Bangladesh J. Bot. **51**(3): 417-424, 2022 (September) DOI: https://doi.org/10.3329/bjb.v51i3.61986

EFFECTS OF DIFFERENT MEDIA ON GROWTH AND FLOWERING TRAITS OF *CALENDULA OFFICINALIS* L.

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Keywords: Calendula, Growing media, Cocopeat, Vermicompost, Vermiculite

Abstract

Effects of eight different potting media compositions on growth and flowering traits of Calendula was studied. Among different media compositions, T5 have positive effect on root length (18.33 cm), number of leaves (62.77) and number of branches (9.12) per plant while T3 was found to be best for root spread (14.10 cm) and plant spread (22.67 cm). Calendula plants raised in T5 exhibited maximum (6.10 cm) flower diameter and flower bud diameter (1.40 cm), took minimum days (66.39) for flower bud initiation and also for flower bud opening (74 days). Maximum number of flower buds and flowers per plant were recorded in T2. The growth and flowering of Calendula was found superior in media composition of vermicompost and cocopeat.

Introduction

Calendula (*Calendula officinalis* L.) commonly known as pot marigold is popular free blooming herbaceous annual belonging to Asteraceae and believed to be native of Southern Europe. It blooms quickly from seed in bright yellows, gold and orange flowers heads. From a long time, Calendula is being utilized as bedding plant, pot plant, cut flower, loose flower, border plant and in medicinal, food and cosmetic preparations in Indian culture.

Cultivation of foliage ornamental plants contributes to the biggest segment of the floriculture industry followed by potted flowering and nursery plants, flowering bulbs and other plant material for propagation purposes (Dole and Wilkins 2005). Growing media or components for potting soil mixtures have gained popularity from several decades and have been successfully used in the cut flower industry with an aim to intensify the commercial production. The use of different growing media offers a valuable alternative to conventional use of soil for quality flower production due to their good water holding capacity, aeration and nutrient status. Several studies advocated that it is much easier to handle soilless growing media and it is also good for growth and development of plants as compared to soil environment (Yasmeen *et al* 2012). Soil media *i.e*. peat can be substituted by synthetic fertilizers without any negative effects on ornamental plants growth and development raised in these substrates. Diverse mineral substrates have distinctive traits which could have direct or indirect effects on plant growth and development (Abad *et al* 2002, Linderman and Davis 2003). Similarly, perlite and clay were incorporated with peat and compost as a part of growing medium. It was determined that growing media statistically affected morphological and reproductive attributes (Savvas *et al* 2004, Ghazvini *et al* 2007). Diversified composition of growing media has a profound effect on physical, chemical and biological properties of the substrate. This diversified composition also alters the activities of microorganisms which ultimately decreases the nitrogen losses and increases the cation exchange

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capacity (Alidoust *et al* 2012, Younis *et al* 2013a). Compost or mixture of these substrates acting as an excellent soil conditioner applied in different ratio had significant effects on plant biomass (Arancon *et al* 2004, Younis *et al* 2011), number of leaves (Eklind *et al* 2001), chlorophyll index (Hashemimajd *et al* 2004), plant fresh and dry weight (Wang and Lin 2006), and greater availability of mineral nutrients to plants (Zaller 2009). However, particular scientific findings regarding this specific ornamental plant are insufficient. Therefore, keeping in view the aesthetic importance of the calendula and role of substrates in its growth, the current study was planned to check the efficacy of diversified composed growing media in different proportions for the growth, physiology and quality characters of the calendula plant.

Materials and Methods

The present investigation was carried out at Department of Floriculture and Landscape Architecture, BUAT, Banda, Uttar Pradesh, India during December, 2019 to April, 2020. A total of 8 treatments were prepared by mixing various components in different ratios:

T_1= Soil +Sand +FYM (2:1:1)
T_2= Soil +Sand +Vermicompost (2:1:1)
T_3= Soil +Sand +Vermicompost+ Cocopeat (1:1:1:1)
T_4= Cocopeat +Perlite + Vermicompost (2:1:1)
T_5= Cocopeat + Vermicompost + Vermiculite (2:1:1)
T_6= Cocopeat +Perlite + Leaf Mould (2:1:1)
T_7= Cocopeat + Vermicompost + Leaf Mould (2:1:1)
T_8= Soil + Leaf Mould +Sand (2:1:1)

