Plant Archives Vol. 25, Supplement 2, 2025 pp. 776-781 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.098

EFFECT OF DIFFERENT GROWING MEDIA AND PLANTING DATES ON GROWTH AND FLOWERING OF CALENDULA (*CALENDULA OFFICINALIS* L.)

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(Date of Receiving : 28-04-2025; Date of Acceptance : 03-07-2025)

ABSTRACT

The present study was conducted to evaluate the effect of different growing media and planting dates on the vegetative growth and flowering performance of calendula (*Calendula officinalis* L.). The experiment included six growing media combinations and two planting dates: the second fortnight of October and the second fortnight of November. Results revealed that both growing media and planting dates significantly influenced key vegetative and floral traits. The combination of Cocopeat: Sand: FYM: Vermicompost (2:1:1:1) planted in the second fortnight of October (G_4P_1) produced the best results, including maximum plant height, plant spread, number of primary branches, number of flowers per plant, and flowering duration, along with the earliest flowering whereas G_6P_1 Sphagnum moss: Sand: FYM: Vermicompost (2:1:1:1) planted in the second fortnight of October gives maximum flower size. The superior performance under this treatment (G_4P_1) was attributed to improved aeration, nutrient availability, and favorable climatic conditions during early plant development. The findings suggest that the use of cocopeat-based media with early October planting is optimal for enhancing the growth and floral yield of calendula under Bundelkhand conditions.

***Keywords*:** Growing media, planting dates,vegetative growth, flowering performance ,calendula (*Calendula officinalis* L.).

Introduction

Calendula (*Calendula officinalis* L.), commonly known as pot marigold, belongs to the family Asteraceae and is one of the most important annual ornamental and medicinal herbs cultivated worldwide. Native to southern Europe and the Mediterranean region. It has gained significant attention not only for its aesthetic appeal in landscapes and home gardens but also for its wide array of therapeutic and industrial uses. However, its growth, flowering behavior, and yield potential are significantly influenced by several factors, particularly planting time and growing media composition. Potted ornamental plants have become increasingly popular not only for home gardens but also for commercial purposes such as weddings, exhibitions, hotel décor, and restaurant aesthetics. In this context, the demand for lightweight and sustainable growing media has grown significantly, as they facilitate easy handling, transportation, and reusability, making them highly suitable for rental-based ornamental plant businesses (Dubey *et al.*, 2012).The quality of potted plant production is greatly influenced by the type of growing media used, as it plays a vital role in supplying nutrients, supporting root development, and providing mechanical stability to plants in containers (Vendrame *et al.*, 2005). Commonly used substrates such as sand, farmyard manure (FYM), cocopeat, and sphagnum moss not only vary in their physical and chemical properties but also significantly influence plant growth and nutrient uptake (Bechmann-Cavalcante *et al.*, 2009).

The vegetative growth and overall quality of calendula can be significantly enhanced by selecting an appropriate planting time, which also helps to fulfil

market and consumer demands (Muhammad *et al.*, 2001). However, the optimal planting period may differ across regions due to variations in environmental factors such as photoperiod, temperature, and light intensity. The growth and flowering response in calendula are primarily influenced by these climatic factors, particularly day length and ambient temperature. To ensure a consistent supply of flowers throughout the year, staggered planting schedules are often adopted. In this regard, the present investigation was undertaken to study the effect of different growing media and planting dates on the growth, flowering, and yield of Calendula, with an objective to identify suitable agronomic practices that can improve its productivity and adaptability under varying environmental conditions.

Materials and Methods

The present investigation was carried out during the year at the Nursery of the Department of Floriculture and Landscape Architecture, Banda University of Agriculture and Technology, Banda. The site is located in the semi-arid agro-climatic zone of Bundelkhand, characterized by low rainfall, high temperature fluctuations, and prolonged dry spells. The soil of the experimental field was sandy loam in texture, low in organic carbon, and medium in available NPK. The experimental crop used was Calendula (*Calendula officinalis* L.), grown from healthy and certified seeds of a commonly procured from a reliable commercial source. The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with three replications, comprising two planting dates as factors and six different growing media compositions, making a total of 12 treatment combinations with total of 108 pots.

