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AV Rathod
Department of Floriculture and Landscape Architecture, VNMKV, Parbhani, Maharashtra, India

VV Bhagat
Associate Professor, College of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

DD Adsure
Ph.D. Scholar, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

PD Wakle
Department of Floriculture and Landscape Architecture, VNMKV, Parbhani, Maharashtra, India

RK Pandit
Department of Floriculture and Landscape Architecture, VNMKV, Parbhani, Maharashtra, India

RH Kudke
Department of Floriculture and Landscape Architecture, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
AV Rathod
Department of Floriculture and Landscape Architecture, VNMKV, Parbhani, Maharashtra, India

Effect of different growing media on growth and flower yield of calendula under shade net condition (*Calendula officinalis* L.)

AV Rathod, VV Bhagat, DD Adsure, PD Wakle, RK Pandit and RH Kudke

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Abstract
The study on "Effect of different growing media on growth and flower yield of calendula under shade net condition (*Calendula officinalis* L.)" was conducted at the College of Horticulture, VNMKV, Parbhani (Maharashtra) during 2024-25. The experiment was laid out in a CRD with nine different media combinations and three replications. Treatments included soil, sand, vermicompost, cocopeat, perlite, leaf mould and black soil in different proportions. Results showed that T_3 (Soil + Sand + Vermicompost + Cocopeat) performed best, recording maximum plant height (28.63 cm), plants spread (30.14 cm), leaves (72.13), branches (22.40) and leaf area (64.61 cm²). It also showed early bud initiation (23.77 days), early flowering after bud initiation (2.36 days), 50% flowering (45.43 days), larger bud (1.41 cm) and flower diameter (5.20 cm), longer flower life (7.73 days) and higher yield (36.50) flowers per plant, (4.77 g) fresh weight, (0.52 g) dry weight. Postharvest soil NPK status was also highest in T_3.

Keywords: *Calendula officinalis*, growing media, vermicompost, cocopeat, perlite, soil nutrients

Introduction
Calendula is an herbaceous annual or short-lived perennial originally native to Egypt, but now widely naturalized across temperate regions. Its cultivation dates back to Roman times, primarily for its medicinal value. At present, calendula is grown both for its therapeutic applications and as an ornamental plant. Ornamental production includes cut flowers and potted plants, while cultivation for cut flowers and herbs can be carried out in open fields, pots, or under greenhouse conditions Kareem *et al.* (2014) [5].

Calendula given its adaptability, aesthetic value and commercial potential, calendula cultivation in Marathwada can contribute significantly to rural livelihoods, diversification of cropping systems and promotion of medicinal plant farming. Research on the use of different growing media such as vermicompost, FYM, cocopeat and perlite is also being explored to enhance the productivity and quality of calendula under local conditions, opening up new areas for horticultural research in the region Kumar *et al.* (2018) [12].

Marathwada's semi-arid climate, moderate winter temperatures and well-drained soils provide a conducive environment for growing calendula during the rabi season (October to March). The crop performs well under low-input farming systems, making it an ideal choice for small and marginal farmers of the region. Calendula cultivation is gaining attention under organic farming and integrated crop systems, especially due to its ability to thrive with minimal irrigation and resistance to common pests and diseases.

Growing media play a crucial role in determining the quality and productivity of flowering plants. Soil available nitrogen content was analysed by the Alkaline $KMnO_4$ method. phosphorus by the Olsen method and potassium was measured using a flame photometer.

