**Influence of Different Soil-Less Media on Seed Germination and Seedling Growth of Papaya cv. Red Lady**

**ABSTRACT**

Papaya (*Carica papaya* L.) is a fast-growing, short-lived, tropical tree, cultivated for its fruit, papain, pectin and antibacterial substances. The delay in nursery seed germination and poor seedling growth is a big problem due to the presence of inhibitor in the gelatinous sarcotesta and seed coat, unsuitable growing media or substrate, soil borne disease, rudimentary embryo or lack of embryo and unsuitable environmental factors such as oxygen, water and temperature. The growing medium plays an important role in seed germination not only it does act as a support, but also a source of key nutrients for seedling growth. Considering this, the present experiment was undertaken to study the effect of soil-less growing media (*viz*. different combinations of vermicompost, cocopeat, sphagnum peat moss, perlite, vermiculite, sand and sawdust) for seed germination as well as seedling growth of papaya. The experiment was laid out in polythene packet following design CRD with 13 treatments and 3 replications in the shade net house situated adjacent to the faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. Maximum number of seeds germinated (19.6 out of 20) and germination percentage (98.3%) were found with (Vermicompost + Sphagnum Peat Moss + Sand) followed by (Vermicompost + cocopeat + Sand) and (Vermicompost + cocopeat). Early seed germination (8.3 days from seed sowing) and duration of seed germination (2.3 days) were noted with (Vermicompost + Cocopeat + Perlite). The seedling vigour index was maximum with (Vermicompost + cocopeat + Sand). From the result of present investigation, it can be concluded that media containing mixture of (vermicompost + sphagnum peat moss + sand) and (Vermicompost + cocopeat + Sand) is ideal for getting higher seed germination and seedling growth.

**Keywords:** Papaya, soil-less media, seed germination, seedling growth

1. **INTRODUCTION**

Papaya (*Carica papaya* L.) is a fast-growing, short-lived, tropical crop, cultivated for its fruit, papain, pectin and antibacterial substances (Niklas and Marler, 2007). Papaya is a member of the Caricaceae family and is the most economically important species in this family (Carvalho and Renner, 2012). It has become very popular to fruit growers due to high palatability, continuous fruiting habit, fruiting within one year and high productivity. Ripe papaya fruit has moisture about 89.6%, protein 0.50 %, carbohydrate 9.5%, vitamin A 2020 IU/100 g, riboflavin 250 mg/100 g, vitamin-C 40 mg/100 g, calorific value 40/100 g (Muthukrishnan and Irulappan, 2001).

Papaya is mainly propagated by seeds as a viable option which shows a wide variability in germination and seedling growth (Dayeswari *et al*., 2017). The germination of seed is found to be slow, erratic and incomplete. The delay in nursery seed germination and poor seedling growth is a big disadvantage for the farmers. The hindrances for successful seed germination and subsequent seedling growth are presence of inhibitor in the gelatinous sarcotesta and seed coat, unsuitable growing media or substrate, soil borne disease, rudimentary embryo or lack of embryo and unsuitable environmental factors such as oxygen, water and temperature. Growing medium directly affects the seed germination, development and proper growth of roots. The most vital thing for the medium is proper aeration and drainage, optimum water conductivity and low bulk density (Carbrera, 2003). The quality of seedlings is very much influenced by growing media under nursery (Agbo and Omaliko, 2006). The quality of seedlings obtained from a nursery influences re-establishment in the field and the eventual productivity of an orchard (Baiyeri and Mbah, 2006). An effective growing medium must consist of mixes that are sufficiently soft for easy seed germination, maintain moisture, drain excess water, and supply adequate nutrients for seedling growth and development (Abad et al., 2002). The composition of the medium influences the quality of the seedlings (Wilson *et al*., 2001). Mixture of media can be used as a growing media for seedling growth. Mixed medium helps in adding porosity which helps proper air circulation, water retention and good nutrient absorption. Soil mixtures for nursery are crucial for promoting vigorous root growth and ensuring good seedlings for plantation or orchard establishment. Common growing media include cocoa shells, sewage sludge, tobacco waste, sugar waste, vermin compost, sawdust, and more. The use of soilless potting media is a common practice in the developed countries. Baiyeri and Mbah (2006) reported on the relative importance of soil less media for growing potted ornamental plants in Nigeria. Commercial potting media are commonly based on vermicompost, cocopeat, sphagnum peat moss, perlite, vermiculite etc. based substrates. So, proper seed germination and seedling growth are most important considerations in successful seedling production under nursery technique of papaya cultivation. Considering this, the present experiment was undertaken to study the effect of soil-less growing media (*viz*., different combinations of vermicompost, cocopeat, sphagnum peat moss, perlite, vermiculite, sand and sawdust) for seed germination as well as seedling growth of papaya.

