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# Optimizing growth and flowering in *petunia hybrida* through biochar enhanced potting media

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## ABSTRACT

*This study, investigates the effect of biochar based potting media on growth and flowering of Petunia hybrida conducted from November 2024 to February 2025 at ASPEE College of Horticulture, Navsari Agricultural University, Gujarat, India. Evaluated the impact of seven potting media on the growth and flowering of Petunia hybrida. Seven treatments included $T_1$ (Sand + Vermicompost + Biochar 1:1:0.1 v/v/v), $T_2$ (Sand + Vermicompost + Biochar 1:1:0.2 v/v/v), $T_3$ (Sand + Vermicompost + Biochar 1:1:0.3 v/v/v), $T_4$ (Cocopeat + Biochar 1:0.1 v/v), $T_5$ (Cocopeat + Biochar 1:0.2 v/v), $T_6$(Cocopeat + Biochar 1:0.3 v/v), $T_7$ (Cocopeat + Vermicompost 2:1 v/v). At 90 days, plants grown in Cocopeat + Biochar 1:0.3 v/v ($T_6$) achieved maximum plant height (25.31 cm), number of leaves/plant (765.68), fresh weight of shoot (120.20 g/g/plant) and dry weight of shoot (12.25 g/g/plant), fresh weight of leaf (70.16 g/g/plant), dry weight of leaf (11.69 g/g/plant). Root measurements in $T_6$ were also notable, with fresh weight (7.63 g/g/plant), dry weight (1.52 g/g/plant), longest root length (60.33 cm), root diameter (0.98 mm), and root count (30.53). While the maximum flower bud diameter (5.91 mm) and flower diameter (5.78 cm) were observed in $T_6$. Additionally, $T_6$yielded the total leaf area (46.37 $cm^2$), net assimilation rate (0.53 x $10^{-3}$ g $m^{-2}$ $day^{-1}$), and relative growth rate (1.935 x $10^{-2}$ g $g^{-1}$ $day^{-1}$). This treatment also showed the lowest root-shoot ratio (0.154), indicating its effectiveness for robust plant growth. This study demonstrates that biochar-based potting media, especially cocopeat + biochar (1:0.3 v/v), significantly enhance growth and flowering in Petunia hybrida.*

***Keywords:*** *Biochar, Cocopeat, Flowering, Plant growth, Petunia hybrida, Net assimilation rate, Relative growth rate.*

## Introduction

*Petunia hybrida* is an annual plant that belongs to the family Solanaceae. It is originated in South America. The name is derived from the French word 'petun', meaning 'tobacco'. It is one of the most popular flowering pot and landscape plants. The flowers are trumpet shaped, borne in leaf axils which are single, double, and semi-double [23]. Petunias are compact and herbaceous plants with a straggling and decumbent habit, pubescent and sticky, producing showy flowers with a wide range of colours. The leaves are simple and alternate [6]. Flowers are solitary, terminal, auxiliary, and pedicillate with 5-lobed calyx and a funnel-shaped corolla exhibiting zygomorphic symmetry [21]. They are commercially grown in various outdoor landscapes, including as bedding plants, borders, potted plants, window boxes, and hanging baskets, *etc.* [26].

Potting media are crucial for the optimal growth and development of potted plants. An ideal medium should support plant growth, retain water and nutrients, and allow gas exchange between roots and the atmosphere. Various materials like soil, sand, vermiculite, vermicompost, perlite, peat, sphagnum moss, cocopeat, biochar, sawdust, and woodchips are used alone or in combination for quality plant production [23]. Biochar improves soil structure, porosity, and water retention [5]. Vermicompost is nutrient-rich, enhances water retention, and boosts plant health [20]. Cocopeat resists shrinkage and microbial breakdown due to high lignin [12] while sand improves drainage and aeration [1].

Keeping these facts in view, the experiment entitled "Optimizing growth and flowering in *Petunia hybrida* through biochar enhanced potting media" was conducted to investigate various potting media to determine the optimal medium for various growth and flowering attributes contributing to better quality of *Petunia hybrida*.

