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Effect of potting mixture and pot size on growth and flowering of calendula

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Abstract

A field experiment entitled "Effect of potting mixture and pot size on growth and flowering of Calendula" was conducted at Floriculture Unit, Horticulture Section, College of Agriculture, Nagpur during *rabi* season of 2019-20. The experiment was laid out in Factorial Completely Randomized Design with 27 treatment combinations, replicated thrice. The treatments consisted of nine potting mixtures *viz.*, Garden Soil, Garden Soil + Sand (2:1), Garden Soil + FYM (2:1), Garden Soil + Vermicompost (2:1), Garden Soil + Cocopeat (2:1), Garden Soil + Sand + FYM (2:1:1), Garden Soil + Sand + Vermicompost (2:1:1), Garden Soil + Sand + Cocopeat (2:1:1) and Garden Soil + FYM + Vermicompost + Cocopeat (2:1:1:1) and three pot sizes of 12.5 cm height × 12.5 cm diameter, 15 cm height × 15 cm diameter and 17.5 cm height × 17.5 cm diameter. The potting media comprising of Garden Soil + FYM + Vermicompost + Cocopeat (2:1:1:1) took minimum days for germination (4.11 days), highest germination percentage (85.56 %), maximum plant height (29.72 cm), number of leaves plant⁻¹ (67.96), leaf area (60.42 cm²), branches plant⁻¹ (17.53), plant spread (33.53 cm), minimum days to first flower bud initiation (34.85 days) and days to opening of flower from bud emergence (7.62 days). Whereas, minimum days to 50 % flowering (54.69 days) was obtained in Garden Soil + FYM. As regards the effects of pot sizes, 17.5 cm height × 17.5 cm diameter pots exhibited, maximum plant height (23.03 cm), number of leaves plant⁻¹ (44.13), leaf area (60.03 cm²), branches plant⁻¹ (13.67), plant spread (31.67), whereas, minimum days to first flower bud initiation (47.68 days), minimum days to opening of flower from bud emergence (9.56 days) and days to 50 % flowering (68.52 days) was observed with 12.5 cm height × 12.5 cm diameter pot size.

Keywords: Calendula, potting mixture, pot size, growth, flowering

Introduction

Calendula (*Calendula officinalis* L.) is grown for its beautiful flowers, edible petals and many medicinal uses of its flowers, stem and leaves. It is a member of Asteraceae and Daisy family. It is originated in South Europe. The plant prefers sunny situations and well drained rich soil. It can be grown as a winter seasonal at the places having mild climate. The plants are very popular for growing in beds as well as pot plants, as a cut flower and also grown in window boxes. Potted calendulas are a popular choice for beautification of the living space, balconies and patios. It can also be arranged or grouped in ground beds and lawns.

The survival of the plant usually depends upon the favourable environmental factors; growing media is one of the most important factors required for the survival and production of good quality pot calendula. The selection of media is an important factor as a good medium should serve as reservoir for plant nutrients, provide support for plant growth, hold water for availability to the plant and facilitate exchange of gases between roots and atmosphere above the root medium.

Container size also plays an important role in manipulating the growth, development and flowering besides the presentability of potted plants. The container size alters the rooting volume of the plants. This in turn greatly affects plant growth and flowering as well. In general, as container size increases, leaf area, shoot biomass and root bio-mass increase linearly (Cantliffe, 1993).

Hence, the present experiment was carried out to study the effect of different potting mixture and pot size on growth and flowering of potted calendula.

