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# Media Standardization for the Propagation of Bush Pepper in Panniyur 1 Variety of Black Pepper (*Piper nigrum* L.)

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## Abstract

*Black pepper is a highly valued spice crop. Growing bush pepper meets the rising demand for pepper. A study was conducted at the Horticultural Research Station, Yercaud (2023-2024) aimed to find the ideal media for rooting and establishment of bush pepper cuttings. The experiment was conducted in a randomized block design with 13 media combinations and two replications, observation was recorded on growth parameters such as sprouting characteristics, number of leaves, plant height, shoot length, plant girth, leaf area, root length, percentage of rooted cuttings, and benefit-cost ratio. Significant differences were recorded among treatments. The best growth parameters were observed in $T_{12}$ (Cocopeat + Sand + Vermicompost, 1:1:1) and $T_8$ (Cocopeat + Vermicompost, 1:1). Specifically: Number of leaves $T_{12}$ (4.96), $T_8$ (4.72); Plant height: $T_{12}$ (31.52 cm), $T_8$ (29.96 cm); Shoot length; $T_{12}$ (5.67 cm), $T_6$(4.92 cm); Leaf area: $T_{12}$ (239.42 $cm^2$), $T_8$(175.69 $cm^2$); Root length; $T_{12}$ (28.93 cm), $T_8$ (26.52 cm); Percentage of rooted cuttings: $T_{12}$ (58.94%), $T_8$ (55.36%). The study concluded that equal proportions of cocopeat, sand, and compost are ideal for the establishment of bush pepper cuttings, followed by an equal ratio of cocopeat and compost.*

***Keywords:*** *Black pepper (Piper nigrum), Bush pepper, Media composition, Rooting, Growth parameters*

## INTRODUCTION

Black pepper (*Piper nigrum* L) known as the "king of spices" and "Black gold" is a perennial spice crop grown mostly for export in India. It belongs to the family Piperaceae. Black pepper is a staple ingredient in cuisine all around the world because of its distinct flavor and pungency. Bush pepper is a modification of the traditional black pepper vine which is grown as a compact, bush-like plant. Space-constrained urban gardening and small-scale farming are well suited for this cultivation technique. Though it originated from traditional black pepper production, the idea of bush pepper has been modified to fit today's agriculture, particularly in areas where land is limited. Bush peppers are easier to grow and handle for both home gardeners and farmers. This is achieved through proper growing techniques. Bush pepper plants are kept at a height of roughly 1-2 mts and do not require the implementation of standards thus, allows increased plant population density, and reduced maintenance efforts ––[1] 2018. Furthermore, bush pepper starts yielding from the first year onwards. Harvesting is not a tedious process in bush pepper and does not require any additional tools like ladders as needed for harvesting in vine pepper. The disadvantages of using plagiotropic cuttings are poor growth rate, high mortality rate resulting from drought or leaf shedding, and a period of two-month root initiation and establishment [2]. Furthermore, bush pepper cuttings are nutrient demanding and need appropriate media for the better growth [3]. Successful bush pepper production can be achieved by producing an abundance of healthy seedlings by adopting techniques that promote the development of strong root. The key is to use of appropriate rooting medium, which can assist root development and supply nutrients. This can be achieved by using organic manures like (Farm Yard Manure (FYM), Vermicompost etc.) with effective utilization of organic waste. Keeping this in view the study aims to find the optimal media composition for the growth of bush pepper cuttings.

## MATERIALS AND METHOD

### Experimental design

The experiment was carried out between 2023 and 2024 (15 Dec 2024 -15 June 2024) for a period of 180 days at the Horticultural Research Station, Yercaud located in the Shevaroy hills in the Eastern Ghats. It is situated at an altitude of 1,515 mts (4,970 ft) above sea level.

Thirteen different treatment combinations followed two times the replication of each treatment. Different media combinations- like $T_1$ – FYM alone (Control), $T_2$-Soil + FYM (3:1), $T_3$-Soil + Vermicompost (3:1), $T_4$ -Soil + Vermicompost (1:1), $T_5$ - Soil + Coir pith + Vermicompost (2:1:1), $T_6$ - Soil + Coir pith + Vermicompost (1:1:1), $T_7$ - Cocopeat + Vermicompost (3:1), $T_8$- Cocopeat + Vermicompost (1:1), $T_9$ - Soil + Rice husk + Cocopeat (2:1:1), $T_{10}$-Soil + Rice husk + Cocopeat (1:1:1), $T_{11}$- Cocopeat + Sand + Vermicompost (2:1:1), $T_{12}$ - Cocopeat+ Sand + Vermicompost (1:1:1), $T_{13}$- Cocopeat + Rice husk + Vermicompost + Soil (1:1:1:1) were prepared with different proportions of media on volume basis and *Trichoderma viride* was added in each media @ 5 g.

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Then as per the treatments, the mixture was filled in polythene bags of size 10 cm width and 15 cm length.