1. **MATERIALS AND METHODS**

**2.1 Experimental site and treatment details**

The experiment was carried out in the shade net house, adjacent to faculty of horticulture, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The experimental plot is located at 22.43°N latitude and 88.34°E longitude, with an altitude of 9.75 m above the mean sea level. The climate of the experimental site was sub-tropical humid having short and mild summer and winter. The entire experiment was conducted under the shade net house; started in the month of March, 2021 and ended June, 2021. A Completely Randomised Design (CRD) was used to set up the experiment and it was replicated thrice with thirteen treatments such as T1 - Vermicompost, T2 - Vermicompost + Cocopeat (2:1), T3 - Vermicompost + Sphagnum Peat Moss (2:1) , T4 - Vermicompost + Cocopeat + Perlite (2:1:1), T5 - Vermicompost + Sphagnum Peat Moss + Perlite (2:1:1) , T6 - Vermicompost + Cocopeat + Vermiculite (2:1:1), T7 - Vermicompost + Sphagnum Peat Moss + Vermiculite (2:1:1) , T8 - Vermicompost + Cocopeat + Sand (2:1:1), T9 – Vermicompost + Sphagnum Peat Moss + Sand (2:1:1), T10 - Vermicompost + Cocopeat + Sawdust (2:1:1), T11 - Vermicompost + Sphagnum Peat Moss + Sawdust (2:1:1), T12 - Soil + Vermicompost (1:1) (Control), T13 - Soil (Control).

**2.2 Preparatory work for seedling raising**

Seeds of papaya cv. ‘Red Lady’ were procured from Kolkata in a 10 g sealed polythyene packet. Red lady is a gynodioecious variety plant which has a dwarf stature, high yielding, and good attractive colour and produces fruit within 8-10 months. The growing media used for experiment were vermicompost, vermiculite, perlite, cocopeat, sphagnum peat moss, sawdust, sand and their combinations. Vermicompost, coco peat and sand was procured from a reputed nursery of Kalyani, Nadia. Vermiculite and perlite were collected from reputed online store in Mumbai. Sawdust was collected from the local saw mill and the soil was taken from the nursery of the department. At first a place is marked in between the shade net so that the plants can get uniform light and air. Raised beds are formed so that packets can be placed at those beds. Each row consisted of 20 packets per treatment. All the media were sterilized with fungicide SAAF (Carbendazim 12% + Mancozeb 63% WP) with a dose of 1 gram in 1 litre of water. The cocopeat, at first was mixed in water so that it increases its volume and retains the moisture more. All the media were mixed according to the treatments and in definite ratio and then they were filled in the respective polybags. Seeds were soaked in water for 12 hours and dried in shade. Single seed was sown in each polypacket on 26 March 2021 at a depth of 1 cm. The packets were kept in shade net in raised beds with uniform conditions. After sowing water was applied with rose can and subsequent watering was done at an interval of 1-2 days at morning. After germination water was given 2 days interval.

**2.3 Procedure for recording observations of parameters**

Water soaked seeds were sown in polythene packet and number of germinated seeds and their speed of germination were recorded in each day up to 25 days after seed sowing. However shoot length, root length and number of leaves of seedlings were recorded 30 days after sowing. Germination percentage was calculated by using the following formula:

Germination (%) = (Total number of seed germinated / Total number of seed sown) × 100

20 seeds were planted in each replication and the dates were noted. The duration of seed emergence were recorded by noting the first seed emerged and the last seed emerged replication wise in each treatment. The length of the shoots and roots of seedlings were recorded with the help of metre scale after 30 days after seed sowing. The ratio was calculated by dividing average root length with average shoot length. Seedling vigour index was calculated by using the following formula:

Seedling vigour index = (Average root length + Average shoot length) × Germination (%)

**2.4 Statistical analysis**

The data obtained were analysed statistically by the analysis of variance method as suggested by Panse and Sukhatme (1985) and the significance of different source of variation was tested by error mean square by Fisher’s ‘F’ test of probability level of 0.05 percent.

