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Effect of different rooting media on growth and root development of bougainvillea cv. Mahara

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Abstract
The present investigation entitled "Effect of different rooting media on growth and development of Bougainvillea cv. Mahara" was conducted at premises of Pt. KLS College of Horticulture And Research Station, Rajnandgaon (C.G.) Department of Floriculture and Landscaping Mahatma Gandhi University of Horticulture and Forestry Durg (C.G.) during *summer Season* 2024 - 2025. The experiment consisting of twelve treatments T_1 Soil, T_2 Sand, T_3 Cocopeat, T_4 Soil + Sand, T_5 Soil + Cocopeat, T_6- Sand + Cocopeat, T_7 Soil + FYM, T_8 Soil + Sand + Cocopeat, T_9 Soil + Sand + FYM, T_{10}Sand + Cocopeat + FYM, T_{11} Soil + Sand + Rice Husk, T_{12}Sand + Cocopeat + Vermicompost) laid out in Completely Randomized Design (CRD), with three replications. Data collected on best rooting media was studied for different parameters which indicates the presence of sufficient effect among the different treatments.The effect of treatment T_9 (Soil + Sand + FYM) was observed best for qualitative growth parameter like minimum days sprouting, number of sprouting, sprouting percentage, vegetative growth parameter like diameter of longest shoot/cutting, length of longest sprout/cutting, length of longest shoot/cutting, plant height, number of leaves/cutting maximum plant height and the effect of treatment T_{11}(Soil + Sand + Rice husk) was observed best for root growth parameter like number of roots/cutting, length of longest root (cm)/cutting. Minimum value was observed T_1 (Soil) for all parameters. For the successful growth and development of Bougainvillea cuttings, it can be concluded that media combination of T_9Soil+ Sand + FYM showed the best result among all the treatments, while the poorest was observed in T_1 Soil.

Keywords: Bougainvillea, FYM, media, sand, soil, vermicompost

Introduction
Bougainvillea, belonging to the family Nyctaginaceae, is admired worldwide for its exceptional ornamental significance in horticulture. Famous for its vividly coloured, paper-like bracts that look like petals, it brings charm and brightness to landscapes, balconies and gardens. Being hardy, drought - resistant and simple to cultivate, it thrives particularly well in warm climates. Its versatile growth habit allows it to be pruned and shaped into climbers, hedges, or container plants, making it a highly preferred choice among landscapers and gardening enthusiasts. (Zhang *et al.*, 2023) [35].

Bougainvillea is native to Peru, southern Argentina, and Brazil in South America, but it is now widely cultivated in warm regions around the world, including the Pacific Islands, Southeast Asia, the Mediterranean, Australia and the Caribbean, where it thrives as a popular landscape plant (Saleem *et al.*, 2021) [27]. First discovered in Brazil during the 18th century by French explorer Louis de Bougainville, after whom the plant is named Captivated by its vivid, colourful bracts and hardy nature, he introduced to Europe, where it was welcomed with enthusiasm. The plant then quickly adapted to the Mediterranean climate and began to thrive across European gardens and landscapes. Its drought tolerance and its long-lasting bracts make it very popular among horticulturists and gardeners.

In Chhattisgarh, Bougainvillea is becoming increasingly popular for its ability to thrive in extreme temperatures and polluted environments where other ornamental plants often fail. It blooms abundantly year-round and adds vibrant color to landscapes and gardens. Its strong tolerance to harsh conditions and air pollution makes it an ideal choice, especially in industrial

areas. Bougainvillea also helps absorb harmful pollutants, enhancing both beauty and environmental health. (Kulshreshtha *et al.*, 2009) [15]. Root development is a critical phase in the vegetative propagation of woody and horticultural plants, as any hindrance in rooting can lead to substantial economic losses for growers and nurseries (Mohammed and Hamid, 2014) [23].

In Bougainvillea, the success of rooting is influenced by several factors, including the variety or cultivar, the physiological condition of the mother plant, the timing of cutting plantation, and the environmental conditions of the propagation setting (Hartmann *et al.*, 2011) [10]. A significant variation in rooting, sprouting, and growth has been observed among different Bougainvillea cultivars, making propagation outcomes inconsistent and challenging. Optimizing these can greatly reduce production costs while maintaining plant quality (Memon *et al.*, 2013) [20] (Hamid *et al.*, 2015) [9].