**Planting material**

The cuttings were collected from Panniyur-1Variety from the mother block of approximately (12.87-16.92 cm) height of pencil size thickness (1.14-2.31 mm girth) and were planted in the polythene bags. Before planting, the basal portion of the cuttings (about 2.5-3 cm) was dipped in IBA@ 2000 ppm for (<5 sec.) to enable rooting. Then, the treated cuttings were planted in polybags containing different combinations of rooting media. The polybag containing potting media was drenched with copper oxy-chloride @ 2% to avoid fungal infestation. The cuttings in polybags are watered sufficiently so that the media is tighter. The cutting samples are immediately placed in a mist chamber with an air humidity of 80% and a temperature of 26°C.

**Determination of physical and chemical properties of media**

The physical and chemical properties of different media compositions were analyzed using standard procedure. Physical characteristics of media like EC, pH and Water holding capacity were analyzed using the methods suggested by [4], [5], [6]. The chemical properties of media like available N, P, K and exchangeable amounts of Ca, Mg and Na were carried out using the methods suggested by [7], [8].For the exchangeable amount of Ca, Mg and Na [9]. Organic Carbon analysis was carried out using the procedure suggested by the [10].

The observation was recorded for various diverse parameters of the bush pepper under different media compositions during the study like sprouting characters (days to sprouting, length of the sprout and percentage of Sprouting), number of leaves per cutting, plant height (cm), number of leaves, shoot length (cm), plant girth (mm), leaf Area ($cm^2$), root length (cm), percentage of rooted cuttings (%), benefit-cost ratio was also calculated.

**Statistical analysis**

The results for each characterization data were obtained from the mean procedure of two replicas and statistical analysis was performed in Randomized block design by SPSS 29 Software and Multiple comparison Test using LSD were carried out to find out the best treatments.

*Table: 1. Observation recorded for various parameters on the sprouting characters of bush pepper cuttings*

| Treatments | Treatment details | Days to early Sprouting | Length of the sprout@105 DAP | Sprouting percentage@105 DAP |
|---|---|---|---|---|
| $T_1$ | FYM alone (Control) | 20.69 e | 4.42 g | 52.53 l |
| $T_2$ | Soil + FYM (1:1) | 18.57 j | 3.98 k | 67.52 d |
| $T_3$ | Soil + Compost (3:1) | 20.13 g | 3.52 l | 64 f |
| T4 | Soil + Compost (1:1) | 18.13 l | 4.08 j | 65.53 e |
| $T_5$ | Soil + Coir pith + Compost (2:1:1) | 19.43 i | 4.35 h | 62.81 g |
| $T_6$ | Soil + Coir pith + Compost (1:1:1) | 21.73 c | 4.98 d | 47.52 m |
| $T_7$ | Cocopeat + Compost (3:1) | 21.32 de | 3.97 k | 62.27 h |
| $T_8$ | Cocopeat + Compost (1:1) | 16.32 m | 6.35 b | 69.73 b |
| $T_9$ | Soil + Rice Husk + Cocopeat (2:1:1) | 22.78 a | 5.59 c | 58.67 j |
| $T_{10}$ | Soil + Rice Husk + Cocopeat (1:1:1) | 20.0 6 h | 4.87 e | 68.74 c |
| $T_{11}$ | Cocopeat + Sand + Compost (2:1:1) | 21.92 b | 4.52 f | 59.62 i |
| $T_{12}$ | Cocopeat + Sand + Compost (1:1:1) | 17.58 k | 6.65 a | 71.53 a |
| $T_{13}$ | Cocopeat +Rice husk + compost + Soil (1:1:1:1) | 20.31 f | 4.19 i | 53.12 k |
| C.D | C.D | 0.012 | 0.011 | 0.137 |
| S.E (m) | S.E (m) | 0.004 | 0.004 | 0.044 |
| S.E (d) | S.E (d) | 0.005 | 0.005 | 0.062 |
| C.V | C.V | 0.027 | 0.109 | 0.101 |

*Mean values within same column, followed by similar letters are not significantly different at p<0,05 according to LSD multiple comparison method.*

*Table: 2 . Observation recorded for various diverse parameters of the bush pepper under different media composition*