## Materials and Methods

The present investigation was conducted from November 2024 to February 2025 at the Advanced Training Centre of Soilless Cultivation, ASPEE College of Horticulture, Navsari Agricultural

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University, Navsari, to evaluate the effect of different potting media on the growth and flowering of *Petunia hybrida*. The experiment was laid out in Completely Randomized Design (CRD) with seven treatments consisting of various potting media composition *viz.*, $T_1$ (Sand + Vermicompost + Biochar 1:1:0.1 v/v/v), $T_2$ (Sand + Vermicompost + Biochar 1:1:0.2 v/v/v), $T_3$ (Sand + Vermicompost + Biochar 1:1:0.3 v/v/v), $T_4$ (Cocopeat + Biochar 1:0.1 v/v), $T_5$(Cocopeat + Biochar 1:0.2 v/v), $T_6$(Cocopeat + Biochar 1:0.3 v/v), $T_7$(Cocopeat + Vermicompost 2:1 v/v). The experiment was replicated thrice, and the treatment combinations were filled in pots having a size of 2.5 L. The plants were grown under consistent conditions, with uniform light, water, and nutrient levels to ensure environmental factors remained standardized. All the morphological parameters were measured at the start of the experiment, at 30 days, 60 days, and at the end of the experiment, *i.e.*, 90 days. Whereas the physiological parameters were observed at 60 and 90 days.

The plant height from base to tip, longest root length were measured with meter scale, number of leaves and number of roots per plant were counted manually, total plant leaf area was measured using *Biovis* digital leaf area meter, fresh weight of shoot, root weight and leaf weight were measured using weighing balance, plants were dried using the hot air oven at 65° C ± 1 and then dry weight of shoot, root weight, leaf weight were measured using weighing balance, longest root diameter, flower bud diameter and flower diameter were measured using digital *vernier calliper,* Net Assimilation Rate (g $m^{-2}$ $day^{-1}$) was computed with the help of formula.

$$NAR = \frac{W - W1}{t2 - t1} \times \frac{logeA2 - logeA1}{A2 - A1}$$

Where, $W_1$ is dry weight of plant at time $t_1$, $W_2$ is dry weight of plant at time $t_2$, $A_1$ is total leaf area of plant at time $t_1$, $A_2$ is total leaf area of plant at time $t_2$, $t_1$= initial days, $t_2$ is final days.

Relative growth rate (RGR) was computed with the help of following formula

$$RGR = \frac{lnW2 - lnW_1}{t_2 - t_1}$$

Where, $W_1$ is dry weight of plant at time $t_1$, $W_2$ is dry weight of plant at time $t_2$, $t_1$= initial days, $t_2$ is final days.

Root to shoot ratio was calculated using formula

$$Root\ to\ shoot\ ratio = \frac{\text{Dry weight of root}}{\text{Dry weight of shoot}}$$

## Results and Discussion

### Shoot parameters

### Plant height

As presented in Table 1, plant height was significantly influenced by different growing media maximum plant height recorded in $T_6$ (Cocopeat + Biochar 1:0.3 v/v) (10.86 cm, 15.49 cm and 25.31 cm) at 30, 60 and 90 days after planting, respectively. Minimum plant height was recorded in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) (6.47 cm, 8.91 cm and 11.59 cm) at 30, 60 and 90 days. This might be due to biochar which alter the physical properties of the media, including increasing aeration and water holding capacity in soil which might have contributed in increase of shoot length [18]. Similar results were reported in *Abelmoschus esculentus* [14], *Dianthus chinensis* [3] and Chinese Rose [22].

### Number of leaves

As presented in Table 1 and Fig.1, plants grown with $T_6$ (Cocopeat + Biochar 1:0.3 v/v) potting media resulted in the maximum total number of leaves per plant (398.25, 649.05 and 765.68) at 30, 60 and 90 days after planting. While the minimum total number of leaves per plant (126.83, 215.39 and 262.52) was obtained in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 30, 60, and 90 days after planting, respectively.

### Total Leaf Area

As presented in Table1, the maximum total leaf area of the plant was recorded from plants grown in $T_6$ (Cocopeat + Biochar 1:0.3 v/v) (40.73 $cm^2$, 44.21 $cm^2$ and 46.37 $cm^2$) at 30,60 and 90 days after planting. Whereas, minimum total leaf area was observed in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) (19.09 $cm^2$, 22.37 $cm^2$, and 24.60 $cm^2$) at 30, 60, and 90 days, respectively.

Number of leaves per plant and total leaf area were found to be maximum in Cocopeat + Biochar 1:0.3 v/v, which may be attributed to the fact that biochar usually, when used as a medium with cocopeat, has good physiochemical properties, especially bulk density, which was recorded lowest as compared to other treatments. The results are in close conformity with the findings reported for *Calathea rotundifola cv*. Fasciata [25], *Rosa rugosa* [13] and *Calophyllum inophyllum* seedlings [16].

### Fresh and Dry Weights of Shoot, Root, and Leaf

### Fresh weight of the shoot

As presented in Table 2, the fresh weight of the shoot was significantly influenced by the different growing media. Among different growing media, $T_6$ (Cocopeat + Biochar 1:0.3 v/v) produced the maximum fresh weight of shoot (56.24 g/g/plant, 108.36 g/g/plant, and 120.20 g/g/plant) at 30, 60, and 90 days after planting, respectively. While the minimum dry weight of shoot was observed in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) (25.88 g/g/plant, 38.14 g/g/plant, and 49.29 g/g/plant) at 30, 60 and 90 days, respectively.