1. **RESULTS AND DISCUSSION**

**3.1 Effect of growing media on initiation, completion, number and percentage of seed germination of papaya**

The data presented in Table 1 revealed that the media played an important role in germination of seeds as well as emergence of seedlings during the investigation time. The early seed germination (8.3 days) was obtained with T4 (Vermicompost + Cocopeat + Perlite) followed by (8.6 days) T2 (Vermicompost + Cocopeat). The initiation of seed germination was late (12.7 days) with T13. The fastest germination completion (10.6) was seen in T4. The longest duration (23.7) for seed germination was seen in T13. This could be due to the fact that vermicompost is high in organic matter which increases water and nutrient holding capacity of the medium for supply to the plant. 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 also having a balanced composition of nutrients (Zaller, 2007). Abirami et al. (2010) revealed that the nutrient-rich cocopeat, when combined with vermicompost and perlite, gives a better nutrient that enhances early germination and plant establishment. It is evident that sand has high water retention capacity and also provides good drainage. So this affect the duration of seed germination. It might due to the reason that media containing organic manures possess organic acid within it. Therefore, more available moisture and some acids may have helped in minimum days to germination initiation and quick completion. Similar results were reported by Parasana *et al*. (2014) in mango. The lowest duration of seed germination (2.3) was seen in T4. The longest duration of seed germination (8) was found in T13. Maximum no of seeds germinated (19.6) was recorded in treatment T9 (Vermicompost + Sphagnum Peat Moss + Sand) followed by (19) T2 (Vermicompost + Cocopeat) and T8 (Vermicompost + Cocopeat + Sand). The least germination (9.3) is recorded in T11 (Vermicompost + Sphagnum Peat Moss + Sawdust) and T12 (Vermicompost + Soil). The highest germination percentage (98.3%) was noted in the treatment T9 followed by (95%) treatment T2 and T8. The least germination percentage (53.7) was found in T13. The favourable impact of the media mixture on water retention, porosity, and soil aeration may enhance root and shoot development compared to media soil alone. The similar results were found by Hasan *et al*. (2010) in papaya. Highest germination percentage was due to the fact that sphagnum peat moss has greater water retaining capacity than most of other soil-less potting media (Alexander *et al*., 2008). This organic soil conditioner can also regulate air and moisture for area neighboring the plant roots. Vermicompost is reported to have bio active principles which are considered to be beneficial for root growth and results in higher germination, enhanced growth and development. The increase in germination in other treatments might be due to the fact that cocopeat when mixed with organic manure improves the overall physical traits of the media.

**Table 1: Effect of growing media on seed germination of papaya**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | Date of seed sowing | Start of seed germination | Period required to initiate seed germination from seed sowing (days) | End of seed germination | Period required to complete seed germination from seed sowing (days) | **Period required from start to end of seed germination (days)** | Number of seeds sown | Number of seeds germinated | Germination (%) |
| T1 | 26.03.21 | 05.04.21 | 10 | 12.04.21 | 17 | 7 | 20 | 17 | 85 |
| T2 | 26.03.21 | 03.04.21 | 8.6 | 12.04.21 | 15.6 | 7 | 20 | 19 | 95 |
| T3 | 26.03.21 | 05.04.21 | 10.3 | 12.04.21 | 17 | 6.6 | 20 | 12.6 | 63.3 |
| T4 | 26.03.21 | 03.04.21 | 8.3 | 07.04.21 | 10.6 | 2.3 | 20 | 18.3 | 91.6 |
| T5 | 26.03.21 | 05.04.21 | 10.3 | 12.04.21 | 17 | 6.3 | 20 | 15.3 | 76.6 |
| T6 | 26.03.21 | 05.04.21 | 10 | 12.04.21 | 15.6 | 5.6 | 20 | 18.6 | 93.3 |
| T7 | 26.03.21 | 06.04.21 | 12 | 12.04.21 | 17 | 5 | 20 | 13.6 | 68.3 |
| T8 | 26.03.21 | 04.04.21 | 9 | 07.04.21 | 12 | 3 | 20 | 19 | 95 |
| T9 | 26.03.21 | 05.04.21 | 10 | 12.04.21 | 15.6 | 5.6 | 20 | 19.6 | 98.3 |
| T10 | 26.03.21 | 05.04.21 | 10 | 12.04.21 | 15.3 | 5.3 | 20 | 17.3 | 86.6 |
| T11 | 26.03.21 | 05.04.21 | 10.6 | 12.04.21 | 17 | 6.3 | 20 | 9.3 | 46.6 |
| T12 | 26.03.21 | 06.04.21 | 12 | 15.04.21 | 20.7 | 6 | 20 | 9.3 | 57.7 |
| T13 | 26.03.21 | 07.04.21 | 12.7 | 17.04.21 | 23.7 | 8 | 20 | 10 | 53.7 |
| C.D. | --- | --- | 0.94 | --- | 2.54 | 2.67 | --- | 3.67 | 18.23 |
| SE(m) | --- | --- | 0.32 | --- | 0.87 | 0.91 | --- | 1.25 | 6.28 |
| SE(d) | --- | --- | 0.45 | --- | 1.23 | 1.29 | --- | 1.77 | 8.82 |
| C.V. | --- | --- | 5.38 | --- | 9.11 | 30.45 | --- | 13.96 | 13.89 |