| Treatments | Treatment details | No. of leaves (Nos.) | plant height | No. of shoots (Nos.) | Shoot length (cm) | Plant girth (mm) | Leaf area ($cm^2$) | Root Length (cm) | Percentage of Rooted cuttings (%) | Benefit cost Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | FYM alone (Control) | 3.24 def | 19.62 m | 1.69 d | 3.98 f | 2.79 j | 146.71 f | 12.53 m | 22.15 l | 0.91 h |
| $T_2$ | Soil + FYM (1:1) | 2.98 g | 22.44 j | 1.54 f | 3.62 h | 2.57 l | 89.72 j | 18.77 k | 28.52 i | 0.83 k |
| $T_3$ | Soil + Compost (3:1) | 2.79 h | 27.55 c | 1.43 h | 3.05 k | 2.92 g | 132.61 g | 19.05 j | 35.12 e | 1.04 g |
| T4 | Soil + Compost (1:1) | 2.92 g | 25.89 e | 2.04 b | 3.57 i | 2.69 k | 149.86 e | 19.32 i | 33.17 f | 1.27 d |
| $T_5$ | Soil + Coir pith + Compost (2:1:1) | 3.06f g | 22.76 h | 1.68 d | 2.89 l | 2.56 m | 123.79 i | 21.52 d | 32.82 g | 0.87 j |
| $T_6$ | Soil + Coir pith + Compost (1:1:1) | 3.32 cde | 26.53 d | 2.01 b | 2.78 m | 2.97 f | 124.36 h | 19.68 h | 39.68 d | 1.22 f |
| $T_7$ | Cocopeat + Compost (3:1) | 3.12 efg | 21.87 l | 1.61 e | 3.56 j | 2.82 i | 156.72 d | 20.18 f | 42.19 c | 0.65 m |
| $T_8$ | Cocopeat + Compost (1:1) | 4.72 a | 29.96 b | 2.04 b | 4.92 b | 3.05 c | 175.69 b | 26.52 b | 55.36 b | 1.58 b |
| $T_9$ | Soil + Rice Husk + Cocopeat (2:1:1) | 2.45 h | 22.01 k | 1.42 h | 3.67 g | 2.98 e | 156.68 l | 21.47 e | 29.23 h | 1.24 e |
| $T_{10}$ | Soil + Rice Husk + Cocopeat (1:1:1) | 3.54 c | 24.57 f | 1.49 g | 4.09 d | 3.01d | 123.89 d | 20.17 g | 26.15 j | 1.33 c |
| $T_{11}$ | Cocopeat + Sand + Compost (2:1:1) | 3.42 cd | 23.82 g | 1.41 h | 4.18 c | 3.26 b | 146.84 f | 18.57 l | 23.54 k | 0.9 i |
| $T_{12}$ | Cocopeat + Sand + Compost (1:1:1) | 4.96 a | 31.52 a | 2.4 ac | 5.67 a | 3.96 a | 239.42 a | 28.93 a | 58.94 a | 1.77 k |
| $T_{13}$ | Cocopeat +Rice husk + compost + Soil (1:1:1:1) | 3.87 b | 22.53 i | 1.54 f | 4.03 e | 2.87 h | 166.773 c | 22.17 c | 33.17 f | 0.82 l |
| C.D | C.D | 0.257 | 0.049 | 0.039 | 0.007 | 0.009 | 0.398 | 0.139 | 0.012 | 0.006 |
| S.E (m) | S.E (m) | 0.082 | 0.016 | 0.012 | 0.002 | 0.003 | 0.128 | 0.045 | 0.004 | 0.002 |
| S.E (d) | S.E (d) | 0.117 | 0.022 | 0.018 | 0.003 | 0.004 | 0.181 | 0.063 | 0.006 | 0.003 |
| C.V | C.V | 3.438 | 0.09 | 1.022 | 0.078 | 0.136 | 0.121 | 0.304 | 0.016 | 0.233 |

*Mean values within same column, followed by similar letters are not significantly different at p<0,05 according to according to LSD multiple comparison method.*