There are various growing media and combination of media is used for rooting and growth of plants - Soil is the basic media for plant. It is easy to handle and cheaply available. (Gohil *et al* 2018) [8]. Sand is a naturally occurring granular material made of finely divided rock and mineral particles, mostly silica in the form of quartz. Its particle size ranges from 1/16 mm to 2 mm. While sand can be costly to transport, it is a valuable component in potting and propagation media. Cocopeat is a secondary product from the coconut processing industry (Arenas and Vavrina, 2002) [3]. Cocopeat is an ideal planting media for nurseries due to their good physical properties including high total pores, low shrinkage, low bulk density and slow degradation. The low bulk density of cocopeat makes it light, thus it is easier and more efficient to handle in transportation and distribution to the field. The good physical properties of cocopeat include high total pores, low shrinkage, low bulk density and slowly degraded (Treder, 2008) [33].

Farmyard manure (FYM) is an important organic source of nutrients widely used to improve soil health. Its quality varies with region and the type of livestock, as dung forms the main component. FYM not only enriches the soil with essential nutrients but also enhances its physical, chemical, and biological properties, making it especially valuable for sustaining productivity on small farm holdings (Kale *et al.*, 2023) [12].

Vermicompost plays a major role in improving growth and yield of different cereal, pulse, fruit vegetable and flower crops. Vermicompost shows a positive effect on vegetative growth, stimulating root and shoot growth (Edwards *et al.*, 2004) [5]. Vermicompost not only enhances soil health but also boosts the growth and yield of various crops, eliminating the need for chemical fertilizers (Alam *et al.*, 2007) [1].

Rice husk are a bio - product of the rice milling industry. Although they are extremely light in weight, rice husk are very effective at improving drainage (Kaushal and Kumari, 2020) [13].

Methods and Materials

Treatment details

The experiment was laid out in Completely Randomized Design (CRD) with three replications. Twelve treatments were allocated in each replication; the details of treatment were given below: -

Notation	Different media	Ratio
T_1	Soil	-
T_2	Sand	-
T_3	Cocopeat	-
T_4	Soil + Sand	1: 1
T_5	Soil + Cocopeat	1: 1
T_6	Sand + Cocopeat	1: 1
T_7	Soil + FYM	1: 1
T_8	Soil + Sand + Cocopeat	1: 1: 1
T_9	Soil + Sand + FYM	1: 1: 1
T_{10}	Sand + Cocopeat + FYM	1: 1: 1
T_{11}	Soil + Sand + Rice Husk	1: 1: 1
T_{12}	Sand + Cocopeat + Vermicompost	1: 1: 1

Detail of field operation

Preparation of cuttings

The study utilized 10 - 15 cm long hardwood stem cuttings taken from the middle portion of one year old Bougainvillea shoots. Each cutting was prepared with a slanting cut 1 cm above the upper node and a straight cut 1 cm below the lower node. A total of 540 cuttings (180 per replication) were used for the experiment to assess rooting performance under various treatments.

Preparation of growing media

Various growing media under study *viz*. Soil, Sand, Cocopeat, Soil + Sand (1:1), Soil + Cocopeat (1:1), Sand + Cocopeat (1:1), Soil + FYM (1:1), Soil + Sand + Cocopeat (1:1:1), Soil + Sand + FYM (1:1:1), Sand + Cocopeat + FYM (1:1:1), Soil + Sand + Rice Husk (1:1:1), Sand + Cocopeat + Vermicompost (1:1:1) were used for experimentation. Cells of portray were filled well with this growing mixture. The media were thoroughly mixed as per different treatment combination.

Treatment of cuttings

The Plant cutting was deep with Carbendazim 0.2% to avoiding the fungal diseases. The regular water system was given to the cutting plant with the help of hazara (rose can) at the between time 2 to 3 days, as required.

Cultural Operations

Polybag filling

In the experiment, polybags with pre-punched holes at the bottom were used to ensure proper drainage and aeration, which are essential for healthy root development. These polybags were uniformly filled with various treatment combinations consisting of different rooting media, each selected for its physical and chemical properties believed to influence rooting efficiency. The media were carefully prepared and filled to a consistent level to maintain uniform moisture conditions across treatments. This setup aimed to create a controlled environment that would allow for the comparative evaluation of the effects of different media compositions on the rooting and vegetative performance of Bougainvillea cuttings.