Materials and Methods
The present investigation was carried out during the winter season 2024-25. At experimental filed of the College of Horticulture, VNMKV, Parbhani, Maharashtra. The experiment was laid out in Completely Randomized Design (CRD) with nine different potting media *viz.* T_1

(Soil + Sand + FYM), T_2 (Soil + Sand + Vermicompost), T_3 (Soil + Sand + Vermicompost + Cocopeat), T_4 (Cocopeat + Vermicompost + Perlite), T_5 (Cocopeat + Perlite + Leaf Mould), T_6 (Cocopeat + Vermicompost + Leaf Mould), T_7 (Soil + Leaf Mould + Sand), T_8 (Cocopeat + Sand + Vermicompost), T_9 (Black Soil). In this experiment the seeds of calendula were sown in third week of November 2024 and transplanted in second week of December 2024 in 8 inches plastic pots filled with different potting media as per treatments. Observations on growth and flowering were recorded. Total amount of initial and post-harvest soil available N, initial and post-harvest available P and initial and postharvest K were evaluated from each treatment from the potting media. The potting media were prepared by mixing thoroughly the different components *viz.*, sand, soil, cocopeat, vermicompost, leafmould and perlite in different proportions as per the treatment.

Results and Discussion

Plant height (cm)

The maximum plant height (28.63 cm) at 120 DAT was observed in T_3 (Soil + Sand + Vermicompost + Cocopeat), followed by T_2 (27.47 cm), while the minimum (14.30 cm) was recorded in T_9 (Black Soil). The higher growth in T_3 and T_2 may be attributed to the slow release of nutrients, micronutrients, and growth regulators from vermicompost and cocopeat, along with improved soil properties and microbial activity. Poor growth in black soil was likely due to nutrient deficiency. Similar results were reported by Mehakar *et al.* (2022) [16] and Deogade *et al.* (2020) [14].

Table 1: Effect of different growing media on plant height (cm).

Treat. No	Treatment details	Days after transplanting (DAT)			
		30	60	90	120
T_1	Soil+ Sand+ FYM	9.28	14.53	18.60	20.50
T_2	Soil+ Sand + Vermicompost	11.30	20.66	23.47	27.47
T_3	Soil + Sand + Vermicompost + Cocopeat	12.30	22.53	25.13	28.63
T_4	Cocopeat + Vermicompost + Perlite	11.02	18.80	22.32	25.00
T_5	Cocopeat + Perlite + Leaf mould	9.02	13.13	17.24	19.17
T_6	Cocopeat + Vermicompost + Leaf mould	8.20	12.67	15.37	17.50
T_7	Soil + Leaf mould + Sand	10.00	16.87	19.30	22.28
T_8	Cocopeat + Sand + Vermicompost	10.37	17.80	20.30	23.70
T_9	Control (Black soil)	7.70	10.40	12.55	14.30
SE (m ±)		0.67	1.02	1.35	0.94
CD at 5%		0.23	0.34	0.45	0.32

Leaves per plant

The maximum leaves per plant 72.13 at 120 DAT were recorded in T_3 (Soil + Sand + Vermicompost + Cocopeat) which were followed by T_2 (Soil + Sand + Vermicompost) which was recorded 70.57 in (Table 2). This variation may be attributed to better aeration, higher water-holding capacity and the continuous supply of nutrients, particularly nitrogen in available form, which promotes root proliferation and overall plant growth, ultimately resulting in a higher number of leaves per plant. These results are in agreement with the findings of Deogade *et al.* (2022) [14].

Table 2: Effect of different growing media on leaves per plants.

Treat. No	Treatment details	Days after transplanting (DAT)			
		30	60	90	120
T_1	Soil+ Sand+ FYM	19.87	38.23	52.60	59.37
T_2	Soil+ Sand + Vermicompost	33.70	41.07	60.13	70.57
T_3	Soil + Sand + Vermicompost + Cocopeat	40.03	56.00	61.13	72.13
T_4	Cocopeat + Vermicompost + Perlite	28.72	40.73	57.63	68.70
T_5	Cocopeat + Perlite + Leaf mould	17.07	34.23	48.54	55.57
T_6	Cocopeat + Vermicompost + Leaf mould	15.40	30.44	44.06	57.70
T_7	Soil + Leaf mould + Sand	20.70	39.37	54.70	62.17
T_8	Cocopeat + Sand + Vermicompost	24.33	40.13	56.85	66.50
T_9	Control (Black soil)	14.37	28.33	38.07	45.57
SE (m ±)		10.35	3.59	2.56	3.89
CD at 5%		3.48	1.21	0.86	1.31