Table 1 : Treatment combinations

No.	Notation	Details
T_1	G_1P_1	Soil + Sand + FYM (2:1:1, v/v) and Planting on 2nd fortnight of October
T_2	G_1P_2	Soil + Sand + FYM (2:1:1, v/v) and Planting on 2nd fortnight of November
T_3	G_2P_1	Soil + Sand + FYM +Vermicompost (2:1:1:1, v/v) and Planting on 2nd fortnight of October
T_4	G_2P_2	Soil + Sand + FYM +Vermicompost (2:1:1:1, v/v) and Planting on 2nd fortnight of November
T_5	G_3P_1	Cocopeat + Sand + FYM (2:1:1, v/v) and Planting on 2nd fortnight of October
T_6	G_3P_2	Cocopeat + Sand + FYM (2:1:1, v/v) and Planting on 2nd fortnight of November
T_7	G_4P_1	Cocopeat + Sand + FYM + Vermicompost (2:1:1:1, v/v) and Planting on 2nd fortnight of October
T_8	G_4P_2	Cocopeat + Sand + FYM + Vermicompost (2:1:1:1, v/v) and Planting on 2nd fortnight of November
T_9	G_5P_1	Sphagnum peat moss + Sand + FYM (2:1:1, v/v) and Planting on 2nd fortnight of October
T_{10}	G_5P_2	Sphagnum peat moss + Sand + FYM (2:1:1, v/v) and Planting on 2nd fortnight of November
T_{11}	G_6P_1	Sphagnum peatmoss + Sand + FYM + Vermicompost (2:1:1:1, v/v) Planting on 2nd fortnight of October
T_{12}	G_6P_2	Sphagnum peatmoss + Sand + FYM + Vermicompost (2:1:1:1, v/v) Planting on 2nd fortnight of November

Sowing was done manually on the respective planting dates, with healthy seedling. Regular irrigation and standard cultural practices such as weeding and pest management were followed uniformly for all treatments. Observations were recorded on growth, flowering at proper stages.

Result and Discussion

The appropriate choice of growing medium plays a crucial role in ensuring adequate root anchorage, efficient nutrient and water supply, and proper gaseous exchange between the root zone and the external environment (Abad *et al.,* 2001). Growing substrates that are lightweight, nutrient-rich, and possess good drainage capacity are regarded as highly suitable for promoting optimal growth and development in flowering plant species (Dubey *et al.,* 2013). The result of the present investigation is given in Tab 2 and Tab 3. Which revealed that the highest plant height was recorded in treatment G_4P_1, which consisted of Cocopeat: Sand: FYM: Vermicompost (2:1:1:1) planted during the second fortnight of October, with a height of 14.44 cm. Conversely, the lowest plant height was observed in treatment G_1P_2, comprising Soil: Sand: FYM (2:1:1) planted in the second fortnight of November, with a value of 10.88 cm. The superior performance of G_4P_1 can be attributed to the favorable physical and biological properties of cocopeat. Its lightweight and porous nature facilitates improved aeration and moisture retention in the root zone, thereby enhancing plant growth. These findings are in agreement with those of Thumar *et al.* (2020), who reported maximum plant height in a growing medium composed of Soil + Cocopeat + Leaf Mould (2:1:1).

