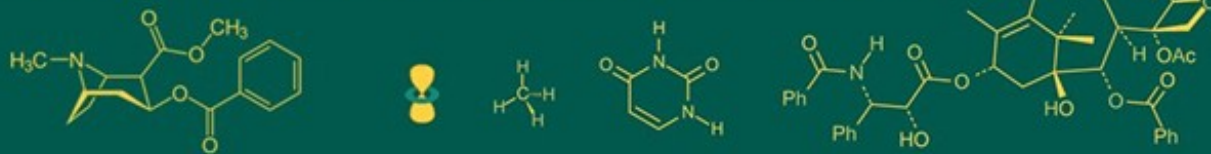


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Effect of different potting media on vegetative growth and flower yield of *Calendula* (*Calendula officinalis* L.)

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ABSTRACT

The present investigation entitled “Effect of different potting media on vegetative growth and flower yield of *Calendula* (*Calendula officinalis* L.)” was conducted during the Rabi season in 2025–26 at the Horticultural Research Instructional Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh. The experiment was laid out in a Completely Randomized Design (CRD) with eight treatments and replicated thrice i.e. T_0 (Garden soil), T_1 and T_2 (Garden soil + Sand + Vermicompost in 2:1:1 and 3:1:1), T_3 and T_4 (Garden soil + Sand + Enriched Vermicompost in 2:1:1 and 3:1:1), T_5 and T_6 (Cocopeat + Sand + Enriched Vermicompost in 2:1:1 and 2:1:2) and T_7 (Garden soil + Sand + Enriched Vermicompost + Cocopeat, 1:1:1:1). The result showed that among the vegetative growth parameters, the treatment T_6 (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) recorded maximum plant height (27.40, 36.74, 44.02 cm), number of branches (23.66, 31.73, 37.13), number of leaves (50.40, 102.93, 159.06), stem diameter (7.56, 8.31, 9.41 mm) at 30, 60 and 90 days after planting, respectively. In flowering parameters, earliest opening of first flower bud (41.00 days), days to 50% flowering (51.80 days), while the maximum number of flowers per plant (67.00), flower diameter (5.977 cm), longest flowering duration (64.13 days) and highest flower yield per plant (414.20 g) were recorded under T_6 (Cocopeat + Sand + Enriched Vermicompost, 2:1:2), followed by treatment T_5 . Whereas T_0 (Garden soil) recorded the minimum for the vegetative growth, flowering and yield parameters. The findings revealed that treatment T_6 (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) significantly superior vegetative growth, flowering and yield as compared to treatment T_0 (Garden soil), might due to favourable physical and biological properties that enhanced aeration, moisture retention and nutrient availability. Hence can be recommended as a suitable potting media for pot culture of calendula.

Keywords: *Calendula officinalis*, Potting media, Vegetative growth, Flowering, Flower yield, Pot culture

Introduction

The growing demand for ornamental plants and increasing urbanization have encouraged the use of potted flowering plants for decorating homes, balconies, terraces, offices, hotels and other urban spaces. Pot culture offers an efficient and flexible method of growing flowering plants where availability of land is limited and expanding opportunities for beautification of ornamental landscaping. Their attractive appearance, portability and suitability for make them an important choice for enhancing the aesthetic value of indoor and outdoor environments. Moreover, the production of flowering plants in pots offers opportunities for value addition, ready-to-display plant sales and small-scale as well as commercial ornamental plant enterprises. Among potted flowering crops, calendula (*Calendula officinalis* L.) is an annual herb belonging to the family asteraceae and is native to the Mediterranean region. It grows well under cool climatic conditions with moderate sunlight and well-drained soil (Mohammad and Kashani, 2012 (Anonymous, 2012; Mohammad *et al.*, 2012)) [1, 2]. It is an important ornamental and medicinal plant valued for its attractive yellow to orange flowers and diverse applications in floriculture, pharmaceuticals, cosmetics, culinary products and also used for ornamentation, garland making, landscaping, natural colouring and culinary garnishing, while its extracts possess anti-inflammatory, antimicrobial, antiseptic and wound-healing properties (Golestani *et al.*, 2013 (Anuje *et al.*, 2004) [3]; Arora *et al.*, 2013 [4]; Lohani *et al.*, 2019 (Arunesh *et al.*, 2020) [5]; Szopa *et al.*, 2020 (Atiyeh *et al.*, 2000) [6]) [7, 4, 8, 9]. The major problems associated with the use of conventional soil-based potting media in pots often results in poor water retention, low microbial activity and inadequate aeration, cause poor germination, weak seedlings, delayed/inferior flowering and limit the commercial potential of calendula pot cultivation. These constraints can be effectively overcome through the standardization of suitable potting media combinations. According to Vendrame *et al.* (2005) [10, 11], the growing substrate plays a vital role in determining the quality of pot-grown plants. Various growing materials such as garden soil, sand, vermicompost, enriched vermicompost and cocopeat can be combined in different proportions to