**3.2 Effect of growing media on progress of seed germination of papaya**

The data presented in Table 2 revealed that the combinations of media played important role in affecting the progress of seed germination. It was observed that about 5 seeds in T2 (Vermicompost + Cocopeat) and 14 seeds in T4 (Vermicompost + Cocopeat + Perlite) were germinated within 7 days of seed sowing. Above 90% of seed germination was seen in T4 (Vermicompost + Cocopeat + Perlite), T6 (Vermicompost + Cocopeat + Vermiculite), T8 (Vermicompost + Cocopeat + Sand) and T9 (Vermicompost + Sphagnum Peat Moss + Sand). It can also be concluded that both the control treatments *i.e.*, T12 (Vermicompost + Soil) and T13 (Soil) had negative impact in the rate of seed germination. Here both seed germination percentage and duration of seed germination had a negative result. Above 90% of seed germination might be due to the beneficial effect of media mixture on water holding capacity, porosity and soil aeration which is good for root and shoot growth over media soil alone or soil mixed with vermicompost. Similar result was observed by Bharadwaj (2013).

**Table 2: Effect of growing media on progress of seed germination of papaya**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **Seed Germination** | | | | | | | | | | | | | |
| **7 DAS (3/4/21)** | | **8 DAS (4/4/21)** | | **9 DAS (5/4/21)** | | **10 DAS (6/4/21)** | | **11 DAS (7/4/21)** | | **12 DAS (8/4/21)** | | **15 DAS (12/4/21)** | |
| **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| T1 | - | - | - | - | 15 | 25 | 20 | 33.3 | 37 | 61.7 | 40 | 66.7 | 51 | 85 |
| T2 | 5 | 8.3 | 20 | 33.3 | 31 | 51.6 | 41 | 68.3 | 44 | 73.3 | 49 | 81.6 | 52 | 86.7 |
| T3 | - | - | - | - | 3 | 5 | 6 | 10 | 10 | 16.6 | 21 | 35 | 38 | 63.3 |
| T4 | 14 | 23.3 | 42 | 70 | 52 | 86.7 | 54 | 90 | 55 | 91.7 | - | - | - | - |
| T5 | - | - | - | - | 3 | 5 | 15 | 25 | 28 | 46.7 | 35 | 58.3 | 46 | 76.7 |
| T6 | - | - | - | - | 34 | 56.7 | 49 | 81.7 | 50 | 83.3 | 52 | 86.7 | 56 | 93.3 |
| T7 | - | - | - | - | - | - | 6 | 10 | 10 | 16.7 | 26 | 43.3 | 41 | 68.3 |
| T8 | - | - | 39 | 65 | 50 | 83.3 | 51 | 85 | 57 | 95 | - | - | - | - |
| T9 | - | - | - | - | 29 | 48.3 | 49 | 81.7 | 53 | 88.3 | 55 | 91.7 | 59 | 98.3 |
| T10 | - | - | - | - | 23 | 38.3 | 33 | 55 | 37 | 61.7 | 44 | 73.3 | 52 | 86.7 |
| T11 | - | - | - | - | 3 | 5 | 7 | 11.6 | 15 | 25 | 17 | 28.3 | 28 | 46.7 |
| T12 | - | - | - | - | 2 | 3.3 | 8 | 13.3 | 10 | 16.6 | - | - | 12 | 20 |
| T13 | - | - | - | - | 3 | 5 | 9 | 15 | - | - | 11 | 18.3 | - | - |