### Dry weight of the shoot

As presented in Table 2, the maximum dry weight of the shoot was recorded from the plants grown in $T_6$ (Cocopeat + Biochar 1:0.3 v/v) (6.75 g/g/plant, 10.50 g/g/plant, and 12.25 g/g/plant) at 30, 60, and 90 days after planting. While the minimum dry weight of shoot was observed in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) (3.15 g/g/plant, 3.75 g/g/plant and 5.01 g/ g/plant) at 30, 60, and 90 days, respectively.

### Fresh weight of root

As presented in the Table 2, the highest value of fresh weight of root (2.97 g/g/plant, 7.21 g/g/plant and 7.63 g/g/plant) was recorded in $T_6$ (Cocopeat + Biochar 1:0.3 v/v) at 30,60 and 90 days after planting. Whereas, lowest fresh weight of root was observed in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) (0.73 g/g/plant, 2.80 g/g/plant and 2.96 g/g/plant) at 30, 60 and 90 days, respectively.

### Dry weight of root

As presented in Table 2, petunia grown under $T_6$ (Cocopeat + Biochar 1:0.3 v/v) was resulted in significantly maximum root dry weight of root (0.59 g/g/plant, 1.44 g/g/plant, and 1.52 g/g/plant) at 30, 60, and 90 days after planting. While the minimum dry weight of root (0.15 g/g/plant, 0.56 g/g/plant and 0.59 g/g/plant) was found in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 30, 60 and 90 days after planting.

### Fresh weight of leaf

As presented in Table 2, the maximum fresh weight of leaf (37.49 g/g/plant, 57.09 g/g/plant and 70.16 g/g/plant) was

recorded in $T_6$ (Cocopeat + Biochar 1:0.3 v/v) at 30, 60 and 90 days, respectively. While, the minimum fresh weight of leaf (17.25 g/g/plant, 20.67 g/g/plant and 26.67 g/g/plant) was found in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 30, 60, and 90 days after planting.

**Dry weight of leaf**

As presented in Table 2, the highest dry weight of leaf (5.35 g/g/plant, 9.51 g/g/plant, and 11.69 g/g/plant) was recorded in $T_6$ (Cocopeat + Biochar 1:0.3 v/v) at 30, 60 and 90 days respectively. However, the minimum dry weight of leaf (2.47 g/g/plant, 3.45 g/g/plant and 4.44 g/g/plant) was noted in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 30, 60 and 90 days after planting.

This may be due to biochar's fine-grained, highly porous structure, which improves substrate conditions by enhancing nutrient release, increasing water retention and effectively reducing media degradation [25]. Incorporating biochar helps equilibrate water content and increase the availability of water for plants as well as improves the air porosity and structure of the substrate, which leads to a positive impact on the dry weight of shoots, leaves and roots [11]. Our observations concur with those reported for petunia and pelargonium [2], *Calophyllum inophyllum* [16], jackfruit[15], and *Polianthes tuberosa* [4].

**Root parameters**

**Root length**

As presented in Table 3, the longest root length (22.17 cm) was recorded in treatment $T_5$ (Cocopeat + Biochar at 1:0.2 v/v) at 30 days after planting, whereas at 60 and 90 days, the maximum root length (57.97 cm and 60.33 cm) was observed in treatment $T_6$ (Cocopeat + Biochar at 1:0.3 v/v). The shortest root length (13.19 cm, 20.27 cm, 23.67 cm) was noted in potting media $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 30, 60, and 90 days, respectively.

**Number of Roots per Plant**

As presented in Table 3 and Fig.2, the maximum number of roots per plant (25.61, 27.83, 30.53) was found with the growing media $T_6$ (Cocopeat + Biochar at 1:0.3 v/v) at 30, 60, and 90 days, respectively. However, the minimum number of roots per plant (11.17, 12.83, 15.83) was obtained with $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 30, 60, and 90 days after planting.

**Root diameter**

As presented in Table 3, among different growing media, maximum root diameter (0.90 mm, 0.95 mm, and 0.98 mm) was found in $T_6$ (Cocopeat + Biochar at 1:0.3 v/v) at 30, 60, and 90 days after planting. While the minimum root diameter (0.53 mm, 0.57 mm, and 0.60 mm) was reported in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 30, 60, and 90 days after planting.