Planting and Irrigation

The hardwood cutting of the Bougainvillea was planted in polybags on 7 February 2025 after filling the polybags with

various growing media. After 15 planting plants were further watered and subsequently irrigated on alternating days during the entire crop period.

Weeding
During the entire crop growth period weeding has been carried out as and when required.

Plant Protection
To shield the crop against the attack of insect - pests and diseases, measures have been taken timely and consistently as and when necessary.

Details of Observations Recorded
The experimental plot was monitored daily to carefully observe the cuttings planted under different treatments. Regular inspection ensured timely recording of changes in rooting and growth behavior. The observations gathered from these evaluations are summarized below.

1. Vegetative Growth Parameter
Diameter of longest shoot (cm)/cutting
The diameter of the longest shoot from five randomly selected cuttings was measured at 90 days after planting using Vernier Calipers. Measurements were taken from the base of the shoot to assess stem thickness and vigor across different treatments.

Length of longest sprout (cm)/cutting
The length of the longest sprout from five randomly selected cuttings was measured at 45 days after planting using a scale. Measurements were taken from the base of the sprout to the shoot tip to evaluate shoot growth under different treatments.

Length of longest shoot (cm)/cutting
The length of the longest shoot from five randomly selected cuttings was measured at 60 and 90 days after planting using a scale. Measurements were taken from the base of the shoot to the shoot tip to evaluate shoot growth under different treatments.

Plant height (cm)/cutting
In this treatment, five cuttings were randomly selected and measured their height in cm at 60 and 90 days using a scale.

Number of leaves/cutting: From each treatment, five cuttings were randomly selected and the total number of leaves / cutting was counted and recorded at 30, 60 and 90 days after planting. This helped assess the vegetative growth and overall health of the cuttings over time.

2. Qualitative Growth Parameter
Number of days taken for sprouting
Under each treatment, the cuttings were observed daily to monitor sprouting. The number of days taken for the first sprouting was carefully recorded, providing valuable insights into the early response of cuttings to different media conditions.

Sprouting percentage
The sprouting percentage was recorded at an interval of 45 days after planting of cuttings and calculated using the following formulae.

$$\text{Percentage of sprouting} = \frac{\text{Total number of sprouting cutting}}{\text{Total number of planted cutting}}$$

Number of sprouting / cutting
From each treatment, five cuttings were randomly selected and the total number of sprouting/cutting was counted and recorded at 30 days after planting. This helped assess the vegetative growth and overall health of the cuttings over time.

3. Root Growth Parameter
Number of roots/cutting
Five randomly selected cuttings were carefully uprooted without damaging the roots and gently washed with water to remove any soil particles. It was recorded at 90 days after planting to evaluate root development under each treatment.

Length of longest root (cm)/cutting: The root length of five randomly selected cuttings was measured at 90 days after planting. Measurements were taken from the base of the cutting to the tip of the longest root to assess the extent of root development under different treatments.

Results and Discussion
Qualitative growth parameters
Days taken to first sprouting: Among the applied treatments, a significant effect of different rooting media on the number of days taken to first sprouting was observed. The minimum days to sprouting initiation (9.00) were observed in T_9 Soil + Sand + FYM and maximum day to sprouting (18.00) are observed in T_1 Soil. The Soil + Sand + FYM media combination promoted the fastest sprouting owing to its superior aeration and moisture retention capacity. FYM contain 0.5% nitrogen, which supports quick sprouting by enhancing the synthesis of proteins, enzyme and chlorophyll essential for early growth. In addition, FYM provides approximately nitrogen, which supplies energy to developing buds as a key component of ATP, thereby facilitating the formation of new cells. These results are consistent with the finding by Shitole *et al.* (2025) [28] in Bougainvillea, Kumaresan (2019) [18], Sodi *et al* (2024) [31] in Jasmine.