The effectiveness of cocopeat and leaf mould is likely due to their enhanced nutrient content and their ability to improve the physicochemical environment of the root zone. Supporting evidence is also provided by Younis *et al.* (2015), who demonstrated the significant role of cocopeat and leaf mould in promoting increased plant height compared to other growing media. With respect to October planting attained significantly greater height. The enhanced vegetative growth under October can be ascribed to more favorable environmental conditions prevailing during early plant establishment, such as optimal temperatures and sufficient light intensity. These conditions likely promote higher metabolic activity, leading to more vigorous growth. Similar observations were reported by Verma *et al.* (2001) and Lakshmi *et al.* (2014) in African marigold cv. Pusa Narangi, where earlier planting dates resulted in increased plant height due to conducive climatic factors. Among the different growing media Tab 2. A significant interaction effect was observed between growing media and planting dates on plant spread in both the East–West (E–W) and North–South (N–S) directions, indicating a differential response to the combined influence of these factors. In the E–W direction, the maximum value of 24.45 cm was recorded in treatment G_4P_1, which comprised Cocopeat: Sand: FYM: Vermicompost (2:1:1:1) and was planted in the second fortnight of October. Similarly, for plant spread in the N–S direction, the highest value of 24.41 cm was also observed in the same treatment (G_4P_1), highlighting the superior horizontal growth achieved under this media and planting date combination. In contrast, the minimum plant spread of 19.96 cm (N–S) was recorded in G_1P_2, which consisted of Soil: Sand: FYM (2:1:1) planted during the second fortnight of November. The enhanced plant spread under the G_4P_1 treatment can be attributed to the balanced composition of the growing media, particularly the inclusion of vermicompost. Vermicompost is rich in organic matter and beneficial microorganisms, which enhance soil structure, nutrient availability, and root development, thereby promoting better canopy expansion. These findings are supported by the results of Nair and Bharathi (2015) and Deogade *et al.* (2020), who also reported improved plant spread with the use of vermicompost-enriched media. The superiority of October planting may be due to the availability of more favorable environmental conditions—such as moderate temperatures and better light intensity during the early vegetative phase, which likely contributed to enhanced lateral growth. These observations are in close agreement with the findings of Sreekanth *et al.* (2006) and Smita *et al.* (2012), who reported greater plant spread under early planting schedules due to extended vegetative growth periods and optimal climatic conditions.

The maximum number of primary branches (11.97) was observed in treatment G_4P_1, where calendula seedlings were transplanted in the second fortnight of October using the cocopeat-based growing medium (Cocopeat: Sand: FYM: Vermicompost – 2:1:1:1). This enhanced branching may be attributed to the improved physical properties of cocopeat, such as higher porosity and water retention capacity, coupled with the nutrient-rich profile of vermicompost, which collectively enhance nutrient uptake and support vigorous vegetative growth. These observations are in agreement with the findings of Nair *et al.* (2015), who reported that a growing medium composed of cocopeat, sand, FYM, and vermicompost significantly improved the number of branches and flower yield per plant. The enhancement in vegetative and reproductive parameters is likely due to the better availability of essential nutrients particularly nitrogen, phosphorus, and potassium in such organic-rich, soilless media, as previously highlighted by Gupta *et al.* (2007).The superiority of October planting can be attributed to favorable climatic conditions during the early vegetative phase, such as optimal temperature, light, and humidity, which facilitate better cell division and elongation, thereby promoting increased branching. These results suggest that earlier planting extends the vegetative growth period, enabling plants to develop a more robust and well-structured canopy. Similar trends were reported by Laxmi and Pratap (2011) in chrysanthemum and by Hazarika *et al.* (2003), who also observed improved branching and vegetative growth in response to earlier transplanting dates.

Table 2 : Effect of growing media and planting dates on Vegetative growth of Calendula

	Plant Height (cm)			**Plant spread (cm) E-W**			**Plant spread (cm) N-S**			**Number of Primary Branches per plant**		
FACTOR	**P1**	**P2**	**MEAN**	**P1**	**P2**	**MEAN**	**P1**	**P2**	**MEAN**	**P1**	**P2**	**MEAN**
G1	12.08	10.88	11.48	20.71	19.37	20.04	21.36	19.96	20.66	10.38	8.74	9.56
G2	11.96	12.50	12.23	21.23	22.11	21.67	21.62	21.74	21.68	9.21	10.26	9.73
G3	12.37	11.66	12.02	21.44	20.72	21.08	21.65	20.57	21.11	10.00	9.63	9.82
G4	14.44	13.67	14.05	24.45	23.46	23.95	24.41	23.42	23.92	11.97	11.25	11.61