Biochar added to the potting mixture had increased the root development it might be due to its ability to reduce soil compaction, increase aggregation of soil, and improve soil aeration and water retention, which assist fine root growth [15]. By applying the biochar, it improves the soil void ratio and optimizes the soil structure, thus promoting the healthy growth of plant roots [22]. Since biochar lowered soil bulk density, thereby increasing soil porosity and soil aeration, it may have positive effects on roots. Furthermore, it improved the root length and number of roots [8].

**Flowering parameters**

**Flower Bud Diameter**

As presented in Table 4, the flower bud diameter (5.91 mm) was found to be maximum in plants grown in $T_6$ (Cocopeat + Biochar at 1:0.3 v/v). The minimum flower bud diameter (4.77 mm) was noted in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at the full blooming stage.

**Flower diameter**

As presented in Table 4 and Fig. 3, during the full blooming stage, $T_6$ (Cocopeat + Biochar at 1:0.3 v/v) was noted to have the maximum flower diameter (5.78 cm). The minimum flower diameter (4.45 cm) was noted in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at the full blooming stage.

Potting media $T_6$ (Cocopeat + Biochar @ 1:0.3 v/v) excelled all other treatment with respect flower bud diameter (5.91 mm) and flower diameter (5.78 cm) these enhancements can be attributed to various factors such as improved soil pH, nutrient availability, water retention and microbial activity facilitated by biochar incorporation in chilli [7]. Higher rates of biochar resulted in an increase in curd diameter, which might be due to the enhanced nutrient retention, improved nutrient release, increased microbial activities, and better soil structure provided by higher rates of biochar [10]. Our findings align well with those reported for gerbera [24], marigold [9], and Chinese Rose [3,22].

**Physiological Parameters**

**Net Assimilation Rate**

As presented in Table 5, the net assimilation rate (NAR) was significantly influenced by different growing media. During 60 and 90 days after planting, among various potting media, $T_6$ (Cocopeat + Biochar at 1:0.3 v/v) resulted in the maximum net assimilation rate ($0.67 \times 10^{-3}$ g $m^{-2}$ $day^{-1}$ and $0.53 \times 10^{-3}$ g $m^{-2}$ $day^{-1}$). While a minimum net assimilation rate ($0.14 \times 10^{-3}$ g $m^{-2}$ $day^{-1}$ and $0.11 \times 10^{-3}$ g $m^{-2}$ $day^{-1}$) was observed in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 60 and 90 days after planting.

Results revealed that the maximum net assimilation rate was recorded in the treatment Cocopeat + Biochar 1:0.3 v/v ($T_6$). The probable reason might be that the addition of cocopeat in the media increases the porosity of the potting mixture, which helps to keep the soil loose and airy [23]. Incorporating biochar helps equilibrate water content and increase the availability of water for plants, while also improving the air porosity and structure of the substrate [11].

**Relative Growth Rate**

As presented in Table 5, during 60 and 90 days after planting, maximum relative growth rate ($2.923 \times 10^{-2}$ g $g^{-1}$ $day^{-1}$ and $1.935 \times 10^{-2}$ g $g^{-1}$ $day^{-1}$) was recorded in $T_6$ (Cocopeat + Biochar at 1:0.3 v/v). While a minimum relative growth rate ($1.112 \times 10^{-2}$ g $g^{-1}$ $day^{-1}$ and $0.643 \times 10^{-2}$ g $g^{-1}$ $day^{-1}$) was observed in the $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 60 and 90 days, respectively.

Significantly higher relative growth rate (RGR) has been noted in ($T_6$) media. The combination of cocopeat and biochar creates an optimized root environment, supporting both physical and biochemical factors needed for plant growth. The media composition has a positive impact on plant growth, especially by improving textural and structural properties that enhance nutrient availability [17]. This leads to increased plant growth, resulting in more plant stored material, thereby recording a higher relative growth rate (RGR).

## Root shoot ratio

As presented in Table 5 and Fig. 4, among different potting media, theminimum root shoot ratio (0.225, 0.201, and 0.154) was recorded in $T_6$(Cocopeat + Biochar at 1:0.3 v/v) at 30, 60, and 90 days after planting. The maximum root shoot ratio (0.578, 0.402, and 0.322) was noticed in $T_7$ (Cocopeat + Vermicompost 2:1 v/v) at 30, 60, and 90 days after planting.

Results revealed that the lowest root shoot ratio was obtained in cocopeat and biochar-based media. This might be due to the improved physical and chemical conditions of the growing media and thus, a favoured increase in the dry matter of the shoot. The highest root to-shoot ratio was obtained in the control. A probable reason may be that poor nutrient supply by the media may have reduced the growth of the shoot and resulted in a high root to-shoot ratio. A lower root-to-shoot weight ratio in plants treated with biochar may indicate that less energy is needed for root growth as the improved soil fertility and structure facilitate easier access to nutrients and water around the roots, allowing more resources to be directed to shoot growth and reproduction [19]. Our data support the findings for *Calophyllum inophyllum* seedlings [16].