## Physical and Chemical Characteristics of Media Used in the Experiment

***Fig 1 Exchangeable amount of Ca, Mg and Na (C mol/Kg) before and after the experiment***

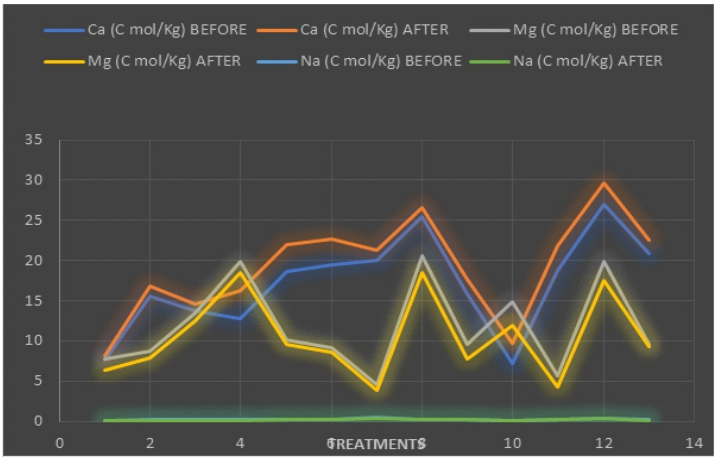



***Fig 2 Amount of N, P, K (%) before and after the experiment***

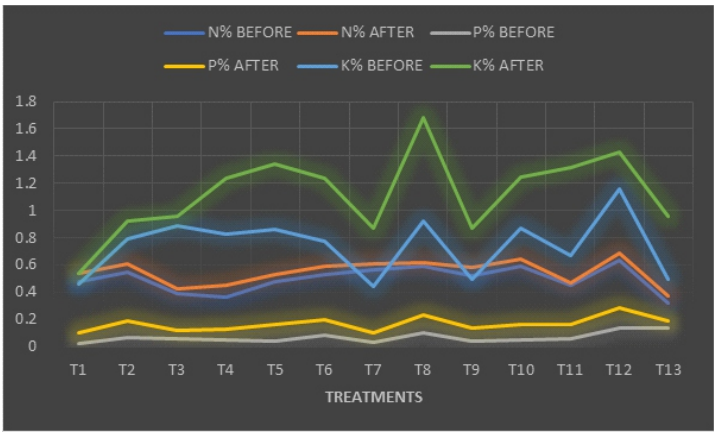
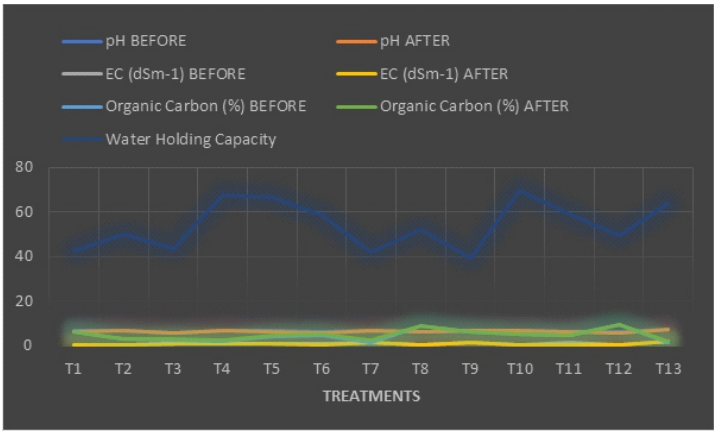



***Fig 3 Physical characters of media composition before and after the experiment***




## RESULTS AND DISCUSSION

Bush pepper is propagated through plagiotropic shoot cuttings. The disadvantage of this method is the poor establishment of the cuttings and also low availability of source of planting material. During propagation, it has been observed that the optimal media with the appropriate physical and chemical properties for successful rooting of laterals and producing bush pepper has yet to be established. To overcome, this Various media combinations with moisture and nutrient availability must be used in appropriate proportions to improve the rooting and establishment percentage of bush pepper cuttings.

The physical and chemical characteristics of the media composition were analyzed, and soil pH was classified according to the USDA Natural Resources Conservation Service (NRCS) standards to determine the suitability and nutritional characteristics of media for the establishment of bush pepper [11]. The treatments under study were categorized as moderately acidic (5.6 - 6.0) for $T_3$ (5.75), $T_8$ (6.01), and $T_{12}$ (5.91); slightly acidic (6.1 - 6.5) for $T_5$ (6.65), $T_7$ (6.76), $T_9$ (6.52), and $T_{11}$ (6.1); and neutral (6.6 - 7.3) for $T_1$ (6.71), $T_2$ (6.76), $T_4$ (6.69), $T_{10}$ (6.9), and $T_{13}$ (7.08. pH plays an important role in increasing the nutrient uptake for plants, moderately acidic soils enhance the availability of essential nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, and sodium, which enhances the growth and development of bush pepper cuttings [12] [13] [14]. $T_6$ Soil + Coir pith + Compost (1:1:1) was found to be highly acidic with a pH value of 5.39, resulting in the lowest shoot length (2.78 cm). The increase in chemical characteristics of the media after the experiment may be attributed due to the microbial breakdown of organic matter in different media compositions this which often results in increased nutrient availability for plants. Soil microorganisms can convert organic forms of N, P and K into inorganic forms that are more readily available for plant uptake, increasing the measurable levels of these nutrients in the media composition. The other reason may be attributed due to the reduced plant uptake or leaching. In some cases, plants may not take up all the available nutrients during the establishment, leaving higher levels of N, P, and K in the soil [15]. This can also occur if nutrient leaching was minimal, allowing more nutrients to remain in the soil.

Other physical characteristics like EC range, reflecting soil salinity and nutrient uptake, were low in treatment $T_1$ (0.11 mS/cm), indicating minimal salinity and ideal conditions for growth. Mild salinity in $T_8$ (0.59 mS/cm) and $T_{12}$ (0.46 mS/cm) could cause stress in sensitive plants, but the growth performance of bush pepper cuttings remained good [16] .The organic carbon (OC) content of the media improves soil structure, water retention, and nutrient supply, $T_6$ (4.70%), $T_8$ (8.79%), and $T_{12}$ (9.47%) recorded high OC, and moderate organic content was recorded $T_3$ (2.35%) and $T_{11}$ (4.43%).