Number of sprouting/cutting: The highest number of sprouts/cutting (3.80) was noticed in T_9 (Soil + Sand + FYM) which was at par with (3.68) T_{12}. The lowest number of sprouts (1.30) was noticed in T_1 (Soil). The Soil + Sand + FYM mixture provided a balanced medium for optimum growth. Sprouting in the cuttings used for sprouting was often due to the accumulated carbohydrates. Mitra and Bose, (1954) [22]. Singh *et al.* (2020) [30].

Sprouting percentage: The sprouting percentage was seen to be greatly influenced by media-containing treatments. The maximal sprouting percentage (75%) was noted in T_9 (Soil + Sand + FYM) at 45 DAP and the minimal sprouting percentage (27%) was noted in Control T_1 (Soil).The Soil + Sand + FYM mixture are balanced physical and nutritional properties enable over sprouting percentage through improved aeration and water retention. FYM are containing nitrogen and they are help increasing sprouting. Nitrogen help produce chlorophyll, which is essential for photosynthesis. More photosynthesis means more energy for the sprouting process. These findings align with the results reported by Thakur *et al.* (2010) [32] in Jaismine. The enhanced sprouting in FYM based media may be attributed to its higher organic matter content, with improves nutrient availability particularly nitrogen and phosphorus. Phule *et al.* (2024) [26]. Shitole *et al.* (2025) [28] in Bougainvillea.

Vegetative growth parameters

Diameter of longest shoot (cm)/cutting at 90 DAP: At 90 day after sowing, a significant effect of media on diameter of longest shoot was observed. The treatment T_9 (Soil + Sand + FYM) recorded the maximum diameter of longest shoot (3.32 cm), which was statistically at par with T_{12} (Sand + Cocopeat + Vermicompost) at (3.14 cm). In contrast, the minimum diameter of longest shoot (1.61) was observed in treatment T_1 (Soil).This might be due to the fact that Soil + Sand + FYM media combination facilitated optimum shoot diameter due to its balanced water retention and nutrient availability compared to other media.FYM which contain about nitrogen, they are helping better water regulation, enhancing nutrient transport and enzyme activation there by contributing to strong and thicker shoots with higher shoot diameter as also reported by Singh *et al.* (2005). Moreover the increase in photosynthetic area and stem diameter can be attributed to the improved nutrient availability that support better plant growth. Kumar *et al.* (2006) [16], Shitole *et al.* (2025) [28]**.** Hence, Soil + Sand + FYM offer a more balanced medium for vigorous vegetative development in Bougainvillea. These finding are consistent with the result reported by Sing *et al.* (2020), Minj *et al.* (2023) [21] in Bougainvillea. In conjunction with the discovery of previous investigator Bala and Singh (2013) [4] in Chrysanthemum, Pradhan *et al* 2020.reported that Soil + Sand + FYM offers the best combination of findings for the diameter of longest shoot.

Length of longest sprout (cm)/cutting at 45 DAP: At 45 DAP, the different rooting media are significantly impacted the length of longest sprout (cm). The highest length of longest sprout (5.59 cm) was recorded in T_9 (Soil + Sand + FYM), which was statistically on at par with T_{12} (4.95). The lowest sprout length (1.59 cm) was observed in T_1 (Soil). The balanced nutrition and water retention of Soil + Sand + FYM mixture facilitated optimal sprout elongation over time compared to other media. These findings align with the results reported by Kumaresan (2019) [18] in Jasmine, who underscored the role of mixed media in promoting vigorous shoot and root growth. Moreover, similar benefits of organic amendment integration have been documented in other studies. Singh *et al.* (2020) [30] observed that a mixture of Soil, Sand, and FYM produced greater sprout length in Bougainvillea. Sodi (2024) [31] also reported that a mix of Soil + Sand + FYM let to better sprout growth. Shitole *et al.* (2025) [28].