improve the physical, chemical and biological properties by ensuring adequate drainage, aeration, water retention, nutrient availability thereby the potting media enhance the plant growth, flower and yield (Khan *et al.*, 2006)^[12, 13]; Anonymous, 2012 (Deogade *et al.*, 2020)^[14]; Singh *et al.*, 2015 (Golestani *et al.*, 2013)^[7]). Garden soil provides physical support and essential mineral nutrients, while sand improves drainage, aeration and structural stability. Vermicompost enhances porosity, water-holding capacity, nutrient availability and microbial activity (Atiyeh *et al.*, 2000 (Gupta *et al.*, 2024)^[15] [6]. Cocopeat improves water retention, porosity and aeration and contributes to nutrient retention through its cation exchange capacity. Enriched vermicompost enhances beneficial microbial activity and nutrient availability, thereby supporting a favourable root zone and promoting plant growth and flower yield.

Materials and methods

The experiment was conducted at the Horticultural Research Instructional Farm, College of Agriculture, IGKV, Raipur (C.G.), during the Rabi season of 2025–26. The experiment was laid out in a Completely Randomized Design (CRD) with eight treatments and three replications. The treatments comprised T₀ Garden soil (control), T₁ Garden soil + Sand + Vermicompost (2:1:1), T₂ Garden soil + Sand + Vermicompost (3:1:1), T₃ Garden soil + Sand + Enriched Vermicompost (2:1:1), T₄ Garden soil + Sand + Enriched Vermicompost (3:1:1), T₅ Cocopeat + Sand + Enriched Vermicompost (2:1:1), T₆ Cocopeat + Sand + Enriched Vermicompost (2:1:2) and T₇ Garden soil + Sand + Enriched Vermicompost + Cocopeat (1:1:1:1). All potting media were prepared by thoroughly mixing the respective components in the prescribed proportions on a volume basis (v/v). Uniform and healthy (*Calendula officinalis* L.) seedlings are planted into pots filled with the respective potting media on 31st December 2025. Throughout the crop period, all the necessary cultural practices were followed. For recording vegetative growth and flowering observations, Five plants per treatment were randomly selected and tagged at 30, 60 and 90 days after planting (DAP). Observations were taken *viz.*, Plant height (cm), number of leaves per plant, number of branches per plant, stem diameter (mm), days to opening of first flower bud, days to 50% flowering, number of flowers per plant, diameter of fully opened flower (cm), flowering duration, and yield of flower per plant (g). The recorded observations were subjected to analysis of variance (ANOVA) appropriate for a Completely Randomized Design (CRD). Treatment means were compared using the critical difference (CD) at the 5% level of significance and standard error of mean (SEM).

Results and discussion

Vegetative parameters

Plant height (cm) - Plant height was significantly influenced by different potting media at 30, 60 and 90 DAP and were presented in Table 1. Among the treatment T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) recorded the maximum plant height at 30

(27.40 cm), 60 (36.74 cm) and 90 DAP (44.02 cm) followed by T₅ (25.67, 34.84 and 39.88 cm, respectively). The minimum height was recorded in T₀ (Garden soil). The superior performance of T₆ may be attributed due to the better moisture, aeration and nutrient conditions of the potting medium, which favoured healthy root growth and resulted in better plant establishment and height. Similar findings have also been reported by Deogade *et al.* (2020)^[14, 16] in calendula, Gupta *et al.* (2024)^[15, 17] in marigold, Yadav *et al.* (2024)^[18, 19] in china aster and Rathod *et al.* (2025)^[13, 20] in calendula.