High organic carbon content supports robust growth by enhancing the fertility, structure, and microbial activity of the media. High water holding capacity (WHC) is crucial for maintaining moisture around plant roots, with $T_4$ (67.83%), $T_5$ (66.78%), $T_{10}$ (69.72%), and $T_{13}$ (64.14%) exhibiting high WHC, and $T_6$ (58.53%), $T_{11}$ (58.92%), $T_8$ (52.15), and $T_{12}$ (49.49%) showing moderate WHC, thus supporting steady growth and reducing water stress of bush pepper cuttings in treatments containing moderate WHC [17].

Other essential nutrients like Calcium (Ca) required for cell wall structure and stability were high in $T_{12}$ (27 C mol/kg) and $T_8$ (25.4 C mol/kg), contributing to strong cell wall development. Magnesium (Mg), essential for chlorophyll production and enzyme activation, was high in T4 (19.9 C mol/kg), $T_8$ (19.9 C mol/kg), and $T_{12}$ (19.9 C mol/kg), ensuring efficient photosynthesis and enzyme function. Low to moderate sodium (Na) levels, found in $T_3$ (0.22 C mol/kg), $T_6$ (0.26 C mol/kg), $T_8$ (0.24 C mol/kg), and $T_{12}$ (0.36 C mol/kg), minimize the risk of sodium toxicity, supporting healthy plant growth [18]. The treatments containing cocopeat + sand + compost (1:1:1) and cocopeat + compost (1:1) provided favorable conditions for the growth of bush pepper cuttings [19]

The observation recorded on sprouting characters is an indicator of media with optimum conditions for the enhanced growth of bush pepper cuttings.

In this study, the highest sprouting percentage was observed in $T_{12}$ (Cocopeat + Sand + Compost (1:1:1) with 71.53%. This suggests that a balanced mix of cocopeat, sand, and compost provides an optimal environment for sprouting. Cocopeat is known for its water retention and aeration properties, while sand improves drainage, and compost adds essential nutrients, enhancing overall sprouting efficiency[20].

The time to early sprouting is an essential factor in determining the speed of initial plant growth. The shortest duration to early sprouting was recorded in $T_8$ (Cocopeat + Compost (1:1)) at 16.32 days. This media combination offers a balanced nutrient supply and moisture retention and also the utilization of reserved carbohydrates in cuttings has resulted in early sprouting of cuttings [21]. Conversely, the longest duration was in $T_9$ (Soil + Rice Husk + Cocopeat (2:1:1)) at 22.78 days, indicating that this mixture has suboptimal conditions for rapid sprouting, possibly due to varying water retention and aeration levels [22]. The sprout length recorded maximum in $T_{12}$ (Cocopeat + Sand + Compost (1:1:1)) at 6.65 cm. This result highlights the benefits of a well-aerated and nutrient-rich medium causing vigorous supporting growth. The shortest sprouts were in $T_3$ (Soil + Compost (3:1)) at 3.52 cm, suggesting that a higher proportion of soil may limit aeration and water availability, thus restricting growth of the cuttings[23].

The observation recorded varied significantly among the treatments, with superior growth characters recorded in the treatment containing $T_{12}$ Cocopeat + Sand + Compost (1:1:1) which was followed by $T_8$ Cocopeat + Compost (1:1) with a maximum number of leaves recorded in $T_{12}$ (4.96), $T_8$ (4.72), plant height $T_{12}$ (31.52 cm) ,$T_8$ (29.96 cm), no. of Shoots: $T_{12}$ (2.00), $T_8$ (2.04), Shoot Length: $T_{12}$ (5.67cm), $T_6$ (4.92 cm), plant girth: $T_{12}$ (3.26 mm),$T_8$ (3.05 mm), leaf area: $T_{12}$ (239.42 $cm^2$) ,$T_8$ (175.69 $cm^2$), root length: $T_{12}$ (28.93 cm) ,$T_8$ (26.52 cm), percentage of rooted cuttings: $T_{12}$(58.94%), $T_8$ (55.36%).

This is because the media containing Cocopeat + Vermicompost (1:1) have suitable physical properties and chemical properties like water holding capacity (52.15), favorable pH (6.01), EC (0.59 mS/cm) and Organic Carbon of (8.79) for rooting and increased amount of available N (0.5), P (0.1), K (0.44), Ca (25.4), Mg (20.6) and Na (0.24) (Fig 1,Fig 2 and Fig 3) that support the growth of the cuttings. Also, the increase in N, P, K and Mg content after the experiment would have resulted from the decomposition of the media composition during the development of the root. Also, the increase in Ca and Na after the experiment shows the use of these micronutrients for root development. The growth performance of cuttings in media containing cocopeat and vermicompost has been extensively studied. [24], found that a plant growth medium composed of cocopeat, FYM, and vermicompost (2:2:1) significantly influenced the root, shoot, and leaf growth of Kusum cuttings, with maximum rooting observed in this medium. Similarly, [25] discovered that a combination of 50% cocopeat and 50% vermicompost led to optimum crop performance and the highest yield in cucumber cultivation. These studies collectively suggest that the inclusion of cocopeat and vermicompost in plant growth media positively impacts the growth and yield of various plant cuttings, making it an ideal choice for the establishment of cuttings. Vermicompost is rich in nutrients and beneficial microorganisms, enhancing soil fertility and providing essential nutrients like nitrogen, phosphorus, and potassium for healthy plant growth and development [26]. The ideal physical and chemical characteristics of the media with cocopeat and vermicompost combination have enhanced the growth of the cuttings. This increased growth of the cuttings resulted in increased dry matter accumulation of shoots and roots. The findings are in accordance with the findings of[27]