G5	11.61	12.43	12.02	20.82	21.12	20.97	20.76	21.25	21.00	11.19	11.22	11.20
G6	13.01	11.35	12.18	22.59	21.30	21.95	23.01	22.56	22.79	11.69	10.62	11.15
MEAN P	12.58	12.0		21.87	21.35		22.13	21.58		10.7	10.28	
	C.D.	**SE(d)**	**SE(m)**	**C.D.**	**SE(d)**	**SE(m)**	**C.D.**	**SE(d)**	**SE(m)**	**C.D.**	**SE(d)**	**SE(m)**
G	0.80	0.38	0.27	0.78	0.37	0.26	0.63	0.30	0.21	0.70	0.33	0.24
P	0.46	0.22	0.15	0.45	0.21	0.15	0.36	0.17	0.12	0.40	0.19	0.13
G X P	1.14	0.55	0.38	1.10	0.53	0.37	0.89	0.43	0.30	0.99	0.48	0.33

As mentioned in Tab 3. The earliest flowering was recorded in treatment G_4P_1, comprising Cocopeat: Sand: FYM: Vermicompost (2:1:1:1) planted in the second fortnight of October, with a value of 62.83 days. The early onset of flowering in this treatment may be attributed to the favorable properties of cocopeat, such as its lightweight structure, excellent aeration, and high water-holding capacity, which collectively enhance root development and overall plant vigor. These results are in agreement with the findings of Treder (2008), who reported earlier flowering in lilies grown in cocopeat-based media. Similar conclusions were drawn by Treder and Nowak (2002), who emphasized the advantages of soilless substrates like cocopeat in promoting early flowering in ornamental crops. The earlier flowering observed under October planting may be due to more favorable environmental conditions, particularly lower ambient temperatures and shorter photoperiods during the early stages of plant development, which can stimulate floral induction in certain long-day species like calendula. These findings are in close conformity with the results reported by Lakshmi *et al.* (2014) in marigold and Sharma *et al.* (2015) in *Gaillardia*, where early planting led to significantly reduced days to flowering, attributed to optimal climatic conditions during the early growth phase. The highest flower count per plant (43.90) was noted in treatment G_4P_1, where seedlings were planted in the second fortnight of October using the cocopeat-based medium. This was closely followed by treatment G_6P_1, comprising Sphagnum Moss: Sand: FYM: Vermicompost (2:1:1:1), which recorded 43.99 flowers per plant. These findings emphasize the superior performance of both cocopeat- and sphagnum-based soilless media when supplemented with FYM and vermicompost, likely due to enhanced nutrient availability and improved aeration in the root zone.The present results are corroborated by Riaz *et al.* (2015), who reported increased flower production with the incorporation of FYM, and by Kameswari *et al.* (2014), who observed that media enriched with cocopeat and FYM significantly improved floral yield. The beneficial effect of these media may be attributed to their capacity to retain moisture, supply essential nutrients, and foster a favorable micro environment for root and shoot development. The enhanced floral output in October plantings can be attributed to a longer vegetative growth period and a higher number of primary branches, which provided more potential sites for flower initiation. Favorable climatic conditions during early growth stages also likely contributed to better floral differentiation and development. These findings are consistent with those reported by Sreekanth *et al.* (2006) and Ghosh and Pal (2008), who found that earlier planting dates resulted in significantly higher flower production, owing to improved environmental conditions and prolonged growth duration. In Tab. 3 with respect to flower size, indicating that the combined effect of these factors did not influence flower diameter in a statistically meaningful way. However, among all treatment combinations, the largest flower size (5.95 cm) was recorded in G_6P_1, comprising Sphagnum Peatmoss: Sand: FYM: Vermicompost (2:1:1:1) planted in the second fortnight of October. The enhanced flower size observed in this treatment may be attributed to the beneficial physical and biochemical properties of sphagnum peatmoss, including its superior water retention capacity, aeration, and ability to stimulate hormonal activity particularly growth regulators like cytokinins and gibberellins that are crucial for flower and fruit development. These findings align with those of Moneruzzaman *et al.* (2013), who reported that peat-based substrates positively influence the size and quality of flowers through hormonal and physiological enhancement. The improved flower size under October planting may be due to favorable environmental conditions during the early growth stages which allowed for extended vegetative development and better resource accumulation, ultimately contributing to larger floral organs. These results are consistent with the findings of Lakshmi *et al.* (2014) in African marigold and Sharma *et al.* (2015) in *Gaillardia*, where earlier planting dates significantly improved flower size due to optimal temperature and light conditions during critical growth periods. The maximum flowering duration (73.33 days) was recorded in treatment G_4P_1, comprising Cocopeat: Sand: FYM: Vermicompost (2:1:1:1) planted in the second fortnight of October. The superior performance of this treatment can be attributed to the favorable characteristics of cocopeat, which ensures optimal moisture retention