Branches per plant

At 120 DAT, the maximum number of branches per plant was obtained in T_3 (Soil + Sand + Vermicompost + Cocopeat), followed by T_2 (Soil + Sand + Vermicompost). The minimum number of branches was noted in T_9 (Black Soil). The superior performance of T_3, T_2 and T_4 can be attributed to the synergistic role of soil and vermicompost, where soil provides essential mineral nutrients while vermicompost enriches the medium with macro-and micronutrients along with growth-promoting hormones (Table 3). In addition, vermicompost improves the physical properties of the substrate by preventing compaction and enhancing aeration, which facilitates better branching. The inclusion of cocopeat further aids in moisture retention and organic matter enrichment, thereby creating favourable conditions for enhanced branch formation. Deogade *et al.* (2020) [14] and Kareem *et al.* (2014) [5] who also reported improved branching in plants grown in vermicompost-enriched media.

Table 3: Effect of different growing media on number of branches.

Treat. No	Treatment details	Days after transplanting (DAT)			
		30	60	90	120
T_1	Soil+ Sand+ FYM	4.27	10.33	12.25	17.60
T_2	Soil+ Sand + Vermicompost	8.27	14.33	17.13	21.10
T_3	Soil + Sand + Vermicompost + Cocopeat	9.40	15.00	19.37	22.40
T_4	Cocopeat + Vermicompost + Perlite	7.40	13.70	15.47	20.23
T_5	Cocopeat + Perlite + Leaf mould	3.63	8.57	11.35	16.11
T_6	Cocopeat + Vermicompost + Leaf mould	3.50	7.30	10.40	12.56
T_7	Soil + Leaf mould + Sand	5.50	12.17	13.01	18.53
T_8	Cocopeat + Sand + Vermicompost	6.27	13.00	14.33	19.53
T_9	Control (Black soil)	3.07	6.23	8.50	11.02
CD at 5%		0.42	0.48	0.41	0.29
SE (m ±)		1.26	1.44	1.22	0.86

Plants spread (cm)

The maximum plant spread (30.14 cm) at 120 DAT was recorded by T_3 (Soil + Sand + Vermicompost + Cocopeat) which was followed by T_2 (Soil + Sand + Vermicompost)) which recorded value of 28.47 cm (Table 4). The minimum plant spread (16.03 cm) was recorded by T_9 (Black Soil). It is due to soil provides essential minerals and vermicompost contributes both macro-and micronutrients along with growth-promoting substances. Vermicompost also improves the physical structure of the medium, preventing compaction and enhancing aeration. Additionally, the presence of cocopeat in the mixtures helps retain moisture and enriches organic matter, thereby creating favourable conditions for better plant spread. Similar result was found by Sardoei *et al.* (2015) [8] and Chauhan *et al.* (2014) [4].

Table 4: Effect of different growing media on plant spread (cm).

Treat. No	Treatment details	Days after transplanting (DAT)			
		30	60	90	120
T_1	Soil+ Sand+ FYM	10.43	12.03	14.02	22.31
T_2	Soil+ Sand + Vermicompost	13.47	15.83	18.02	28.47
T_3	Soil + Sand + Vermicompost + Cocopeat	14.90	16.43	19.43	30.14
T_4	Cocopeat + Vermicompost + Perlite	12.03	14.57	16.15	26.01
T_5	Cocopeat + Perlite + Leaf mould	10.06	11.43	13.30	20.24
T_6	Cocopeat + Vermicompost + Leaf mould	9.03	10.59	12.02	18.34
T_7	Soil + Leaf mould + Sand	12.03	14.57	16.15	26.01
T_8	Cocopeat + Sand + Vermicompost	11.24	13.37	14.48	24.18
T_9	Control (Black soil)	7.43	9.07	11.01	16.03
SE (m ±)		0.64	0.56	0.38	0.42
CD at 5%		0.22	0.19	0.13	0.14