The cocopeat bricks were saturated by keeping in water overnight in the container. The saturated bricks were beaten with a wooden rod to ensure homogenous mixture without any clods or foreign particles. The growing media was then filled in plastic pots (diameter-15cm, Length-15cm). Proper care was taken for uniform filling of media mixtures into all pots by tapping to maintain equal compaction levels. The pots were saturated with water immediately after filling to ensure settling down of media mixtures. The basic characteristics of different growing media have been presented in Table 1. One seedling per pot of Calendula was transplanted into pots with thrice replication in open condition. One plant per pot was allowed to grow and develop till maturity. The chemical fertilizer NPK (20:20:20) was applied after one month from transplanting and then at two weeks interval until reaching the flowering stage. Weeding was done manually with hand hoe and plants were inspected daily. The pots were irrigated once a week during the months of December to February and twice a week during March to April (due to temperature fluctuations) with 5 cm of irrigation water. The mean temperature during the course of experiment varied from 5-34^{o}C. Dried, shrivelled buds/flowers were periodically removed to encourage more bud initiation for longer duration of flowering with quality blooms.

The air dried growth media were used for estimation of pH (1:2 media: water suspension) using pH meter, electrical conductivity (1:2 media: water suspension) using EC meter (Jackson 1973). Organic carbon (%) was determined by wet digestion method (Walkley and Black 1934), total nitrogen (%) by the Kjeldahl method (Asija *et al* 1956) and total phosphorus determined by spectrophotometer. Total K, Ca, Mg, Na was estimated by Flame Photometer. Diethylenetriamin penta acetic acid (DTPA) extractable Zn, Fe, Cu and Mn were determined in media samples by Atomic Absorption Spectroscopy (AAS).

Plant growth parameters such as root length, root spread, number of branches per plant, number of leaves per plants, plant spread, plant height, stem diameter and floral parameter such as

flower diameter, flower bud diameter, number of buds per plant, number of flowers per plant, days taken to flower bud initiation and first flower opening were recorded at full bloom stage. Days to flowering duration were recorded from the appearance of 50% buds showing colour till 50% of the inflorescence showing withering.

Results and Discussion

The physico-chemical characteristics *viz.* Soil pH, EC and chemical characteristics *viz.* total organic carbon, total nitrogen, phosphorus, potassium, Calcium, Magnesium, Sodium, Iron, Manganese, Copper and Zinc were found to differ greatly among different treatments (Table 1). Cocopeat containing growing media recorded more total organic carbon over other media compositions. The media composition comprising Cocopeat +Perlite + Vermicompost (2 : 1 : 1) in T4 recorded highest total organic carbon (22.73%) and Soil + Leaf Mould +Sand (2 : 1 : 1) in T8 exhibited the lowest organic carbon (5.94%). The maximum value of total nitrogen (0.81%), total phosphorus (0.13%) and total potassium (1.41%) was obtained in T5 [Cocopeat + Vermicompost + Vermiculite (2 : 1 : 1)], whereas minimum values (0.28, 0.077, 0.44%) were recorded in T1 [Soil +Sand +FYM (2 : 1 : 1)], respectively.

The media compositions significantly ($p < 0.05$) influenced the root length (cm), root spread (cm), number of leaves per plants, number of branches per plant, plant height (cm), plant spread (cm) and stem diameter (cm) of calendula plant (Table 2). The highest root length (18.33 cm) was recorded at full bloom stage in media composition T5 followed by media composition T3 (17.50 cm) and T4 (16.37 cm). The lowest root length (13.13 cm) was found in media composition T7. However, T8 was significantly different from T6 and T1 while at par with T7 and T2.

Root spread (cm) exhibited significant variation among different growing media compositions (Fig. 1). Maximum root spread (14.10 cm) was observed in plants grown in media composition T3 followed by media T8 and T1 recording 11.23 cm and 11.17 cm, respectively. However, minimum root spread (8.50 cm) was recorded in calendula plants raised in treatment T7, followed by T5 (8.83 cm) and T6 (8.87 cm). The root growth parameters *i.e.* root length and root spread were found better in treatments containing Vermicompost and cocopeat. The superiority of this composition over other media compositions could be due to high phosphorus content (0.13%) and water holding capacity that enhances the root length and root spread. The results are in agreement with the findings of Singh *et al*. (2015).

Among different treatments, T5 showed significantly more number of leaves per plant than other treatments. Plants grown in media composition maximum leaves per plant (62.77) were recorded in T5 followed by T4 and T2 each recorded 57.63 and 52.43 leaves/plant, respectively. The minimum number of leaves per plant (11.77) was observed in T7. More number of leaves might be due to high nutritional status of vermicompost and cocopeat residues. It could be hypothesized that using organic substrates may increase the aeration, which influences N mineralization (Succop and Newman 2004).