***Table 1: Effect of different potting media on growth parameters of Petunia hybrida***

| Shoot Characteristics | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Plant height (cm) | | | Number of Leaves | | | Total leaf area ($cm^2$) | | |
| Treatments | 30 Days | 60 Days | 90 Days | 30 Days | 60 Days | 90 Days | 30 Days | 60 Days | 90 Days |
| $T_1$ | 7.66 | 10.65 | 14.23 | 247.93 | 344.75 | 367.61 | 31.94 | 34.96 | 37.30 |
| $T_2$ | 7.12 | 9.96 | 12.96 | 146.39 | 250.65 | 335.33 | 25.33 | 28.50 | 31.10 |
| $T_3$ | 6.66 | 9.44 | 12.30 | 133.52 | 226.83 | 283.01 | 20.99 | 24.49 | 27.04 |
| $T_4$ | 8.86 | 14.93 | 20.62 | 279.73 | 516.22 | 582.13 | 35.85 | 39.71 | 42.48 |
| $T_5$ | 10.38 | 15.47 | 24.36 | 363.08 | 596.88 | 697.18 | 38.46 | 42.39 | 44.79 |
| $T_6$ | 10.86 | 15.49 | 25.31 | 398.25 | 649.05 | 765.68 | 40.73 | 44.21 | 46.37 |
| $T_7$ | 6.47 | 8.91 | 11.59 | 126.83 | 215.39 | 262.52 | 19.09 | 22.37 | 24.60 |
| SEm (±) | 0.21 | 0.31 | 0.43 | 6.82 | 11.49 | 10.99 | 0.59 | 0.55 | 0.59 |
| CD at 5 % | 0.65 | 0.96 | 1.32 | 20.89 | 35.22 | 33.65 | 1.82 | 1.68 | 1.80 |
| CV (%) | 4.45 | 4.47 | 4.31 | 4.88 | 4.98 | 4.04 | 3.41 | 2.80 | 2.82 |

***Table 2: Influence of various potting media on fresh and dry biomass of Petunia hybrida***

| Fresh and Dry Weights of Shoot, Root and Leaf | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fresh weight of shoot (g/g/plant) | | | Dry weight of shoot (g/g/plant) | | | Fresh weight of root (g/g/plant) | | | Dry weight of root (g/g/plant) | | | Fresh weight of leaf (g/g/plant) | | | Dry weight of leaf (g/g/plant) | | |
| Treatments | 30 Days | 60 Days | 90 Days | 30 Days | 60 Days | 90 Days | 30 Days | 60 Days | 90 Days | 30 Days | 60 Days | 90 Days | 30 Days | 60 Days | 90 Days | 30 Days | 60 Days | 90 Days |
| $T_1$ | 30.60 | 65.21 | 87.48 | 3.83 | 6.50 | 7.63 | 0.84 | 3.52 | 4.54 | 0.17 | 0.70 | 0.91 | 20.40 | 35.78 | 41.22 | 2.91 | 5.81 | 6.79 |
| $T_2$ | 29.49 | 57.35 | 77.78 | 3.69 | 6.00 | 6.50 | 0.82 | 3.17 | 3.82 | 0.16 | 0.64 | 0.76 | 19.66 | 33.28 | 37.67 | 2.81 | 5.39 | 5.81 |
| $T_3$ | 28.73 | 46.37 | 67.58 | 3.59 | 4.75 | 5.86 | 0.80 | 2.86 | 3.18 | 0.15 | 0.57 | 0.63 | 19.15 | 28.52 | 31.53 | 2.74 | 4.23 | 5.25 |
| $T_4$ | 41.15 | 75.97 | 97.33 | 5.01 | 8.21 | 9.56 | 1.44 | 6.54 | 6.95 | 0.29 | 1.30 | 1.39 | 27.43 | 46.39 | 49.76 | 3.91 | 7.73 | 8.29 |
| $T_5$ | 49.28 | 85.78 | 102.53 | 6.46 | 9.21 | 10.25 | 2.62 | 6.92 | 7.25 | 0.52 | 1.38 | 1.45 | 32.85 | 49.57 | 56.14 | 4.84 | 8.26 | 9.35 |
| $T_6$ | 56.24 | 108.36 | 120.20 | 6.75 | 10.50 | 12.25 | 2.97 | 7.21 | 7.63 | 0.59 | 1.44 | 1.52 | 37.49 | 57.09 | 70.16 | 5.35 | 9.51 | 11.69 |
| $T_7$ | 25.88 | 38.14 | 49.29 | 3.15 | 3.75 | 5.01 | 0.73 | 2.80 | 2.96 | 0.15 | 0.56 | 0.59 | 17.25 | 20.67 | 26.67 | 2.47 | 3.45 | 4.44 |
| SEm (±) | 1.47 | 2.80 | 2.61 | 0.20 | 0.26 | 0.33 | 0.04 | 0.11 | 0.09 | 0.01 | 0.02 | 0.02 | 0.98 | 0.95 | 1.61 | 0.38 | 0.17 | 0.26 |
| CD at 5 % | 4.49 | 8.57 | 8.00 | 0.63 | 0.78 | 1.01 | 0.13 | 0.35 | 0.28 | 0.03 | 0.07 | 0.06 | 2.99 | 2.91 | 4.94 | 0.12 | 0.51 | 0.80 |
| CV (%) | 6.80 | 7.11 | 5.26 | 7.79 | 6.30 | 7.06 | 5.11 | 4.24 | 3.12 | 5.10 | 4.30 | 3.11 | 6.80 | 4.24 | 6.24 | 6.01 | 4.55 | 6.14 |