Leaf area (cm^2)

The maximum leaf area 64.61 cm^2 was recorded in T_3 (Soil + Sand + Vermicompost + Cocopeat) was followed by T_2 (Soil + Cocopeat + Vermicompost) which was recorded as 58.43 cm^2 respectively (Table 5). highlighting its beneficial effect on early leaf expansion and photosynthetic surface development. On the other hand, T_9 (Black Soil) produced the minimum leaf area (33.32 cm^2), reflecting its limitation in supporting vigorous early leaf growth. Similar observations were also reported by Deogade *et al.* (2020) [14].

Table 5: Effect of different growing media on leaf area (cm^2)

Treat. No	Treatment details	Leaf area (cm^2)
T_1	Soil+ Sand+ FYM	39.87
T_2	Soil+ Sand + Vermicompost	58.43
T_3	Soil + Sand + Vermicompost + Cocopeat	64.61
T_4	Cocopeat + Vermicompost + Perlite	50.67
T_5	Cocopeat + Perlite + Leaf mould	37.35
T_6	Cocopeat + Vermicompost + Leaf mould	34.10
T_7	Soil + Leaf mould + Sand	35.07
T_8	Cocopeat + Sand + Vermicompost	44.20
T_9	Control (Black soil)	33.32
SE (m ±)		15.78
CD at 5%		5.31

Days taken to first bud initiation

The data presented in Table 6 reveal that minimum days to first flower bud initiation (23.77 days) were recorded in T_3 potting mixture Soil + Sand + Vermicompost + Cocopeat. Whereas, maximum days to first flower bud initiation (39.79 days) was observed in T_9 (Black soil). The present findings might be due to better aeration, higher porosity, higher moisture and nutrient retention leads in higher accumulation of carbohydrate that ultimately resulted in early flowering.

Similar findings of results were also reported by Deogade *et al.* (2020) [14] in gerbera.

Days taken to first flower initiation

The shortest duration for flower opening from bud emergence (2.57 days) was observed in T_3 the potting mixture of Soil + Sand + Vermicompost + Cocopeat, whereas the longest duration (7.39 days) was noted in T_9 (Black soil). This variation may be attributed to the fact that the former combination also promoted earlier flower bud initiation compared to other treatments. Comparable findings were reported by Deogade *et al.* (2020) [14] and Chauhan *et al.* (2014) [4] in gerbera.

50% flowering (days)

The earliest occurrence of 50% flowering (45.43 days) was recorded in T_3 the potting mixture of Soil + Sand + Vermicompost + Cocopeat, while the longest duration to reach 50% flowering (56.36 days) was observed in T_9 (Black soil). Comparable results were reported by Deogade *et al.* (2020) [14].

Table 6: Effect of different growing media on days taken to first bud initiation, days taken to first flower initiation and 50% flowering.

Treat. No	Treatment details	Days taken to first flower bud initiation	Days taken to first flower initiation	50% flowering (days)
T_1	Soil+ Sand+ FYM	30.67	3.83	51.00
T_2	Soil+ Sand + Vermicompost	26.13	2.57	46.44
T_3	Soil + Sand + Vermicompost + Cocopeat	23.77	2.36	45.43
T_4	Cocopeat + Vermicompost + Perlite	28.33	3.23	48.00
T_5	Cocopeat + Perlite + Leaf mould	35.24	4.66	51.10
T_6	Cocopeat + Vermicompost + Leaf mould	38.85	6.48	54.40
T_7	Soil + Leaf mould + Sand	37.19	6.20	52.53
T_8	Cocopeat + Sand + Vermicompost	33.37	4.31	48.63
T_9	Control (Black soil)	39.79	7.39	56.33
	SE (m ±)	2.88	0.80	0.48
	CD at 5%	0.97	0.27	0.16

Flower bud diameter and flower diameter (cm)

The maximum diameter of flower bud (1.41 cm) was observed in T_3 (Soil + Sand + Vermicompost + Cocopeat) which was closely followed by T_2 (Soil + Sand + Vermicompost) was recorded (1.33 cm) and minimum diameter of flower bud (1.02 cm) was recorded in T_9 (Black soil).

