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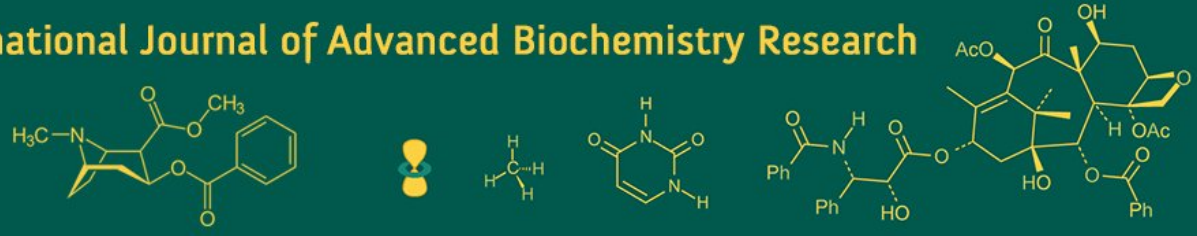

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Effect of different media mixtures for dianthus with and without biofertilizer under vertical gardening

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Abstract
A experiment was conducted at wall mounted vertical garden establish structure in Department of Floriculture and Landscape under College of Agriculture Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2024-25. The experimental design utilized a Completely Randomized Design with 9 treatments, included three replications. The present investigation revealed that the maximum plant height (22.08), number of branches (6.55), plant canopy area (83.95 cm^2), no. of flower (53.00), flower diameter (24.59 mm), flowering duration (98.00 days), root length (13.78 cm), root density (0.63 cm^3) and root weight (1.21 gm), shoot weight ((8.83 gm) was recorded in T_4 (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio). The minimum number of days required for days 50% bud initiation (83.00 days), days 50% Flower initiation (89.00 days) and flower longevity (22.00 days) respectively was observed in T_8 (Garden soil + Vermicompost + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 2:2:1 ratio). Thus, it can be concluded that the medium containing a mixture of KSB, PSB, and ZSB is most promising for vegetative growth, flowering, and rooting parameters. Therefore, this medium containing the mixture may be suitable for landscape vertical gardening.

Keywords: Dianthus, media mixture, biofertilizer, vertical gardening, landscape

Introduction
Dianthus, a flower of divine charm, derives its name from the Greek words "dios" (divine) and "anthos" (flower), symbolizing its celestial beauty. The genus *Dianthus* L., belonging to the family Caryophyllaceae, comprises about 300 species distributed mainly in Europe and Asia, with some extending into Africa (Brickell, 2001) [4]. Dianthus have a fringed petals, clove-like fragrance, and a stunning array of colors, Dianthus flowers have captivated gardeners for centuries. Their ability to adapt to different environments, coupled with their low maintenance nature, makes them an ideal choice for Indian gardens. These flowers are especially popular during the cooler months, adding vibrancy and fragrance to the landscape.
Vertical Gardening is a special type of urban gardening suitable for small spaces, particularly for decorating walls and roofs in various styles. A vertical garden also helps keep a building cool in summer and warm in winter, thereby reducing electricity consumption. Vertical gardens make the most of limited space and can transform neglected areas into attractive and visually stimulating green spaces. Vertical gardens also improve both indoor and outdoor air quality by removing harmful volatile organic compounds (VOCs) and absorbing pollutants. Growing plants vertically, even in compact spaces such as windowsills, balconies, or entrances, makes a noticeable difference to the air you breathe (Kedar and Panchbhai, 2022) [9].

Materials and Methods
The present investigation was carried out in in wall mounted vertical garden establish structure in Department of Floriculture and Landscape under College of Agriculture Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2024-25. On the basis of prevailing climatic conditions, Raipur is characterized as dry sub-humid, with an average annual rainfall of 1200 mm, mostly occurring during the monsoon months (June to September). However, the rainfall pattern during this period varies significantly each year. Temperature extremes range from as high as 46 °C during summer to as low as 9 °C during winter. This vertical garden system, made of 4 x 6 ft. polypropylene vertical plastic stand