Length of longest shoot (cm)/cutting at 60 and 90 DAP: Observations of the length of shoots/cutting were reported at 60 and 90 days after the cuttings were planted. The different media have different effects on shoot length/cutting at various planting days. Data are observed length of longest shoot/cutting at 60 DAP, the highest value (28.02 cm) was noted with T_9 (Soil + Sand + FYM) which was at par with T_{12} (26.85), followed by T_8 (26.02), T_{10} (26.68). The lowest value (19.65 cm) was noted in T_1 (Soil).At 90 DAP data are recorded maximum (39.69 cm) the improvement in shoot growth T_9 (Soil + Sand + FYM) which was at par with T_{12} (37.78), followed by T_8 (37.10 cm), T_{10} (36.19 cm). The lowest value (25.60cm) was noted in T_1 (Soil). May be due to better media properties like balanced nutrition and water retention, good aeration better root development facilitated and optimal shoot elongation. These findings align with the results reported by Kumaresan (2019) [18], Sodi *et al* (2024) [31]. Shitole *et al.* (2025) [28].

Plant height (cm)/cutting at 60 and 90 DAP: At 60 Days after planting the maximum plant height (37.10 cm) was observed in T_9 (Soil + Sand + FYM) which were at per T_{11} (39.00) and followed by T_{12} (39.00), T_8 (39.00) while the minimum plant height (29.46 cm) was recorded by media T_1 (Soil). At 90 Days after planting the maximum plant height (43.83 cm) was observed in T_9 (Soil + Sand + FYM), while the minimum plant height (32.67cm) was recorded in T_1 (Soil).During the initial stage, Soil + Sand + FYM media combination (1:1:1) are supplemented with inorganic nutrients provided by the slow-release fertilizers might have supported the luxuriant growth among all other media. The nutrient retention capacity and slightly acidic nature of media were might be the reasons. The result is in conformity with the finding of Shitole *et al.* (2025) [28] and Sodi *et al.* (2024) [31].

Number of leaves/cutting at 30, 60 and 90 DAP: At 30 DAP the different rooting media are significantly impacted the number of leaves. The maximum number of leaves (28.53) was recorded in T_9 (Soil + Sand +FYM). At 60 DAP the different rooting media are significantly impacted the number of leaves. The maximum number of leaves (37.67) was recorded in T_9 (Soil + Sand + FYM), which was statistically on par with T_{12} (33.87), followed by T_8 (32.96). The minimum number of leaves (21.40) was observed in T_1 (Soil). At 90 DAP the different rooting media are significantly impacted the number of leaves. The maximum number of leaves (49.56) was recorded in T_9 (Soil + Sand + FYM), which was statistically on par with T_{12} (47.62), followed by T_8 (43.95). The minimum number of leaves (30.52) was observed in T_1 (Soil). The maximum plant height was observed in the Soil + Sand + FYM media combination, which created a balanced physicochemical environment that supported optimal leaf production over time. The presence of FYM, containing about 0.5% nitrogen, further enhanced growth as nitrogen play a crucial role in cell enlargement and respiration. These positive effects of vegetative growth are in line with the findings reported by Nichal *et al.* (2010) [25]. The increment in the number of leaves/cutting from 30 DAP, 60 DAP and 90 DAP can be attributed to an increase in the number of branches/cutting, i.e. more branches/cutting, leading to a higher number of leaves/cutting. Ikram *et al.* (2012) [11] stated that Sand + FYM indicate an increased number of leaves in tuberose. Similar results were obtained by earlier researchers, Khayyat *et al.* (2007) [14] in Pothos, Anuje*et al.* (2004) [2] in Gerbera, Nazari *et al.* (2011) [24] in Hyacinthus orientalis and Eed *et al.* (2015) [6] in Bougainvillea. Shitole *et al.* (2025) [28] in Bougainvillea.

Length of longest root (cm)/cutting at 90 DAP: At 90 DAP the root length was significantly influenced by different rooting media treatments. The height root length (19.09 cm) was recorded in T_{11} (Soil + Sand + Rice husk) which followed byT_9 (16.05), T_{12} (16.04). The lowest root length observed (9.08 cm) in the T_1 (Soil). Among various media Soil + Sand + Rice husk showed maximum root length. It might be due to good aeration, drainage and high porosity in media combination which leads to proper gas exchange by maintaining sufficient oxygen supply to the roots. Simultaneously removal of respiratory CO_2 helped in root elongation. Similar results were obtained by Shitole *et al.* (2025) [28] in Bougainvillea. Marasini and Khanal (2018) [19] for Bougainvillea in Sand + FYM media, Mehmood *et al.* (2020) in FYM for cuttings, Minj *et al.* (2023) [21] for Bougainvillea in Soil + Sand + Cocopeat media.