***Table 3: Effect of different potting media on root parameters of Petunia hybrida***

| | Root length (cm) | | | Number of roots per plant | | | Root diameter (mm) | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatments | 30 Days | 60 Days | 90 Days | 30 Days | 60 Days | 90 Days | 30 Days | 60 Days | 90 Days |
| $T_1$ | 13.49 | 28.00 | 30.63 | 15.46 | 17.33 | 21.91 | 0.74 | 0.77 | 0.83 |
| $T_2$ | 17.78 | 22.77 | 24.65 | 13.12 | 14.67 | 18.04 | 0.68 | 0.76 | 0.80 |
| $T_3$ | 15.76 | 21.08 | 23.68 | 12.30 | 14.59 | 17.00 | 0.65 | 0.70 | 0.74 |
| $T_4$ | 18.35 | 35.25 | 41.02 | 17.56 | 19.95 | 23.11 | 0.83 | 0.87 | 0.90 |
| $T_5$ | 22.17 | 41.85 | 52.05 | 20.53 | 22.83 | 25.99 | 0.86 | 0.89 | 0.92 |
| $T_6$ | 21.30 | 57.97 | 60.33 | 25.61 | 27.83 | 30.53 | 0.90 | 0.95 | 0.98 |
| $T_7$ | 13.19 | 20.27 | 23.67 | 11.17 | 12.83 | 15.83 | 0.53 | 0.57 | 0.60 |
| SEm (±) | 0.67 | 1.27 | 1.46 | 0.57 | 0.65 | 0.71 | 0.02 | 0.02 | 0.01 |
| CD at 5 % | 2.05 | 3.89 | 4.48 | 1.76 | 2.00 | 2.17 | 0.05 | 0.06 | 0.04 |
| CV (%) | 6.67 | 6.79 | 6.92 | 6.02 | 6.09 | 5.64 | 3.82 | 4.35 | 3.28 |

***Table 4: Influence of different potting on flowering parameters of Petunia hybrida***

| Treatments | Flower Bud Diameter (mm) | Flower Diameter (cm) |
|---|---|---|
| $T_1$ | 5.24 | 5.12 |
| $T_2$ | 5.06 | 4.89 |
| $T_3$ | 4.99 | 4.56 |
| $T_4$ | 5.37 | 5.29 |
| $T_5$ | 5.79 | 5.45 |
| $T_6$ | 5.91 | 5.78 |
| $T_7$ | 4.77 | 4.45 |
| SEm (±) | 0.13 | 0.15 |
| CD at 5 % | 0.39 | 0.46 |
| CV (%) | 4.12 | 5.08 |