panel frames, is designed for growing dianthus plants, and a total of 36 frames can hold 108 pots. The experimental design utilized a Completely Randomized Design with 9 treatments, and three replications. For vertical gardening, a mixture of cocopeat, garden soil, farmyard manure (FYM), perlite, organic fertilizers (KSB, PSB, ZSB) and vermicompost in different proportions was used as growing medium. Healthy and diseases free dianthus the roots of all healthy plants were dipped in Bavistin solution for one hour and then transplanted into pots in the evening and Light irrigation was given to the immediately after transplanting. Plant growth characteristics such as plant height, number of branches, canopy area, and floral characteristics such as number of flowers, flower diameter, flower age, days to 50% bud formation, days to 50% flower formation, flowering period, terminal root characteristics, root length, root density, and shoot weight, root weight were observed. And statistical analysis was performed according to the procedures.

Result and Discussion

Observations on different growth, flower, and root parameters were systematically recorded and presented.

Growth parameters

The data presented in Table 1.0 clearly shows that the plant height showed significant increase among flowering plants. The effect of treatments on plant height of Dianthus under vertical gardening was found to be significant at the 20, 40, 60, and 80 DAT growth stages. The tallest plant height (22.08 cm) was recorded in the treatment combination T_4 (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio), whereas the lowest plant height (17.91 cm) was observed in the T_9 treatment (Garden soil).

This superior growth in T_4 can be attributed to the combined effect of FYM, perlite, and garden soil, along with biofertilizers that improved nutrient availability, soil aeration, and root development. Considerable variation in plant height was observed among the treatments, with optimum heights ranging from 25 cm to 35 cm. These results are in agreement with the findings of Ashok (2019) [2], who also reported enhanced plant growth with enriched media compositions.

At 40, 60, and 80 DAT, the number of branches showed significant variation among the treatments. The highest branching (6.55) was recorded in plants under the T_4 treatment combination (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio), whereas the lowest branching (4.16) was observed in plants under the T_9 treatment (Garden soil). The data are presented in Table 1.0.

The enhanced growth response in T_4 can be ascribed to the synergistic effect of a nutrient-enriched growing medium and the use of biofertilizers. These factors collectively improved nutrient uptake, soil aeration, and overall plant vigor, resulting in better plant performance compared to other treatments. Similar observations on branching variations among Dianthus genotypes under different growth conditions were also reported by Sharma *et al.* (2020) [16].

The present study revealed that the plant canopy area (cm²) at 20, 40, 60, and 80 DAT showed significant variation among the treatments. The T_4 treatment combination (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio) recorded the highest canopy area (83.95 cm²), whereas the plants under the T_9 treatment (Garden soil) exhibited the lowest canopy area (59.46 cm²). The data are presented in Table 1.0.

In the present experimented, the highest canopy area was recorded in plants under the T_4 treatment, indicating superior vegetative growth compared to the other treatments. Similar emphasis on canopy characteristics was reported by Huaccha (2023) [8], who highlighted the ecological importance of leaf area as a major component of plant canopy in their study on non-destructive leaf area estimation in Dianthus.

Table 1: Performance of vertical gardening different media mixtures for growth parameters under Chhattisgarh condition.

Treatment	Plant height (cm)	Number of branches	Plant canopy area (cm²)
T_1	18.63	4.58	68.02
T_2	19.58	5.41	70.66
T_3	19.61	4.25	68.92
T_4	22.08	6.55	83.95
T_5	18.66	4.00	69.96
T_6	18.71	4.83	72.42
T_7	19.04	4.75	67.83
T_8	19.57	5.08	71.17
T_9	17.91	4.16	59.46
CD at 5%	2.04	0.90	10.69
SE(m) ±	0.68	0.30	3.57

Flowering parameters

The data pertaining to flowering parameters like the time required for Dianthus plants to reach 50% bud initiation showed non-significant variation among treatments. Among all treatments, plants under treatment T_9 (Garden soil) produced the maximum Days 50% bud initiation (106.33), and minimum Days 50% bud initiation (85.33) treatment combination T_4 (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) 1:2:1) represented in Table 2.

The timing to reach 50% bud initiation in Dianthus in our vertical garden agreed with previously published findings under protected/controlled environments: earlier studies reported significant varietal and management effects on bud initiation (Sree Devi *et al.* 2017) [6].