Number of branches per plant was significantly different among different soil media compositions. Maximum number of branches per plant (9.12) was recorded in media composition T5 followed by T3 (6.85) and T2 (5.72). However, minimum branches per plant (1.37) were found in media composition T7 which was statistically at par with T6 (1.68). This might also be due the organic fertilization and other factors during crop raising. The other possible reason might be the organic matter and aeration of media that facilitated the root growth that leads to more uptake of water and nutrients.

Table 1. Physico-chemical characteristics of different growth media compositions.

Treatments	Soil pH	EC (dS/m)	OC	Total N	Total P	Total K	Total Ca	Total Mg	Total Cu	Total Fe	Total Mn	Total Zn	Total Na
			%								ppm		
T1	7.26	0.28	7.45	0.28	0.077	0.44	3.23	0.46	19.36	108.12	260.13	77.44	521.50
T2	7.24	1.36	8.72	0.50	0.09	0.88	2.04	0.30	21.4	120.56	251.89	81.14	1593.00
T3	7.41	1.70	15.58	0.45	0.095	0.86	1.74	0.55	20.57	102.67	1130.3	71.39	1855.80
T4	7.15	2.91	22.73	0.60	0.12	0.85	0.85	0.40	14.63	51.35	229.82	62.86	2876.50
T5	6.54	3.37	22.16	0.81	0.13	1.41	1.40	2.38	14.87	197.88	271.43	78.83	2081.50
T6	6.64	1.84	21.62	0.50	0.085	0.62	0.62	0.50	9.71	74.92	132.39	77.72	2214.40
T7	6.61	2.17	22.45	0.60	0.085	0.99	0.51	1.36	14.23	151.11	250.7	97.88	1129.26
T8	7.35	0.34	5.94	0.49	0.12	0.48	2.90	0.53	21.02	102.42	287.18	76.47	536.30

Where EC: Electrical conductivity, OC: Organic carbon

Table 2. Effects of different growing media combinations on vegetative parameters of Calendula.

Treatments	Root length (cm)	Root spread (cm)	No. of leaves/plant	No. of branches/plant	Plant height (cm)	Plant spread (cm)	Stem diameter (cm)
T1	٤.54	11.17	٤.37	5.48	9.20	17.70	0.37
T2	٤.27	10.03	٤.43	5.72	12.80	22.02	0.40
T3	٦.50	14.10	٤.20	6.85	9.87	22.67	0.35
T4	٤.37	10.13	٦.63	5.05	9.60	20.05	0.30
T5	٤.33	8.83	٤.77	9.12	10.50	19.68	0.35
T6	٤.83	8.87	٤.13	1.68	6.03	14.82	0.28
T7	٤.13	8.50	.77	1.37	3.70	11.77	0.30
T8	٤.32	11.23	٥.01	3.88	12.23	20.37	0.33
C.D @5%	.47	0.33	.60	1.91	3.11	4.84	0.13

Plant spread recorded in calendula plants showed significant differences among different growing media compositions. The highest plant spread (22.67 cm) was observed in plants grown in media composition T3 followed by media T2 and T8 which showed plant spread of 22.02 cm and 20.37 cm, respectively. However, minimum plant spread (11.77 cm) was recorded in plant raised in media composition T7 which was at par with T6 which showed plant spread of 14.82 cm.

An effects of different growth media compositions on stem diameter of calendula was not observed significant. The maximum stem diameter (0.40 cm) was observed in T2 followed by T1 (0.37 cm). The maximum vegetative attributes *i.e.* number of leaves per plant, number of branches per plant, plant spread and root length were recorded in T5 which is due to the highest total N (0.81%), total P (0.13%) and total K (1.41%) content which corresponds to high photosynthetic activity, root enlargement and cell formation in plants, thereby exhibiting abundant vegetative growth, better plant spread and root development. Significant higher growth parameters could only be achieved by the combination of soil and cocopeat, while these growth parameters could be increased once the treatment of vermicompost was introduced. This can be explained by calendula's soil pH tolerance i.e. pH values of different potting media were suitable for its growth. Calendula plants may have received additional nutrients, especially P, K and micronutrients from the vermicompost and other organic substances (Gong *et al*. 2018).

Fig. 1. Effects of growing media compositions on root growth attributes of pot Calendula.

The different media compositions significantly ($p < 0.05$) influenced flower bud diameter, flower diameter, number of buds per plant, number of flowers per plant, days taken to flower bud initiation and days taken to first flower opening (Table 3). Different potting growth media

composition showed significant influence on flower bud diameter. It was significantly higher in media composition T5 (1.40 cm) followed by T4 (1.33 cm) and T3 (1.17 cm). The minimum flower bud (1.03 cm) was obtained from plants grown in T2. However, the effect of these media compositions on flower bud diameter was found to be at par with T7, T6, T1 and T8. Similar findings were reported by Dubey *et al.* (2013) revealing a significant positive effect of vermicompost on flower bud diameter in Petunia.