***Table 5: Influence of different potting on physiological parameters of Petunia hybrida***

| | Net assimilation rate ($\times 10^{-3}$ g $m^{-2}$ $day^{-1}$) | | Relative growth rate ($\times 10^{-2}$ g $g^{-1}$ $day^{-1}$) | | Root shoot ratio | | |
|---|---|---|---|---|---|---|---|
| Treatments | 30 Days | 60 Days | 30 Days | 60 Days | 30 Days | 60 Days | 90 Days |
| $T_1$ | 0.34 | 0.22 | 1.654 | 1.132 | 0.378 | 0.298 | 0.212 |
| $T_2$ | 0.32 | 0.17 | 1.533 | 1.102 | 0.442 | 0.312 | 0.256 |
| $T_3$ | 0.22 | 0.15 | 1.293 | 0.828 | 0.451 | 0.352 | 0.295 |
| $T_4$ | 0.39 | 0.28 | 1.987 | 1.421 | 0.352 | 0.248 | 0.198 |
| $T_5$ | 0.56 | 0.42 | 2.561 | 1.162 | 0.252 | 0.212 | 0.165 |
| $T_6$ | 0.67 | 0.53 | 2.923 | 1.935 | 0.225 | 0.201 | 0.154 |
| $T_7$ | 0.14 | 0.11 | 1.112 | 0.643 | 0.578 | 0.402 | 0.322 |
| SEm (±) | 0.03 | 0.04 | 0.014 | 0.046 | 0.008 | 0.005 | 0.004 |
| CD at 5 % | 0.09 | 0.12 | 0.043 | 0.139 | 0.025 | 0.016 | 0.014 |
| CV (%) | 6.61 | 5.63 | 5.32 | 4.78 | 6.01 | 6.99 | 7.01 |

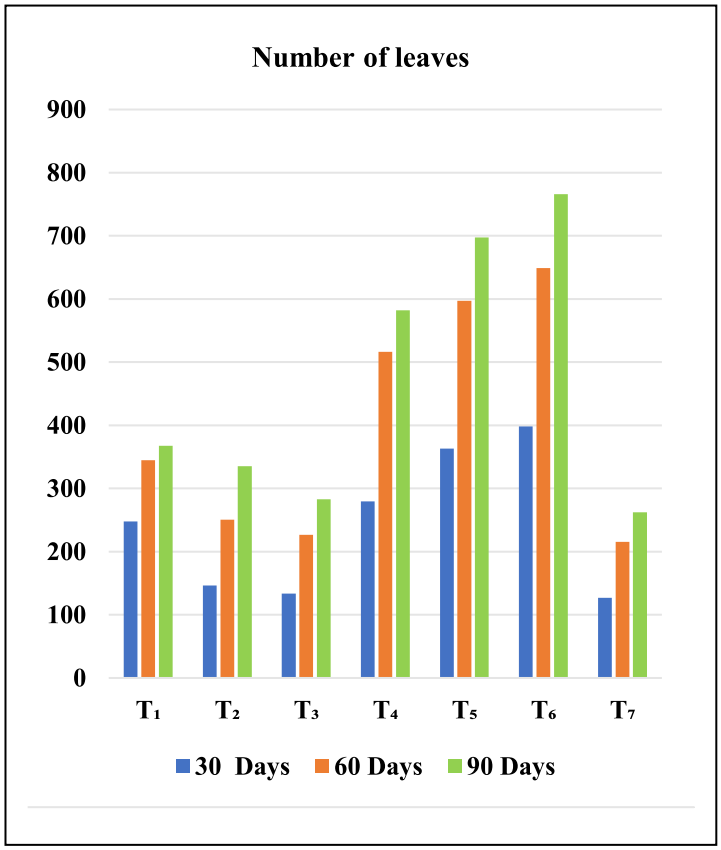


*Figure 1: Effect of different potting media on total number of leaves per plant of Petunia hybrida*

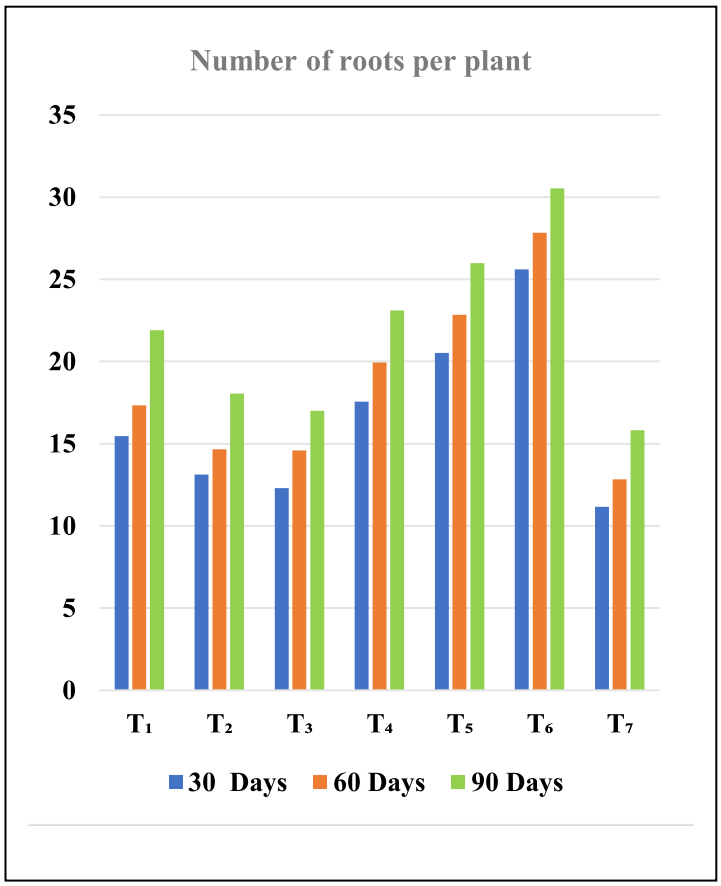


*Figure 2: Effect of different potting media on number of roots per plant of Petunia hybrida*