Among all the treatments, plants under the T_4 treatment combination (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio) produced the highest number of flowers (53.00), whereas plants under the T_9 treatment (Garden soil) produced the lowest number of flowers (19.00), as presented in Table 2.

The highest number of flowers per plant, showing its superiority over the other treatments. The improved flowering in this treatment may be attributed to the combined effect of FYM, perlite, and biofertilizers, which enhanced nutrient availability, soil aeration, and microbial activity, ultimately supporting vigorous plant growth and higher flower production. Similar findings were reported by Dixit and Fatmi (2023) [17], who observed that organic amendments enriched with beneficial microbes significantly improved floral traits by boosting nutrient uptake and physiological efficiency followed by Bhardwaj *et al.* (2013) [3].

The data on flower diameter are presented in the maximum flower diameter (24.59 mm) was observed in treatment combination T_4 (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) 1:2:1), and the minimum flower diameter

(18.77 mm) was recorded in treatment combination T_9 (Garden soil), as presented in Table 2.

The superior flower size observed in T4 may be attributed to the improved nutrient supply, better root aeration, and enhanced microbial activity resulting from the combined application of FYM, perlite, and biofertilizers. These combined effects likely supported stronger vegetative growth and better assimilate translocation towards floral development, resulting in larger flower size. Similar variations in flower diameter have been documented in previous studies for along with Bunt (1978) [5].

The data on days to 50% flower initiation showed significant variation among the treatments. The maximum days to 50% flower initiation (117.33) were observed in the T_9 treatment (Garden soil), whereas the minimum days to 50% flower initiation (89.00) were recorded in the superior T_8 treatment combination (Garden soil + Vermicompost + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 2:2:1 ratio), as presented in Table 2.

The minimum days 50% Flower initiation, indicating the superior performance of this growing medium. The time required to reach 50% flowering in our study is consistent with previous reports in Dianthus. Maguluri Sree Devi *et al.* (2017) [6] similarly observed that nutrient-rich organic treatments such as vermicompost, biofertilizers, and FYM significantly accelerated flowering, where the earliest 50% flowering occurred in treatments receiving a combination of Azospirillum, PSB, FYM, and vermicompost along with 75% RDF.

The data on floral longevity showed clear variation among the treatments. The maximum floral longevity (22.00 days) was recorded in the T_8 treatment combination (Garden soil + Vermicompost + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 2:2:1 ratio), whereas the minimum floral longevity (14.66 days) was observed in the T_9 treatment (Garden soil), as presented in Table 2.

Primack (1985) reported that improved nutrient availability and better physiological balance in plants can enhance flower longevity by slowing senescence and maintaining turgor for a longer period. According to Ashman (2004) [1], the continuous and balanced supply of nutrients promotes stronger plant growth, thereby contributing to longer-lasting flowers and delayed floral senescence.

The maximum flowering duration (98.00 days) was recorded in the T_4 treatment combination (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio), whereas the minimum flowering duration (60.00 days) was observed in the T_9 treatment (Garden soil). The results are presented in Table 2.

This enhanced flowering duration may be attributed to the combined effect of FYM, which improves soil fertility and provides a steady nutrient supply for healthy growth and flowering; perlite, which increases soil aeration and drainage, thereby preventing waterlogging and promoting vigorous root development and nutrient uptake; and biofertilizers, which further enrich the medium by enhancing nutrient availability. These observations are supported by earlier research. Parmar (2023) reported significantly longer flowering duration in Dianthus.

Table 2: Performance of different vertical gardening different media mixtures for flowering parameters under Chhattisgarh condition.