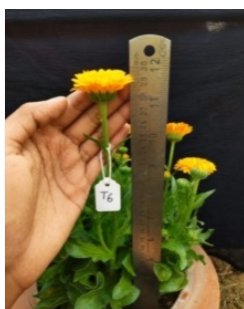
Number of leaves per plant - Number of leaves per plant was significantly influenced by different potting media at 30, 60 and 90 DAP (Table 1). Among the treatments, T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) recorded the maximum number of leaves at 30 (50.40), 60 (102.93) and 90 DAP (159.06) followed by T₅. The minimum number of leaves was recorded in T₀ (Garden soil). The superior performance of T₆ might be due to its better vegetative growth, where improved root development and nutrient availability supported active leaf initiation and expansion, resulting in a higher number of leaves throughout the growth period. These findings are in close agreement with those of Kiran *et al.* (2007)^[21, 22] in dahlia, Makhubela *et al.* (2019)^[22, 23] in white aster, Chaudhary (2021)^[12, 24] in dahlia and Rathod *et al.* (2025)^[13, 20] in calendula.

Number of branches per plant - Number of branches per plant was significantly influenced by different potting media at 30, 60 and 90 DAP were presented in Table 2. Among the treatments, T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) recorded the maximum number of branches at 30 (23.66), 60 (31.73) and 90 DAP (37.13) followed by T₅ (20.06, 28.66 and 34.23, respectively). The minimum number of branches was recorded in T₀ (Garden soil). The higher number of branches in T₆ might be due to the suitable balance of moisture, air space and nutrients in the growing medium, which favoured the initiation and growth of lateral shoots. Similar results were reported by Kiran *et al.* (2007)^[21, 22] in dahlia, Kareem *et al.* (2014)^[18, 8] in calendula, Chaudhary *et al.* (2021)^[12, 24] in dahlia, Kumar *et al.* (2022)^[24, 25] in calendula and Yadav *et al.* (2024)^[18, 19] in china aster.

Stem diameter - Stem diameter was significantly influenced by different potting media at 30, 60 and 90 DAP as shown in Table 2. Among the treatments, T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) recorded the maximum stem diameter at 30 (7.56 mm), 60 (8.31 mm) and 90 DAP (9.41 mm) followed by T₅ (6.14, 7.52 and 8.83 mm, respectively). The minimum stem diameter was recorded in T₀ (Garden soil). The superior performance of T₆ may be attributed due to the better nutritional support and active growth of the plant, which promoted the formation and strengthening of stem tissues resulting in greater stem thickness. These findings are in conformity with those of Kiran *et al.* (2007)^[21, 22] in dahlia also reported by Arunesh *et al.* (2020)^[5, 23] in gerbera, Chaudhary *et al.* (2021)^[12, 24] in dahlia.

Stem diameter

Plant height



Flower diameter

Flower yield



Number of branches per plant

Number of leaves per plant



Flowering parameters

Days to opening of first flower bud - Days to opening of the first flower bud were significantly affected by different potting media as depicted in Table 3. The treatment T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) recorded the minimum days (41.00) followed by T₅ (44.00 days), while the maximum (60.40 days) was recorded in T₀ (Garden soil). The superior performance of T₆ might be due to favourable growing conditions of media, which supported healthy root development, moisture and nutrients, and better plant growth. These conditions may have encouraged earlier bud development and resulted in earlier opening of the first flower. The similar findings were in close conformity with Kiran *et al.* (2007)^[21, 22] in dahlia, Anuje *et al.* (2008)^[26] in gerbera, Panj *et al.* (2012)^[2, 27] in gerbera and Khan *et al.* (2020)^[21, 28] in marigold.

Days to 50% flowering - Days to 50% flowering were significantly varied with different potting media as depicted in Table 3. Among the treatments T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) recorded the minimum days (51.80) followed by T₅ (54.40 days), while the maximum (72.73 days) was recorded in T₀ (Garden soil). The earlier 50% flowering in T₆ may be due to balanced nutrient availability, favourable moisture conditions, and better root environment which enhanced physiological processes and promoted early flowering. Similar results were also obtained with the findings of Mehmood *et al.* (2013)^[26, 27] in antirrhinum, Sahu *et al.* (2023)^[20, 29] in calendula and Kala *et al.* (2020)^[16, 29] in pot mum chrysanthemum.