Number of roots /cutting at 90 DAP: Data recorded at 90 DAP, treatment T_{11} (Soil + Sand + Rice husk) showed highest

number of roots/cutting (40.66) which was at par with T_8, T_{12}. The lowest number of roots (11.67) was recorded with control T_1 (Soil).The findings are corroborated by the findings of Fagge and Manga (2011) [7] who reported that with Topsoil + sawdust as a medium, the number of roots/cuttings was found to increase. Singh *et al.* (2020) [30] also recorded highest shoot length (44.75%) when hardwood cuttings of Bougainvillea were planted in Sand + cocopeat + perlite media, Minj *et al.* 2023 [21]. Shitole *et al.* (2025) [28].

Treatments	Days taken to first sprouting	Number of sprouting/cutting	Sprouting percentage	Diameter of longest shoot (cm)/cutting	Length of longest sprout (cm)	Length of longest shoot (cm)/cutting		Plant height/cutting		Number of leaves/cutting			Length of longest root (cm)/ cutting	Number of roots/ cutting
		45 DAP	50 DAP	90 DAP	45 DAP	60 DAP	90 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	90 DAP	90 DAP
T_1	18.00	1.30	27.00	1.61	1.56	19.65	25.60	29.46	32.67	12.60	17.45	28.64	9.08	11.67
T_2	17.00	2.00	45.00	1.67	2.15	19.84	29.40	30.84	35.82	15.20	22.65	33.72	9.05	15.33
T_3	15.00	2.22	45.35	1.67	2.19	20.12	31.12	31.12	36.64	17.33	24.87	36.95	9.00	15.67
T_4	15.60	2.65	48.00	1.70	2.36	21.55	31.47	32.55	36.83	18.20	25.67	35.87	9.06	22.74
T_5	11.42	2.70	46.91	1.75	3.10	22.69	32.65	33.69	38.58	17.54	29.76	39.86	10.05	25.64
T_6	10.75	2.21	53.00	1.80	3.12	20.47	31.47	31.47	37.47	17.50	26.20	38.61	10.09	27.36
T_7	11.23	2.60	49.00	1.95	2.88	25.78	36.78	36.78	42.78	18.65	25.69	36.47	11.00	35.00
T_8	10.10	3.10	61.34	3.10	4.54	26.02	37.10	37.10	43.83	25.74	32.96	43.95	12.05	37.67
T_9	9.00	3.80	75.00	3.32	5.59	28.69	39.69	39.69	47.60	27.89	34.65	48.67	16.05	35.00
T_{10}	10.36	2.90	59.00	2.90	3.47	26.68	36.19	36.19	43.43	23.54	27.87	37.95	13.07	35.44
T_{11}	11.00	2.59	58.00	2.95	3.41	28.00	36.22	39.00	42.78	23.10	28.64	38.47	19.09	40.66
T_{12}	9.95	3.68	65.00	3.14	4.95	26.85	37.78	37.03	44.00	26.47	33.87	47.62	16.04	36.70
SE(d)	0.46	0.10	1.78	0.09	0.12	0.92	1.13	0.91	1.90	0.52	0.75	0.97	0.43	1.06
CD at 5%	0.94	0.21	3.67	0.18	0.24	1.90	2.33	1.88	2.51	1.22	2.07	2.88	0.89	2.18
CV	4.50	4.76	4.10	4.54	4.38	4.68	4.09	4.33	3.99	3.58	4.45	4.39	4.40	4.52

Conclusion

In case of growth parameter *viz* Diameter of longest shoot (cm)/cutting, sprouting length (cm)/cutting, number of leaves/cutting, shoot length (cm)/cutting, plant height (cm)/cutting and case of qualitative parameter the sprouting percentage, sprouting number and minimum days of sprout initiation was significantly influenced and increased under the treatment T_9 Soil + Sand + FYM (1:1:1). Among various media composition, the media combined with Soil + Sand + Rice husk (1:1:1) T_{11} reported better and showed superior performance for most of the root parameters like number of root, length of longest root. It was also observed that, T_{12} Sand + Cocopeat + Vermicompost (1:1:1) also performed better as compared to other treatments making it second best treatment to increase root and growth parameters of Bougainvillea.

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