Material and Methods

A field experiment was carried out at Floriculture Unit, Horticulture Section, College of Agriculture, Nagpur during *rabi* season of 2019-20 to study the effect of potting mixture and pot size on growth and flowering of calendula. Present experiment consists of nine potting mixture *viz.*, M₁ - Garden Soil, M₂ - Garden Soil + Sand (2:1), M₃ - Garden Soil + FYM (2:1), M₄ - Garden Soil + Vermicompost (2:1), M₅ - Garden Soil + Cocopeat (2:1), M₆ - Garden Soil

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+ Sand + FYM (2:1:1), M₇ - Garden Soil + Sand + Vermicompost (2:1:1), M₈ - Garden Soil + Sand + Cocopeat (2:1:1), M₉ - Garden Soil + FYM + Vermicompost + Cocopeat (2:1:1:1) and three pot sizes i.e. S₁ - 12.5 cm height × 12.5 cm diameter, S₂ - 15 cm height × 15 cm diameter, S₃ - 17.5 cm height × 17.5 cm diameter in Factorial Completely Randomized Design with 27 treatment combinations, replicated thrice. Nine potting mixtures were prepared after thoroughly mixing of various ingredients on volume by volume basis and pots filled with different potting mixture and seeds of calendula were sown. Calendula plants were regularly watered once a day by water can. Observations were recorded for various growth and flowering parameters in calendula.

Results and Discussion:

Effect of potting mixture and pot size on growth:

Days required for germination: Minimum days required for germination (4.11 days) was observed in potting mixture Garden soil + FYM + Vermicompost + Cocopeat (2:1:1:1), while maximum (5.78 days) was recorded in Garden soil. The reason for the better performance of vermicompost with farm yard manure, cocopeat and garden soil might be probably high organic matter content of the media, which would have increased the water and nutrient holding capacity of the medium, and improved water utilization capacity of the plant. Vermicompost boosts the nutrients available to plants and enhances soil structure and drainage. Similar results were reported by Verma and Singh (2015) in pyrethrum. The higher available well decomposed organic matter of media would have preserved soil humidity, increased nutrient content and improved soil structure which increased water absorption and maintained the cell turgidity, cell elongation and increase respiration at optimum level, leading to favourable seed sprouting. The effect, due to pot size on days required for germination was found to be non-significant. However, earliest germination was observed in pot size 15 cm × 15 cm in (4.96 days) and delayed in pot size S₁ and S₃.

Data presented in the Table 1 revealed that, the interaction effect of potting mixture and pot size on days required for germination of calendula seeds was found to be non-significant.

Germination percentage (%): Maximum germination (85.56 %) was recorded in potting mixture Garden soil + FYM + Vermicompost + Cocopeat (2:1:1:1). While minimum (65.00 %) was recorded in Garden soil. The present findings might be due to beneficial effect of combination of different media leading to improved physical, biological and chemical properties of media. Soil provides natural support to plant, cocopeat given warm condition, high water holding capacity and vermicompost as a source of organic manure provided better nutrition to the germinating seedlings (Hartmann and Kester, 1997). Vermicompost and soil provides a uniform physical structure which ensures close contact between seeds and media, increased balanced moisture supply, facilitates root respiration and encourages overall plant growth (Chatterjee and Choudhari, 2007) [5]. It exhibits a beneficial effect on soil health which might have enhanced the seed germination. More or less similar findings are supported by Verma and Singh (2015) in pyrethrum. The effect due to pot size on days required for germination percentage was found to be non-significant. However, highest germination (76.30 %) was observed in pot size 15 cm × 15 cm and lowest (74.26 %) in pot size S₁.

The interaction effect of potting mixture and pot size on germination percentage was found to be non-significant.

Plant height (cm): The data in respect of plant height was recorded at 60 DAS. Significantly maximum plant height (29.72 cm) was recorded in potting mixture Garden soil + FYM + Vermicompost + Cocopeat (2:1:1:1). While minimum (9.13 cm) was recorded in potting mixture Garden soil + Sand + Cocopeat (2:1:1). An increase in vegetative growth in terms of plant height mainly due the fact that, potting mixture combination had lower down clay content and compactness of potting mixture. This improved drainage, aeration, water holding capacity and highest nutrients uptake by root system. Similar results were reported by Bala and Singh (2013) [2] in chrysanthemum, Thakur *et al.* (2013) [17] in calendula, Kameshwari *et al.* (2014) [12] and Kala *et al.* (2020) [11] in chrysanthemum.