Number of flowers per plant - Number of flowers per plant was significantly influenced by different potting media as depicted in Table 3. The treatment T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) recorded the maximum number of flowers (67.00) followed by T₅ (62.33), while the minimum was recorded in T₀ (Garden soil). The superior performance of T₆ might be due to better nutrient availability, favourable moisture conditions and improved root development, which promoted greater flower bud formation and higher flower production. Similar findings were also reported by Sangwan *et al.* (2010)^[30] in marigold, Kareem *et al.* (2014)^[18, 8] in calendula,

Kameshwari *et al.* (2017)^[31] in chrysanthemum, Padhiyar *et al.* (2017)^[9] in marigold, Lokhande *et al.* (2019)^[25, 11] in marigold.

Diameter of fully opened flower (cm) - Flower diameter was significantly affected by different potting media as presented in Table 3. The highest flower diameter (5.977 cm) was recorded in T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) followed by T₅ (5.627 cm), whereas T₀ (Garden soil) recorded the lowest flower diameter (2.973 cm). The increased flower diameter under T₆ might be due to improved nutrient availability and better root development, which supported efficient uptake of nutrients and greater accumulation of photosynthates, and flower growth, resulting in larger blooms. Similar results were found in the findings of Sangwan *et al.* (2010)^[30] in marigold and Kumar *et al.* (2022)^[24, 2] in calendula.

Flowering duration (days) - Flowering duration was significantly affected by different potting media as presented in Table 3. Among the treatment T₆ (Cocopeat + Sand + Enriched Vermicompost), was recorded the maximum flowering duration (64.13 days), followed by T₅ (61.53 days), whereas the minimum (42.40 days) was recorded in T₀ (Garden soil). The prolonged flowering in T₆ might be due to the favourable condition of the growing media and plant growth, which encouraged successive production and development of flower buds and maintained flowering over a longer period. A similar trend was also reported by Kameshwari *et al.* (2014)^[17, 31] in chrysanthemum, Kiran *et al.* (2007)^[21, 22] in dahlia and Khan *et al.* (2020)^[21, 28] in marigold under different potting media.

Yield parameters

Flower yield per plant (g) - Flower yield per plant was significantly influenced by different potting media were presented in Table 3. The highest flower yield (414.20 g) was recorded in T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) followed by T₅ (366.00 g) and T₃ (343.53 g), whereas the minimum (180.10 g) was recorded in T₀ (Garden soil). The superior performance of T₆ may be attributed due to favourable physical, chemical and organic matter content of the growing media, which supported vigorous vegetative growth with greater plant height, leaf production and branching, which provided a stronger plant framework for flower production and contributed to

higher flower yield. These observations are supported by the similar findings of Mehmood *et al.* (2010)^[27] in marigold and Lokhande *et al.* (2019) ^[25, 11] in marigold.

Conclusions

The study demonstrated that potting media composition significantly influenced the growth, flowering and flower yield of *Calendula* (*Calendula officinalis* L.). Among the treatments, T₆ (Cocopeat + Sand + Enriched Vermicompost, 2:1:2) recorded the best overall performance in vegetative growth, flowering and yield. In vegetative growth maximum plant height (27.40, 36.74, 44.02 cm), number of branches (23.66, 31.73, 37.13), number of leaves (50.40, 102.93, 159.06), stem diameter (7.56, 8.31, 9.41 mm) at 30, 60 and 90 days after planting, respectively. In flowering parameters earliest opening of first flower bud (41.00 days), days to 50% flowering (51.80 days), maximum number of flowers per plant (67.00), flower diameter (5.977 cm), flowering duration (64.13 days) and flower yield per plant (414.20 g) followed by T₅. Whereas T₀ (garden soil) recorded the lowest performance. The superior performance of T₆ might be due to the favourable potting media that provided better aeration, moisture retention and nutrient availability, thereby promoting healthy root development and vigorous plant growth, which ultimately contributed to improved flowering and higher flower yield. Therefore, T₆ can be

recommended as a suitable potting media for calendula under pot culture, as it resulted in better plant height, compact and highly branched plants, more leaves with desirable plant spread, stronger and thicker stems, synchronized and profuse flowering with longer duration, and higher flower yield.

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Table 1. Effect of different potting media on plant height and number of leaves per plant at 30, 60 and 90 DAP of *Calendula* (*Calendula officinalis* L.).