Additionally, the fine sand medium added to the $T_{12}$ where, an equal proportion of Cocopeat + Sand + Compost (1:1:1) provides adequate pH (5.91), EC (0.46 mS/cm), Organic Carbon of (9.47%) available N (0.63), P (0.14), K (1.16), Ca (25.4) Mg (27.0) and Na (0.36) and increased amount of aeration and drainage, leading to increased porosity for better root initiation and establishment. The addition of Sand to the media improves drainage and prevents waterlogging, creating air spaces in the soil that promote root respiration and overall plant health. This finding is in accordance with[28];[29];[30].

Poor growth characteristics like the lowest plant height (19.62 cm), lowest root length (12.53 cm) and lowest percentage of rooted cuttings (22.15%) were observed in the treatment containing FYM alone (Control). This is because FYM can have a nutrient imbalance, especially in terms of nitrogen (N), phosphorus (P), and potassium (K) ratios, which are critical for plant growth. Studies have shown that FYM provides organic matter, but it may not supply adequate amounts of essential nutrients in the correct proportions required for optimal rooting and plant development A., Khan, [31]. Additionally, the higher bulk density compared to other growing media can lead to poor root aeration and compaction and hinder root growth and water movement, reducing the water use efficiency and nutrient uptake [32]. Moreover, FYM alone might not provide the optimal balance between water retention and drainage. It can either hold too much water, leading to waterlogging, or too little, leading to drought stress. Proper water retention and drainage are essential for rooting media to support healthy root growth and prevent diseases [33]. The high microbial activity in FYM can also sometimes lead to the depletion of oxygen in the rooting zone, creating anaerobic conditions that are detrimental to root growth. High microbial activity in FYM can cause competition for oxygen and nutrients between microbes and plant roots[34, 35]. In addition, FYM can contain plant pathogens or weed seeds that can negatively affect plant growth. The presence of pathogens in organic manures can introduce diseases to the plants, which can be detrimental to their growth and development [36]. The pH of FYM can vary significantly, which might not be suitable for all types of plants. Maintaining the appropriate pH is critical for nutrient availability and uptake in plants [37]. The correlation graph provides insights into the relationships between various plant growth parameters presented in Fig 4. A strong positive correlation is observed between rooting percentage and root length (0.84), indicating that higher rooting percentages are associated with longer roots. Similarly, rooting percentage shows a positive relationship with shoot length (0.81), number of shoots (0.77), and number of leaves (0.78), suggesting that better root establishment supports overall plant development.

Conversely, the variables Days to initial sprouting and Days to final sprouting have strong negative correlations with several growth traits, such as rooting percentage (-0.77 and -0.79, respectively), sprouting percentage (-0.80 and -0.71), and root length (-0.68 and -0.86), implying that higher values of these factors are detrimental to plant growth. Sprouting percentage, in turn, has strong positive associations with the number of leaves (0.90), shoot length (0.82), and root length (0.79), reinforcing its role in promoting overall plant vigor. Root length emerges as a key variable, with strong positive correlations to the number of leaves (0.91), shoot length (0.80), and sprouting

percentage (0.79), highlighting the critical importance of root development for healthy plant growth. Overall, the study suggests that well-established root systems are vital for improving shoot growth, leaf production, and overall plant health, while certain variables like Days to initial sprouting and Days to final sprouting may negatively affect these outcomes.
From the findings it is concluded that Cocopeat, when amended with vermicompost and sand was suitable best media due to its good physical characteristics and this combination has also been successfully tested as a growing medium for petunia cuttings [38].