Similar trend was also observed in diameter of flower which was affected by different potting media combinations. Results revealed that the maximum flower diameter (6.10 cm) was exhibited by the plants grown in T5 which was statistically at par with T3 (5.53 cm) and T8 (5.10 cm). On the other hand, the narrowest flower diameter (4.37 cm) was found from plants grown in T2. This was due to the fact that in T5, T3 and T8 treatments the excess food reserves diverted to only a fewer sinks (flowers) and hence bigger flowers were produced. The results are in confirmation with the findings of Jamil *et al.* (2016). The results are more or less similar to the observations made by Atiyeh *et al.* (2000). They have reported the effects of vermicompost on the growth and productivity of greenhouse tomatoes and marigolds.

Table 3. Effects of different growing media combinations on flowering traits of Calendula.

Treatment	Flower bud diameter (cm)	Flower diameter (cm)	No. of buds/ plant	No. of flowers/ plant	Days taken to flower bud initiation	Days taken to first flower bud opening
T1	1.13	4.53	4.04	4.23	68.24	78.72
T2	1.03	4.37	11.24	11.13	67.33	77.08
T3	1.17	5.53	7.89	7.62	66.43	76.58
T4	1.33	4.93	4.78	4.84	66.97	75.50
T5	1.40	6.10	4.23	4.00	66.39	74.00
T6	1.10	4.40	2.42	2.53	75.93	86.87
T7	1.05	4.50	2.55	2.52	77.38	88.68
T8	1.13	5.10	4.70	4.68	79.20	90.57
C.D @5%	0.33	1.23	1.88	2.01	5.46	4.47

Significant effect of growth media on number of buds per plants were also observed in calendula. Maximum number of buds per plant were observed in T2 (11.24) followed by T3 (7.89). However, minimum buds per plants were observed in T6 (2.42). Likewise, number of flowers per plant was also significantly influenced by different growth media compositions. The media composition T2 recorded highest number of flowers per plants (11.13) followed by T3 (7.62). Similarly, minimum number of flowers was also observed in T7 (2.52). However, the effect of these media compositions on both number of bud per plants and number of flowers per plant was found to be at par with T7, T1 and T5.

Time taken for first flower bud initiation is an important character which decides early flower yield. The significant variation was observed in days required to flower bud appearance by different growth media. However, the earliest flower bud initiation (66.39 days) was found in T5 which were closely followed by T3 (66.43 days) and T4 (66.97 days). Growing media composition T8 and T7 took maximum number of days (79.20 and 77.38) to flower bud initiation

respectively, followed by media composition T6. However, among these media composition, only T5 differed significantly from T6, T7 and T8.

Similarly, growth media combination T5 recorded minimum number of days to opening of first flower bud (74 days) followed by media T4 and T3 with 75.50 days and 76.58 days to first flower bud opening from the date of transplanting, respectively. Media composition T8 took maximum (90.57 days) number of days to first flower bud opening followed by T7. The time taken to first flower bud opening was delayed with cocopeat based media, which could be due to higher availability of nitrogen in these media combinations, which encourages the vegetative growth with delay in reproductive stage (Thakur and Grewal 2019).

Results showed that the potting mixture had a significant effect on physical and chemical properties of growing media. Among different media combinations, T5 recorded maximum root length (18.33 cm), number of leaves (62.77) and number of branches per plant (9.12) while T3 was found to be best for root spread (14.10 cm) and plant spread (22.67 cm). Calendula plants raised in the growing media T5 exhibited more flower diameter (6.10 cm), flower bud diameter (1.40 cm), minimum days taken for flower bud initiation (66.39 days) and flower bud opening (74.00 days). Growth media combination in T2 recorded maximum number of flower buds and flower per plant.

So, it may be concluded that the cocopeat and vermicompost based media composition has significant effects on the growth and productivity of calendula plants as it has higher nutritional value and synergistic effect. The present findings suggest that for quality flower production of potted calendula plants, growing media composition of Cocopeat + Vermicompost + Vermiculite (2:1:1) in T5 is best with better plant morphological development and sustained quality flower production. The use of such type of growing media with appropriate nutrient dose, faster growth and flowering of calendula plants may be achieved.

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(Manuscript received on 15 December, 2021; revised on 18 May, 2022)