Plant height increased significantly with increase in pot size. Maximum plant height (23.03 cm) was recorded in pot size 17.5 cm height × 17.5 cm, while minimum (17.62 cm) was observed in 12.5 cm height × 12.5 cm diameter pot size at 60 days after sowing. This might be due to the reason that bigger pot size could have accommodated more amount of potting mixture that has been helpful in providing sufficient nutrients and space for growth of adequate root system thus resulting in better growth of plants which in turn grow longer. The present results are in agreement with the findings of Gupta and Dilta (2015) [9] in *Primula malacoides* Franch and Dilta *et al.* (2019) [7] in azaleas.

The interaction effect of different potting mixture and pot size on plant height was found to be significant.

Leaves plant⁻¹: Maximum leaves plant⁻¹ (67.96) was recorded in potting mixture Garden soil + FYM + Vermicompost + Cocopeat, while minimum (6.24) was recorded in Garden soil + Sand + Cocopeat (2:1:1) at 45 days after sowing. The present findings might be due to better aeration, water holding capacity, source of nutrient provide nitrogen in available form which increase root spread and plant growth ultimately increase number of leaves per plant. The results are in confirmation with the findings of Barreto and Jagtap (2002) [3] and Thangam *et al.* (2009) in gerbera.

Maximum leaves plant⁻¹ (44.13) was recorded in pot size of 17.5 cm height × 17.5 cm diameter and minimum leaves plant⁻¹ (20.75) was observed in 12.5 cm height × 12.5 cm diameter. This might be due to large sized pots developed very effectual root system hence produced taller plants with maximum leaf number. This characteristic was affected negatively as the pot size decreased. The reason could be when roots growth is confined; they compete for essential resources, increased root mass and decreased rooting space that leads to competition for available oxygen. These results corroborate the previous findings of Alhajhoj (2017) [1] in *Gladiolus*.

The interaction effect of different potting mixture and pot size on leaves plant⁻¹ was found to be significant.

Leaf area: Maximum leaf area of plant (60.42 cm²) was recorded in potting mixture of Garden soil + FYM + Vermicompost + Cocopeat (2:1:1:1) and minimum leaf area (46.03 cm²) was recorded in Garden soil + sand + Cocopeat (2:1:1). This may be due to the favourable physiochemical properties and high nutrient content of the potting mixture that supported proper growth of plants. This is probably due to the vigorous and healthy growth of the plant growing in the

substrates. Similar results were observed by Panj (2012)^[15] in gerbera.

Pot size of 17.5 cm height × 17.5 cm diameter exhibited maximum leaf area (60.03 cm²) and minimum leaf area of plant (47.17 cm²) was recorded in 12.5 cm height × 12.5 cm diameter pot size. In this study leaf area was increased by increasing pot size. The reason for lower leaf area is the production of less and smaller leaves in smaller pots. Van Iersel (1997)^[19] stated that the decrease in root size reduces the leaf area of salvia.

The interaction effect of different potting mixture and pot size on leaf area was found to be significant.

Branches plant⁻¹: Maximum number of branches plant⁻¹ (17.53) was obtained in potting mixture Garden soil + FYM + Vermicompost + Cocopeat (2:1:1:1). Whereas, significantly minimum number of branches plant⁻¹ (4.08) was recorded in Garden soil + Sand + Cocopeat (2:1:1). This might be due to the potting mixture combination of Soil, FYM, Vermicompost and cocopeat which has provided optimal conditions like proper aeration and drainage, water holding capacity and nutrients required for the better growth of plant resulting in more production of branches per plant. These results are in confirmation with the findings of Thakur *et al.* (2013)^[17] in calendula and Nair and Bharthi (2015)^[14] in chrysanthemum. Significantly maximum branches plant⁻¹ (13.67) was recorded in big pot size 17.5 cm height × 17.5 cm diameter and minimum branches plant⁻¹ (8.48) was recorded in small size