## CONCLUSION

From the findings it is concluded that cocopeat when amended with vermicompost is the suitable best media due to its good physical characteristics and the combination of this media with the addition of equal proportion sand recorded better results comparatively. Though the growth performance and rooting of bush pepper cuttings are good at different media composition containing cocopeat, repetition of the same experiment is required to standardize the media for the establishment of bush pepper cuttings.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest

## AVAILABILITY OF DATA

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

*Table: 3. Correlation graph on traits of bush pepper cuttings on different growing media*

| | Rooting percentage | Days to initial sprouting | Days to final sprouting | Sprouting percentage | Length of the sprout | Number of shoots | Number of leaves | Shoot length | Plant height | Root length |
|---|---|---|---|---|---|---|---|---|---|---|
| **Rooting percentage** | 1 | -0.776*** | -0.795*** | 0.727*** | 0.643*** | 0.768*** | 0.785*** | 0.812*** | 0.603** | 0.84*** |
| **Days to initial sprouting** | -0.776*** | 1 | 0.707*** | -0.803*** | -0.472* | -0.645*** | -0.681*** | -0.7*** | -0.636*** | -0.683*** |
| **Days to final sprouting** | -0.795*** | 0.707*** | 1 | -0.71*** | -0.64*** | -0.421* | -0.694*** | -0.602** | -0.508** | -0.862*** |
| **Sprouting percentage** | 0.727*** | -0.803*** | -0.71*** | 1 | 0.575** | 0.606** | 0.902*** | 0.826*** | 0.682*** | 0.793*** |
| **Length of the sprout** | 0.643*** | -0.472* | -0.64*** | 0.575** | 1 | 0.422* | 0.766*** | 0.555** | 0.514** | 0.856*** |
| **Number of shoots** | 0.768*** | -0.645*** | -0.421* | 0.606** | 0.422* | 1 | 0.593** | 0.688*** | 0.445* | 0.569** |
| **Number of leaves** | 0.785*** | -0.681*** | -0.694*** | 0.902*** | 0.766*** | 0.593** | 1 | 0.874*** | 0.699*** | 0.907*** |
| **Shoot length** | 0.812*** | -0.7*** | -0.602** | 0.826*** | 0.555** | 0.688*** | 0.874*** | 1 | 0.626*** | 0.797*** |
| **Plant height** | 0.603** | -0.636*** | -0.508** | 0.682*** | 0.514** | 0.445* | 0.699*** | 0.626*** | 1 | 0.574** |
| **Root length** | 0.84*** | -0.683*** | -0.862*** | 0.793*** | 0.856*** | 0.569** | 0.907*** | 0.797*** | 0.574** | 1 |

**** Correlation is significant at 0.001 level (two tailed)*
*** Correlation is significant at 0.01 level (two tailed)*
** Correlation is significant at 0.05 level (two tailed)*

## REFERENCES

1. Thomas, M. and B.J. Sam, *Bush pepper cultivation–A remunerative hobby for rural women.* Indian Horticulture, 2018. 67(5).
2. Suhermanto, S., G. Rusmayadi, and B.F. Langai, *The Effect of Temperature and Relative Humidity Inside the Shade Netting on the Growth of Pepper Fruiting Branch Cuttings.* TROPICAL WETLAND JOURNAL, 2021. 7(2): p. 87-92.
3. Gayathri, G., S.E. Topno, and V. Prasad, *Effect of Different Levels of Vermicompost on Growth and Establishment of Differernt Varieties of Bush Pepper (Piper nigrum L) under Prayagraj Agro-climatic Zone.* International Journal of Environment and Climate Change, 2023. 13(9): p. 1301-1305.
4. Klute, A., *Methods of soil analysis. Part 1. Physical and mineralogical methods*. 1986.
5. Thomas, G.W., *Soil pH and soil acidity.* Methods of soil analysis: part 3 chemical methods, 1996. 5: p. 475-490.
6. Rhoades, J., *Cation exchange capacity.* Methods of soil analysis: Part 2 chemical and microbiological properties, 1982. 9: p. 149-157.
7. Bremner, J., *Total nitrogen.* Methods of soil analysis: part 2 chemical and microbiological properties, 1965. 9: p. 1149-1178.
8. Bray, R.H. and L.T. Kurtz, *Determination of total, organic, and available forms of phosphorus in soils.* Soil science, 1945. 59(1): p. 39-46.
9. Knudsen, D., G. Peterson, and P. Pratt, *Lithium, sodium, and potassium.* Methods of soil analysis: part 2 chemical and microbiological properties, 1982. 9: p. 225-246.

10. Walkley, A. and I.A. Black, *An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method.* Soil science, 1934. 37(1): p. 29-38.

11. Schaefer, G.L., M.H. Cosh, and T.J. Jackson, *The USDA natural resources conservation service soil climate analysis network (SCAN).* Journal of Atmospheric and Oceanic Technology, 2007. 24(12): p. 2073-2077.

12. Nash, V.E. and A.J. Laiche Jr, *Changes in the characteristics of potting media with time.* Communications in Soil Science and Plant Analysis, 1981. 12(10): p. 1011-1020.

13. He, K., et al., *Effects of calcium carbonate on the survival of Ralstonia solanacearum in soil and control of tobacco bacterial wilt.* European Journal of Plant Pathology, 2014. 140: p. 665-675.

14. Yadav, S., et al., *Diversity and phylogeny of plant growth-promoting bacilli from moderately acidic soil.* Journal of Basic Microbiology, 2011. 51(1): p. 98-106.

15. Deepagoda, T.C., et al., *Integral parameters for characterizing water, energy, and aeration properties of soilless plant growth media.* Journal of Hydrology, 2013. 502: p. 120-127.