The maximum diameter of fully open flower (5.20 cm) was observed in T_3 (Soil + Sand + Vermicompost + Cocopeat) which was followed by T_2 (Soil + Sand + Vermicompost) was recorded (4.20 cm) and minimum diameter o fully open flower (2.11 cm) was recorded in T_9 (Black soil). The larger flower size in certain treatments may be due to improved nutrient availability, enhanced photosynthesis, and the presence of growth-promoting substances in vermicompost, which act similarly to plant growth regulators Mehakar *et al.* (2022) [16] and Gariglio *et al.* (2010) [2].

Individual flower life (days)

The maximum duration of flower (7.73 days) was observed in T_3 (Soil + Sand + Vermicompost + Cocopeat) closely followed by T_2 (Soil + Sand + Vermicompost) which recorded 7.43 days respectively (Table 7). In contrast, the minimum flower duration (5.10 days) was noted in T_9 (Black soil). The extended flower life in certain media combinations can be attributed to the ability of cocopeat to retain higher moisture levels and the contribution of vermicompost in enhancing dry matter accumulation through nutrient supply, thereby prolonging flower longevity. Similar findings are Mehakar *et al.* (2022) [16] and Nair and Bharathi (2015) [6].

Table 7: Effect of different growing media on flower bud diameter, flower diameter in (cm) and individual flower life (days).

Treat. No	Treatment details	Flower bud diameter (cm)	Flower diameter (cm)	Individual flower life (days)
T_1	Soil+ Sand+ FYM	1.07	2.94	6.10
T_2	Soil+ Sand + Vermicompost	1.33	4.20	7.43
T_3	Soil + Sand + Vermicompost + Cocopeat	1.41	5.20	7.73
T_4	Cocopeat + Vermicompost + Perlite	1.25	3.90	7.10
T_5	Cocopeat + Perlite + Leaf mould	1.11	3.24	5.82
T_6	Cocopeat + Vermicompost + Leaf mould	1.10	3.10	5.21
T_7	Soil + Leaf mould + Sand	1.03	2.41	5.28
T_8	Cocopeat + Sand + Vermicompost	1.13	3.27	6.73
T_9	Control (Black soil)	1.02	2.11	5.10
	SE (m ±)	0.15	0.47	0.34
	CD at 5%	0.05	0.16	0.11

Number of bud and flowers per plant

The highest number of buds per plant (37.31) was recorded in T_3 (Soil + Sand + Vermicompost + Cocopeat) followed by T_2 (Soil + Sand + Vermicompost) which recorded 35.10 respectively (Table 4). The lowest number of bud (25.04) was observed in T_9 (Black soil).

The highest number of flowers per plant (36.50) was recorded in T_3 (Soil + Sand + Vermicompost + Cocopeat) followed by T_2 (Soil + Sand + Vermicompost) which recorded 34.71 respectively (Table 8). The minimum number of flower (23.01) was observed in T_9 (Black soil). The superior performance of treatments containing vermicompost may be attributed to its rich nutrient content

and enhanced availability of essential elements during critical growth stages, while cocopeat contributes to improved moisture retention. This combination likely promoted efficient nutrient uptake and carbohydrate accumulation, resulting in a higher number of flowers. In contrast, sand and cocopeat alone provide limited nutrients and moisture, leading to reduced growth and flowering. these results are consistent with earlier findings reported by Mehakar *et al.* (2022) [16] and Arunesh *et al.* (2020) [15].

Table 8: Effect on different growing media on number of buds per plant and number of flowers per plant.