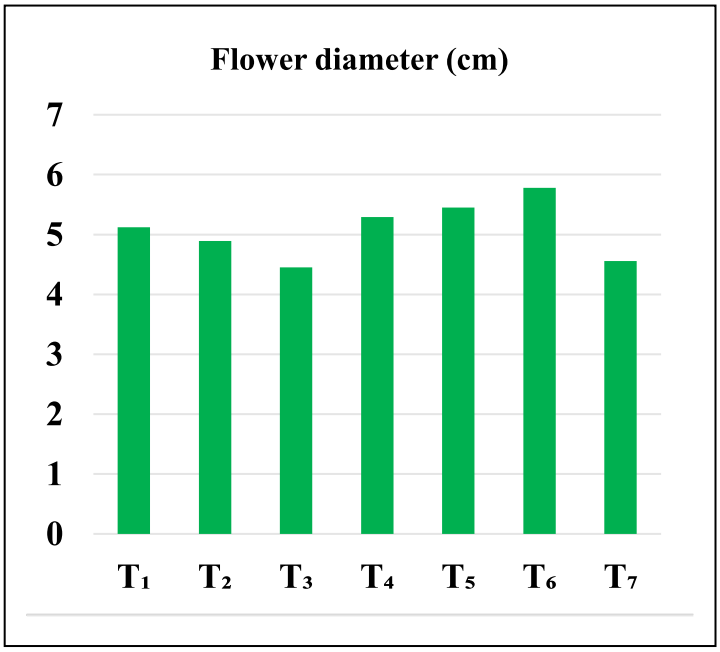


*Figure 3: Effect of different potting media on flower diameter (cm) of Petunia hybrida*

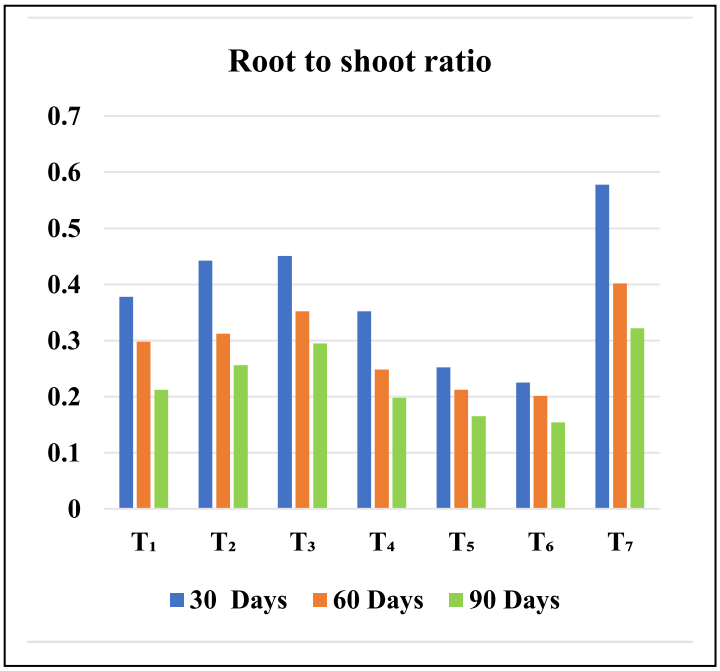


*Figure 4: Effect of different potting media on root shoot ratio of Petunia hybrida*

## Conclusion

From the results of the present experiment, it can be concluded that *Petunia hybrida* grown in Cocopeat + Biochar (1:0.3 v/v) potting media was found to be better for growth and flowering.

**Future scope of study:** Future research could focus on testing the effectiveness of the best performing biochar-based potting medium (Cocopeat + Biochar 1:0.3 v/v) under real field and greenhouse conditions, assessing its influence on flowering, yield, and overall plant performance. Investigating nutrient dynamics, water retention capacity, and microbial activity within different biochar-based mixtures may provide a deeper understanding of their role in promoting plant growth. Expanding this approach to other ornamental and horticultural crops could help determine its broader applicability. Additionally, evaluating the economic feasibility and environmental benefits of using biochar-based media on a commercial scale would support its practical adoption by growers.

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