16. Rhoades, J., et al., *Soil electrical conductivity and soil salinity: new formulations and calibrations.* Soil Science Society of America Journal, 1989. 53(2): p. 433-439.

17. Masood, T.K. and N.S. Ali. *Effect of Different Soil Organic Carbon Content in Different Soils on Water Holding Capacity and Soil Health*. in *IOP Conference Series: Earth and Environmental Science*. 2023. IOP Publishing.

18. Meng, X., et al., *Composted biogas residue and spent mushroom substrate as a growth medium for tomato and pepper seedlings.* Journal of environmental management, 2018. 216: p. 62-69.

19. Shinde, V., et al., *Comparative growth and yield performance of bush pepper (Pepper nigrum L.) cuttings and grafts under shade condition and pepper in open plantation.* Journal of Eco-friendly Agriculture, 2019. 14(1): p. 38-42.

20. Raviv, M., *Production of high-quality composts for horticultural purposes: A mini-review.* HortTechnology, 2005. 15(1): p. 52-57.

21. Kumar, D., et al., *Above-ground morphological predictors of rooting success in rooted cuttings of Jatropha curcas L.* biomass and bioenergy, 2011. 35(9): p. 3891-3895.

22. Evans, M.R., S. Konduru, and R.H. Stamps, *Source variation in physical and chemical properties of coconut coir dust.* HortScience, 1996. 31(6): p. 965-967.

23. Gruda, N.S., *Soilless culture systems and growing media in horticulture: An overview.* Advances in horticultural soilless culture, 2021: p. 1-20.

24. Sarkar, P.K., et al., *Standardization of Protocols for Plant Growth Media and Seasons for Cuttings of Kusum [Schleichera oleosa (Lour.) Oken].* International Journal of Environment and Climate Change, 2022. 12(12): p. 1273-1284.

25. Raju, J.T., et al., *Influence of cocopeat and vermicompost on growth and yield of cucumber.* Ecology, Environment and Conservation, 2022. 29: p. S189-S195.

26. Awang, Y., et al., *Chemical and physical characteristics of cocopeat-based media mixtures and their effects on the growth and development of Celosia cristata.* American journal of agricultural and biological sciences, 2009. 4(1): p. 63-71.

27. Li, Z., L. Wang, and X. Wang, *Flexural characteristics of coir fiber reinforced cementitious composites.* Fibers and Polymers, 2006. 7: p. 286-294.

28. Ephrem, N., S. Nyalala, and U.K.N. Josiane, *Suitability of sand amended with carbonized rice husks and goat manure as a growing medium.* Journal of Horticulture and Forestry, 2022. 14(1): p. 10-15.

29. Tanwar, D.R., et al., *Effect of IBA and rooting media on hardwood cuttings of pomegranate (Punica granatum L.) cv. Bhagwa.* International Journal of Environment and Climate Change, 2020. 10(12): p. 609-617.

30. Truong, H.D., C.H. Wang, and T.T. Kien, *Effect of vermicompost in media on growth, yield and fruit quality of cherry tomato (Lycopersicon esculentun Mill.) under net house conditions.* Compost Science & Utilization, 2018. 26(1): p. 52-58.

31. Malik, M., K. Khan, and P. Marschner, *Microbial biomass, nutrient availability and nutrient uptake by wheat in two soils with organic amendments.* Journal of soil science and plant nutrition, 2013. 13(4): p. 955-966.

32. Waman, A.A., G. Smitha, and P. Bohra, *A Review on Clonal Propagation of Medicinal and Aromatic Plants through Stem Cuttings for Promoting their Cultivation and Conservation.* Current agriculture Research Journal, 2019. 7(2).

33. Bunt, B., *Media and mixes for container-grown plants: a manual on the preparation and use of growing media for pot plants*. 2012: Springer Science & Business Media.

34. Halder, T.K., A.K. Dolui, and D. Saha, *Monitoring of nutrient status in an alluvial soil amended with different inorganic and organic fertilizers.* Int. J. Curr. Microbiol. App. Sci, 2020. 9(5): p. 3465-3473.

35. Bhat, T.A., et al., *Integrated nutrient management and its components in vegetable production.* International Journal of Chemical Studies, 2018. 66: p. 510-517.

36. Saha, R. and V. Mishra, *Effect of organic residue management on soil hydro-physical characteristics and rice yield in eastern Himalayan region, India.* Journal of Sustainable Agriculture, 2009. 33(2): p. 161-176.

37. Peter-Onoh, C., et al., *Efficacy of five different growth media on seedling emergence and juvenile phenology of Monodora myristica (African nutmeg, Ehuru) in the nursery.* J Agric Vet Sci, 2014. 7: p. 60-63.

38. Madurangani, H., *Investigation of Best Potting Media to Enhance Flowering Performance of Petunia Hybrida.* 2020.