Notation	Treatment	Plant height (cm)			Number of leaves per plant		
		30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
T ₀	Garden soil	9.56	14.94	19.82	21.60	42.13	69.06
T ₁	Garden soil+Sand + Vermicompost (2:1:1)	14.04	22.41	28.14	27.66	51.53	79.20
T ₂	Garden soil +Sand +Vermicompost (3:1:1)	18.26	25.92	31.54	32.26	58.06	86.53
T ₃	Garden soil +Sand + Enriched Vermicompost (2:1:1)	22.02	31.81	36.54	42.66	77.20	131.33
T ₄	Garden soil +Sand + Enriched Vermicompost (3:1:1)	21.26	29.29	33.66	38.00	66.80	100.20
T ₅	Cocopeat + Sand + Enriched Vermicompost (2:1:1)	25.67	34.84	39.88	46.80	87.13	141.73
T ₆	Cocopeat + Sand + Enriched Vermicompost (2:1:2)	27.40	36.74	44.02	50.40	102.93	159.06
T ₇	Garden soil +Sand + Enriched Vermicompost + Cocopeat (1:1:1:1)	12.92	18.03	24.82	25.66	46.86	73.06
	C.D. at 5%	1.17	1.67	0.98	1.45	3.25	1.89
	S.E(m)±	0.3	0.55	0.32	0.48	1.07	0.62
	C.V. (%)	3.56	3.58	1.74	2.33	2.80	1.03

(continued on next page)

Table 2. Effect of different potting media on number of branches per plant and stem diameter at 30, 60 and 90 DAP of *Calendula* (*Calendula officinalis* L.).

Notation	Treatment	Number of branches per plant			Stem diameter (mm)		
		30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
T ₀	Garden soil	5.43	9.63	12.66	3.37	4.41	4.87
T ₁	Garden soil+Sand + Vermicompost (2:1:1)	11.10	15.66	19.80	4.63	5.90	6.20
T ₂	Garden soil +Sand +Vermicompost (3:1:1)	12.63	17.26	21.93	5.29	6.26	7.07
T ₃	Garden soil +Sand + Enriched Vermicompost (2:1:1)	17.26	24.53	29.20	6.06	7.60	8.06
T ₄	Garden soil +Sand + Enriched Vermicompost (3:1:1)	14.60	20.86	25.80	5.81	6.73	7.35
T ₅	Cocopeat + Sand + Enriched Vermicompost (2:1:1)	20.06	28.66	34.23	6.14	7.52	8.83
T ₆	Cocopeat + Sand + Enriched Vermicompost (2:1:2)	23.66	31.73	37.13	7.56	8.31	9.41
T ₇	Garden soil +Sand + Enriched Vermicompost + Cocopeat (1:1:1:1)	8.46	12.80	17.26	4.00	5.13	5.69
	C.D. at 5%	0.89	1.13	1.07	0.38	0.36	0.23
	S.E(m)±	0.29	0.37	0.35	0.12	0.12	0.07
	C.V. (%)	3.62	3.22	2.48	3.26	3.26	1.90

Table 3. Effect of different potting media on flowering parameters of *Calendula* (*Calendula officinalis* L.).

Notation	Treatment	Days to opening of first flower bud	Days to 50% flowering	Number of flowers per plant	Diameter of fully openend flower (cm)	Flowering duration	Yield of flower per plant (g)
T ₀	Garden soil	60.4	72.73	29.00	2.97	42.40	180.10
T ₁	Garden soil+Sand + Vermicompost (2:1:1)	56	66.60	44.66	4.00	51.06	244.00
T ₂	Garden soil +Sand +Vermicompost (3:1:1)	53	63.20	50.00	4.56	53.73	284.46
T ₃	Garden soil +Sand + Enriched Vermicompost (2:1:1)	47	58.06	57.00	5.03	59.06	343.53
T ₄	Garden soil +Sand + Enriched Vermicompost (3:1:1)	50	61.20	53.66	4.70	55.06	317.46
T ₅	Cocopeat + Sand + Enriched Vermicompost (2:1:1)	44	54.40	62.33	5.62	61.53	366.00
T ₆	Cocopeat + Sand + Enriched Vermicompost (2:1:2)	41	51.80	67.00	5.97	64.13	414.20
T ₇	Garden soil +Sand + Enriched Vermicompost + Cocopeat (1:1:1:1)	58	68.93	37.66	3.34	48.26	221.00
	C.D. at 5%	1.66	5.55	2.64	0.09	2.75	9.93
	S.E(m)±	0.51	1.83	0.87	0.03	0.91	3.28
	C.V. (%)	1.86	5.12	3.01	1.25	2.89	1.92

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