and aeration, and vermicompost, which enriches the medium with essential macro- and micronutrients. This combination creates an ideal root environment that supports sustained flower production over an extended period. These results are in accordance with the findings of Thakur and Grewal (2019) in chrysanthemum cv. 'Kikiobiory', where a growing medium containing cocopeat and FYM significantly extended the flowering period due to improved substrate aeration, moisture retention, and nutrient supply. The prolonged bloom period under October planting may be attributed to favorable climatic conditions during the early growth phase, which enhanced vegetative vigor and led to the development of robust floral structures capable of sustaining extended reproductive activity. The longer duration of flowering in early-planted calendula is also likely due to greater assimilate accumulation and better resource partitioning toward reproductive organs. These findings are supported by Lakshmi *et al.* (2014) in African marigold, where early transplanting resulted in prolonged blooming owing to improved physiological conditions and extended growth cycles.

Table 3 : Effect of growing media and planting dates on Flowering of Calendula

	Days to 50 % Flowering			Number of Flowers			Flower size (cm)			Duration of Flowering		
FACTOR	**P1**	**P2**	**MEAN**	**P1**	**P2**	**MEAN**	**P1**	**P2**	**MEAN**	**P1**	**P2**	**MEAN**
G1	78.27	81.93	80.09	27.54	26.06	26.80	5.20	4.68	4.94	55.55	51.88	53.72
G2	71.67	75.48	73.57	35.18	33.03	34.12	5.58	5.25	5.41	61.44	59.22	60.33
G3	77.26	73.08	75.17	33.23	35.09	34.16	5.66	5.49	5.57	60.44	56.33	58.38
G4	62.83	67.00	64.91	43.99	41.89	42.94	5.93	5.72	5.83	73.33	68.44	70.88
G5	72.59	72.63	72.61	27.37	28.53	27.97	5.74	5.40	5.57	62.78	67.77	65.27
G6	70.12	72.16	71.14	38.89	35.30	37.09	5.95	5.78	5.86	67.89	62.55	65.22
MEAN P	72.12	73.714		34.37	33.32		5.68	5.38		63.57	61.03	
	C.D.	**SE(d)**	**SE(m)**	**C.D.**	**SE(d)**	**SE(m)**	**C.D.**	**SE(d)**	**SE(m)**	**C.D.**	**SE(d)**	**SE(m)**
G	2.67	1.29	0.91	1.22	0.58	0.41	0.40	0.19	0.13	2.64	1.27	0.90
P	1.54	0.74	0.52	0.70	0.34	0.24	0.23	0.11	0.07	1.52	0.73	0.52
G X P	3.78	1.82	1.29	1.72	0.83	0.58	N/A	0.27	0.19	3.74	1.80	1.27

Conclusion

The present investigation clearly demonstrated that both growing media composition and planting dates had a significant impact on the vegetative and flowering performance of calendula. Among the treatments, the growing medium comprising Cocopeat: Sand: FYM: Vermicompost (2:1:1:1) (G_4), particularly when combined with the second fortnight of October planting (P_1), consistently outperformed all other treatments across most parameters. This combination (G_4P_1) resulted in the tallest plants, maximum plant spread, highest number of primary branches, earliest flowering, maximum number of flowers, and longest flowering duration while G_6P_1 produces larger flower size, The superior performance of the treatment (G_4P_1) can be attributed to the enhanced physical, chemical, and biological properties of the medium—such as better aeration, moisture retention, and nutrient availability—as well as the favorable climatic conditions prevailing during early October, which promoted robust vegetative growth and efficient reproductive development. The findings suggest that for optimal growth and floral yield in calendula under Bundelkhand conditions, a growing medium enriched with cocopeat and organic amendments, combined with early planting in October, offers the most promising results.

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