Treatment	Days 50% bud initiation	Number of flowers	flower diameter	Days 50% flower initiation	Floral longevity	Flowering duration
T_1	99.00	30.33	21.13	110.66	17.56	67.00
T_2	96.67	34.00	22.28	103.33	18.66	72.33
T_3	97.00	39.33	21.56	111.36	19.00	74.33
T_4	85.33	53.00	24.59	92.66	19.33	98.00
T_5	92.00	32.33	21.19	108.30	19.00	69.00
T_6	87.00	35.33	21.38	97.00	19.43	72.33
T_7	98.00	33.66	21.62	108.00	18.66	71.33
T_8	83.00	37.00	20.60	89.00	22.00	78.66
T_9	106.33	19.00	18.77	117.33	14.66	60.00
CD at 5%	N/S	12.62	1.34	14.32	2.37	17.25
SE(m) ±	6.32	4.21	0.45	4.78	0.79	5.76

Root parameters

Significant variation was observed, and considerable differences were noted among the treatments. The maximum root length (13.78 cm) was recorded in the T_4 treatment combination (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio), whereas the minimum root length (6.63 cm) was observed in the T_9 treatment (Garden soil). The results are presented in Table 3.

In the present studied, the maximum root length was recorded under the T_4 treatment. This improvement may be attributed to the balanced combination of FYM, vermicompost, perlite, and biofertilizers. Nutrients supplied by FYM and vermicompost were solubilized by PSB and KSB, making them readily available to plants, while perlite enhanced water retention and aeration, collectively promoting increased root length and overall plant growth. This finding also noted by Zheng (2020) [18].

The maximum root density (0.63 cm^3) was recorded in the T_4 treatment combination (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio), whereas the minimum root density (0.07 cm^3) was observed in the T_9 treatment (Garden soil). The results are presented in Table 3.

This improvement may be due to the combined effect of FYM, perlite, and biofertilizers, thereby promoting better root growth and development. Similar findings have been reported previous. Ramesh Kumar *et al.* (2014) observed that the application of biofertilizers, FYM, and perlite resulted in the longest root length and higher root biomass in Dianthus. In supported of this, Renuka (2017) [14] reported that combinations of media significantly increased root length and root formation in Dianthus under vertical gardening conditions.

The maximum root weight (1.21 g) was observed in the T_4 treatment combination (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio), whereas the minimum root weight (0.17 g) was recorded in the T_9 treatment (Garden soil).

In the present experimented, plants under the T_4 treatment recorded the maximum root weight, indicating superior

compared to other treatments. The enhanced root development may be attributed to the synergistic action of FYM, perlite, and biofertilizers, where FYM enriches the media with nutrients, perlite increases porosity and root aeration, and biofertilizers stimulate nutrient solubilization and root activity. Comparable findings were previously documented by Rajendra (2021) [13].

The maximum shoot weight (8.83 g) was observed and found superior in the T_4 treatment combination (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio), whereas the minimum shoot weight (3.50 g) was recorded in the T_9 treatment (Garden soil).

Based on the observations of this studied, plants under The T_4 treatment recorded the highest shoot weight, indicating superior performance compared to the other treatments. These applied combinations improved shoot weight and vegetative growth in Dianthus, as biofertilizers enhanced nutrient uptake, vermicompost supplied readily available nutrients, perlite improved aeration and root activity, and FYM enriched the media with organic matter. Similar findings were reported by Priyadarshini (2018) [12], who observed maximum shoot weight with organic amendments and biofertilizers.

Table 3: Performance of vertical gardening different media mixtures for root parameters under Chhattisgarh condition.

Treatment	Root length	root density	Root wt. (gm)	Shoot wt. (gm)
T_1	10.96	0.34	0.49	5.58
T_2	11.01	0.36	0.60	5.92
T_3	12.10	0.34	0.75	6.67
T_4	13.78	0.63	1.21	8.83
T_5	9.60	0.36	0.67	6.17
T_6	11.32	0.38	0.60	6.42
T_7	10.96	0.32	0.64	6.50
T_8	11.49	0.35	0.73	6.92
T_9	6.63	0.07	0.17	3.50
CD at 5%	0.93	0.19	0.23	1.30
SE(m) ±	0.31	0.06	0.08	0.43

Conclusion

Based on the overall performance and association studies of various characters, the findings strongly recommend T_4 Treatment combination (Garden soil + FYM + Perlite + Biofertilizer (KSB, PSB, ZSB) in a 1:2:1 ratio), as a promising media mixture for Dianthus cultivation, particularly for improving growth, flowering, and root parameters under vertical gardening.

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