C ratio of papaya seedling (pooled)

| Treatments | Fresh weight of shoot (g) | Fresh weight of root (g) | Survival per cent | Root /Shoot ratio | Days required for gaining transplanting size of seedling | Net return (Rs./1000 seedlings) | B:C ratio |
|---|---|---|---|---|---|---|---|
| $T_1$ | 0.39 | 0.22 | 77.71 | 0.57 | 46.33 | 780.0 | 1.16 |
| $T_2$ | 0.52 | 0.27 | 81.26 | 0.52 | 43.83 | 980.0 | 1.19 |
| $T_3$ | 0.69 | 0.33 | 85.18 | 0.48 | 41.85 | 1880.0 | 1.35 |
| $T_4$ | 0.51 | 0.18 | 82.20 | 0.35 | 42.10 | 1068.0 | 1.20 |
| $T_5$ | 0.78 | 0.23 | 85.77 | 0.30 | 40.00 | 1868.0 | 1.34 |
| $T_6$ | 1.12 | 0.31 | 88.74 | 0.28 | 38.10 | 2368.0 | 1.41 |
| $T_7$ | 1.93 | 0.47 | 85.75 | 0.25 | 40.28 | 2170.60 | 1.65 |
| $T_8$ | 2.94 | 0.66 | 89.80 | 0.23 | 38.33 | 2970.40 | 1.78 |
| $T_9$ | 4.05 | 0.84 | 92.69 | 0.21 | 35.24 | 3470.65 | 1.84 |
| SEm+ | 0.060 | 0.020 | 1.600 | 0.010 | 1.010 | 52.690 | 0.070 |
| CD at 5% | 0.670 | 0.480 | 4.740 | 0.029 | 2.980 | 155.940 | 0.198 |

and the water holding capacity (Soegiman 1982). Combined application of vermicompost and cocopeat in the treatment T9 showed significant effect on seedling growth parameters and plant biomass probably due to the synergistic combination of both the factors in improving the physical conditions of the media and nutritional factors. This result is akin to the findings of Campos Mota *et al.* (2009) and Abirami *et al.* (2010) who suggested that since coir dust is low in nutrients when mixed with vermicompost provides a better growth medium for plant establishment. However, the air filled porosity (AFP), easily available water (EAW) and aeration of vermicompost and FYM were not at the recommended level which in turn limit the root growth and lowered the water holding capacity. Therefore, the medium with vermicompost and cocopeat is more suitable than vermicompost alone because of the better physical properties and enhanced nutrient level.

This treatment combination was also helpful in reducing damping off disease in seedling due to proper aeration in root zone of the seedling and produce highest survival per cent of seedling (92.69 %) which was at par with T8 treatment (91.70 %). Because of the better physical properties and enhanced nutrient level in T9 treatment increased the growth of seedling fast and minimum days required for gaining transplanting size (35.24 days) which was at par with T6 treatment (37.62 days). Vermicompost with cocopeat may improve soil porosity, water content, pore of drainage, soil permeability and water availability, whereas weight of soil may decrease. This may develop soil aggregation, and moreover it improves permeability and air flow in the soil, this type condition sharply reduce damping off disease in nursery stage and provide support to fast growth of the seedling due to availability of better nutrition with water and air in root zone of the seedling ultimately the seedling gain transplanting size very soon in this treatment combination than other treatments. It seems that good physical and biological conditions in cocopeat and vermicompost had positive effect on root development, which is helpful in increased survival per cent of seedling in main field after transplanting. Beneficial effect of cocopeat on root system was observed on nutmeg seedling by Abirami *et al.* (2010), *Osteospermum* cuttings by (Nowak 2004), salvia, viola by (Pickering 1997) and *Impatiens* (Smith 1995). Application of vermicompost: pond soil: sand (1:1:1) with 2 cm cocopeat media (T9) proved profitable and showed maximum net return (Rs. 3470.65/1000 seedlings) and benefit: cost ratio (1.84) due to higher germination percent and survival percent obtained (Table 1 and 3). This treatment was significantly superior to rest of the treatments during both year but benefit: cost ratio was at par with T8 treatment.

## CONCLUSION

On the basis of results obtained from this study, it is concluded that growing media significantly influenced the germination and growth parameters of papaya seedling. Vermicompost, pond soil and sand with cocopeat increased the germination per cent, seedling growth and earn more profit by sale of seedlings.

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