**3.3 Effect of growing media on seedling growth of papaya**

From Table 3, it was quite evident that media treatment had played significant role in affecting the height of the plant at 30 days from the date of sowing. The highest shoot length (11.4 cm) was recorded in treatment T6 (Vermicompost + Cocopeat + Vermiculite), followed by (11.2 cm) treatment T8 (Vermicompost + Cocopeat + Sand) while the smallest height (8.2 cm) was recorded in T13. The longest root length (19.4 cm) was recorded in T8 and smallest (5.9 cm) was observed in T4. The total length of seedling (both shoot & root) was taken into account and the media played significant role in influencing the seedling length. The longest seedling length (30.6 cm) was found in T8 and T6. The shortest length (13 cm) was found in T13. The highest ratio of root:shoot (2.3:1) was found in T5 (Vermicompost + Sphagnum Peat Moss + Perlite) followed by (2.0:1) T1 (Vermicompost). The lowest ratio (0.6:1) was found in T4. The highest seedling vigour (2916.5) was observed in T8 followed by (2866) T6 whereas the least (678) was recorded in T13. Maximum number of leaves (8) was observed in T8. Least number (4.2) was recorded in T13. Vermicompost which contain plant growth regulating materials, such as humic acid and plant growth regulators like auxin, gibberellins and cytokinins which are responsible for increase in plant growth. Higher seedling length as well as maximum number of leaves were observed due to the beneficial effect of media mixture on water holding capacity, porosity and soil aeration which is good for root and shoot growth. Peat moss is the most mainstream constituent in nursery for containerized planting media whereby it is usually incorporated to amplify water retention and plummeting the media total weight along with upright characteristics such as low bulk density, structural stability and low pH made it essential growing medium (Schmilewski, 2008). Combined application of vermicompost and cocopeat or vermicompost and sphagnum peat moss have showed significant effects on seedling growth, perhaps due to the synergistic effect of both these growing media. Similar results were also obtained by Bhardwaj (2013) in papaya seedlings.

**Table 3: Effect of growing media on seedling growth of papaya**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **Shoot length (cm)** | **Root length (cm)** | **Seedling length (cm)** | **Root:shoot ratio** | **Seedling vigour index** | **Number of leaves** |
| T1 | 6.6 | 13.6 | 20.2 | 2.0:1 | 1753.5 | 6.1 |
| T2 | 10.7 | 13.4 | 24.1 | 1.3:1 | 2303 | 7.6 |
| T3 | 6.5 | 11.5 | 18 | 1.8:1 | 1182.83 | 6 |
| T4 | 10.6 | 5.9 | 16.5 | 0.6:1 | 1520.67 | 6.8 |
| T5 | 7 | 16.6 | 23.6 | 2.3:1 | 1855.67 | 6.6 |
| T6 | 11.4 | 19.2 | 30.6 | 1.7:1 | 2866 | 7.3 |
| T7 | 5.7 | 7.5 | 13.2 | 1.1:1 | 959.5 | 5.6 |
| T8 | 11.2 | 19.4 | 30.6 | 1.7:1 | 2916.5 | 8 |
| T9 | 9 | 14.9 | 23.9 | 1.7:1 | 2346 | 6.5 |
| T10 | 10.7 | 15.9 | 26.6 | 1.5:1 | 2299 | 6.6 |
| T11 | 8.1 | 9.8 | 17.9 | 1.2:1 | 818.13 | 6.8 |
| T12 | 6.3 | 10.6 | 16.9 | 1.7:1 | 979.3 | 5.2 |
| T13 | 4.8 | 8.2 | 13 | 1.6:1 | 678 | 4.2 |
| C.D. | 1.99 | 6.1 | 6.91 | 0.72 | 775.91 | 0.883 |
| SE(m) | 0.68 | 2.06 | 2.37 | 0.25 | 265.45 | 0.302 |
| SE(d) | 0.97 | 2.91 | 3.34 | 0.35 | 375.4 | 0.427 |
| C.V. | 14.12 | 27.75 | 19.33 | 27.38 | 26.59 | 8.121 |