Treat. No	Treatment details	Number of bud per plant	Number of flowers per plant
T_1	Soil+ Sand+ FYM	33.03	31.01
T_2	Soil+ Sand + Vermicompost	35.10	34.71
T_3	Soil + Sand + vermicompost + Cocopeat	37.31	36.50
T_4	Cocopeat + Vermicompost + Perlite	34.78	33.19
T_5	Cocopeat + Perlite + Leaf mould	31.63	29.10
T_6	Cocopeat + Vermicompost + Leaf mould	27.04	24.94
T_7	Soil + Leaf mould + Sand	30.05	26.63
T_8	Cocopeat + Sand + Vermicompost	34.02	32.04
T_9	Control (Black soil)	25.04	23.01
	SE (m ±)	0.85	4.01
	CD at 5%	0.29	1.35

Fresh and dry weight of flower (g)

The maximum fresh weight (4.77 g) and dry weight of flower (0.52 g) was recorded by T_3 (Soil + Sand + Vermicompost +Cocopeat) which was followed by T_2 (Soil + Sand + Vermicompost) which recorded (3.20) and (0.47 g) respectively (Table 9). The minimum fresh and dry weight of flower (1.47) and (0.15 g) was recorded by T_9 (Black soil). Similarity in result showed by Mehakar *et al.* (2022) [16] and Nair and Bharathi (2015) [6].

Table 9: Effect on different growing media on fresh weight of flower and dry weight of flower of calendula.

Treat. No	Treatment details	Fresh weight of flower (g)	Dry weight of flower (g)
T_1	Soil+ Sand+ FYM	2.16	0.28
T_2	Soil+ Sand + Vermicompost	3.20	0.47
T_3	Soil + Sand + Vermicompost + Cocopeat	4.77	0.52
T_4	Cocopeat + Vermicompost + Perlite	3.19	0.41
T_5	Cocopeat + Perlite + Leaf mould	2.03	0.21
T_6	Cocopeat + Vermicompost + Leaf mould	1.96	0.18
T_7	Soil + Leaf mould + Sand	2.76	0.31
T_8	Cocopeat + Sand + Vermicompost	3.03	0.33
T_9	Control (Black soil)	1.47	0.15
	SE (m ±)	0.48	0.09
	CD at 5%	0.16	0.03

Postharvest nutrient status affected by different growing media

The maximum soil available nitrogen, phosphorus and potassium were observed with treatment T_3 (Soil + Sand + Vermicompost +Cocopeat) at the post-harvest stages. While minimum soil available nitrogen, phosphorus and potassium were observed with treatment T_9 (Black soil). Similarity in result showed that Mehakar *et al.* (2022) [16].

Table 10: Effect of different growing media on post-harvest soil nutrient status.

Treat. No	Treatment details	Available nitrogen (kg ha$^{-1)}$	Available phosphorus (kg ha$^{-1)}$	Available potassium (kg ha^{-1})
T_1	Soil+ Sand+ FYM	232.97	19.33	491.89
T_2	Soil+ Sand + Vermicompost	250.11	20.44	514.30
T_3	Soil + Sand + vermicompost + Cocopeat	253.83	22.32	523.94
T_4	Cocopeat + Vermicompost + Perlite	240.40	17.64	499.29
T_5	Cocopeat + Perlite + Leaf mould	235.45	15.44	493.94
T_6	Cocopeat + Vermicompost + Leaf mould	225.69	18.06	488.85
T_7	Soil + Leaf mould + Sand	228.78	17.36	489.66
T_8	Cocopeat + Sand + Vermicompost	237.79	21.29	495.65
T_9	Control (Black soil)	152.23	14.73	486.49
	SE (m ±)	6.12	0.86	4.57
	CD at 5 %	2.06	0.29	1.54

Conclusion

On the basis of above results it may be concluded that, among the various growing media, T_3 (Soil + Sand + Cocopeat + Vermicompost) proved most effective, showing superior performance in growth, flowering traits, as well as in maintaining soil available post-harvest nutrient status of the medium.

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