1. **CONCLUSION**

The study of soilless growing media for seed germination and seedling growth in papaya was conducted under shade net house adjacent to Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal in 2021. Seed germination of papaya was found more than 90 percent with treatment T2, T4, T6, T8 and T9. However, maximum number of seeds germinated (19.6 out of 20) and germination percentage (98.3%) were found with treatment T9 followed by T8 and T2. Early seed germination (8.3 days from seed sowing) and duration of seed germination (2.3 days) were noted with treatment T4. The seedling vigour index was higher with treatment T8. Number of leaves was found higher with treatment T8. From the result of present investigation, it can be concluded that media containing mixture of (Vermicompost + Sphagnum Peat Moss + Sand) and (Vermicompost + Cocopeat + Sand) is ideal for getting higher seed germination and seedling growth.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

**REFERENCES**

Abad, M., Noguere, P., Puchades, R., Maquieira, A. & Noguera, V. (2002). Physio- chemical properties of some coconut dusts for use as a peat substitute for containerized ornamental plants. Bioresource Tech.,82: 241-245.

Abirami K, Rema J, Mathew PA, Srinivasan V, & Hamza S. (2010). Effect of different propagation media on seed germination, seedling growth and vigour of nutmeg (*Myristica fragrans* Houtt.). Journal of medicinal plants research, 4(19):2054-2058.

Agbo, C.V. & Omaliko, C.M. (2006). Initiation and growth of shoots of Gongronema latifolia Benth stem cutting in different rooting media. African J. Biotech., 5: 425-428.

Alexander, P.D., N.C. Bragg, R. Meade, G. Padelopoulos & Watts, O. (2008). Peat in horticulture and conservation: The UK response to a changing world. Mires Peat, 3: 1-10.

Bachman, G.R. & Metzger, J.D. (2008). Growth of bedding plants in commercial potting substrate amended with vermicompost. Biores Tech., 99:3155-3161.

Baiyeri, K. P. & B. N. Mbah, (2006). Effects of soilless and soil-based nursery media on seedling emergence growth and response to water stress of African breadfruit (*Treculia africana*). Int. agrophys. 20: in press. 29.

Bharadwaj, R.L. (2013). Effect of growing media on seed germination and seedling growth of papaya c.v. Red Lady. African J. Plant Sci., 8(4):178-184.

Carbrera, R.I. (2003). Fundamentals of container media management. Part -1 Physical Propertise. The State University of New Jersey Agriculture station.

Carvalho, F. A., & Renner, S. S. (2012). A dated phylogeny of the papaya family (Caricaceae). Mol. Phylogenet. Evol. 65: 46–53.

Dayeswari, D, Rayaprolu, S. & Jone, A. (2017). Effect of Potting Media on Seed Germination, Seedling Growth and Vigour in TNAU Papaya Co.8 (*Carica papaya*). Int. J. of pur. & app. Biosci, 5 (3):505-512.

Hasan, M.A, Manna, M. & Suresh, C.P. (2010). Standardisation of growing Media for seed germination in papaya 7-28. Final –KrishiBangla.com.

Muthukrishnan, C.R. & Irulappan, I. (2001). Papaya. Fruits: Tropical and Subtrpical, Vol.1, (eds. Bose, T.K., Mitra, S.K. & Sanyal, D.), NayaUdyog, Calcutta, pp.496- 555.

Niklas, K. J., & Marler, T. E. (2007). *Carica papaya* (Caricaceae): a case study into the effects of domestication on plant vegetative growth and reproduction. Am. J. Bot. 94, 999–1002.

Panse, V.G. & Sukhatme P.V. (1985). Statistical methods for agricultural workers. I.C.A.R. New Delhi.4th ed. l. C. A. R. New Delhi. pp: 131-143.

Parasana, J. S., Leua, H. N. & Ray, N. R. (2014). Effect of different growing media mixtures on germination and seedling growth of mango (*Mangifera indica* L.) cultivars under net house conditions. The Bioscan. 8(3): 897-900.

Schmilewski, G. (2008). The role of peat in assuring the quality of growing media. Mires Peat, 3: 1-8.

Wilson, S.B., Stoffella, P.J. & Graetz, D.A. (2001). Use of compost as a media amendment for containerized production of two subtropical perennials. J. Environ. Hort., 19(1): 37–42.

Zaller, J.G. (2007). Vermicompost as a substitute for peat in potting media: Effects on germination, biomass allocation, yields and fruit quality of three tomato varieties. Sci. Hort., 112:191-199.