pots of 12.5 cm height × 12.5 cm diameter. The present findings might be due to root restriction in small size pot branching of shoots decreases as roots did not get sufficient space for their growth besides the fact that the small pots could accommodate less substrate so failed to provide requisite growing conditions and hence in small size pots number of branches or shoots per plant was less and on the contrary, more branches were produced in the larger size pots due to availability of more space and higher amount of potting media which provided superior physico-chemical and biological properties for the growth of calendula. Similar results were also observed by Van Iersel (1997)^[19] in *Salvia splendens*, Thapa *et al.* (2015)^[18] and Dilta *et al.* (2019)^[7] in azaleas.

The interaction effect of different potting mixture and pot size on branches plant⁻¹ was found to be significant.

Plant spread: Maximum plant spread (33.53 cm) was recorded in potting mixture Garden soil + FYM + Vermicompost + Cocopeat (2:1:1:1) and minimum plant spread (21.76 cm) was recorded in Garden soil + Sand + Cocopeat (2:1:1). From above finding maximum plant spread is due to high carbon content corresponds to high photosynthetic activity and cell formation in plants, thereby exhibiting abundant vegetative growth and better plant spread (Thakur *et al.* 2013)^[17]. Similar results were obtained by Bala and Singh (2013)^[2] and Kameshwari *et al.* (2014)^[12].

Table 1: Effect of potting mixture and pot size on growth parameters of calendula

Treatments	Days required for germination (days)	Germination percentage (%)	Plant height (cm)	Leaves plant ⁻¹	Leaf area (cm ²)	Branches plant ⁻¹	Plant Spread (cm)
Potting mixture (M)							
M ₁	5.78	65.00	14.02	12.73	50.50	8.16	23.17
M ₂	5.56	69.44	17.04	14.13	51.54	9.42	24.22
M ₃	5.33	72.22	22.45	33.34	54.45	12.82	26.09
M ₄	4.56	83.89	27.97	60.33	58.54	15.84	29.92
M ₅	4.33	74.44	10.63	8.02	47.19	4.53	21.84
M ₆	5.44	73.89	24.51	39.53	55.19	12.13	24.74
M ₇	5.33	79.44	25.62	37.96	56.82	14.69	27.52
M ₈	4.78	76.11	9.13	6.24	46.03	4.08	21.76
M ₉	4.11	85.56	29.72	67.96	60.42	17.53	33.53
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±	0.18	0.95	0.27	0.50	0.33	0.35	0.39
C D at 5%	0.51	2.71	0.79	1.44	0.94	1.00	1.12
Pot size							
S ₁	5.04	74.26	17.62	20.75	47.17	8.48	21.26
S ₂	4.96	76.30	19.72	28.54	53.03	10.93	24.67
S ₃	5.04	76.11	23.03	44.13	60.03	13.67	31.67
F test	N.S.	N.S.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E. (m) ±	0.10	0.55	0.16	0.29	0.19	0.20	0.22
CD at 5%	-	-	0.45	0.83	0.54	0.58	0.64
Interaction M X S							
F test	N.S.	N.S.	Sig.	Sig.	NS	Sig.	Sig.
S.E. (m) ±	0.38	0.05	0.59	1.07	0.70	0.75	0.84
CD at 5%	-	-	1.68	3.06	-	2.13	2.38

Maximum plant spread (31.67 cm) was recorded in 17.5 cm height × 17.5 cm diameter pot size Whereas, minimum plant spread (21.26 cm) was recorded in 12.5 height × 12.5 diameter pot size.

The maximum plant spread in big pot size is due to more amount of potting media, that have assured optimum physico-chemical properties besides providing sufficient space for development of better root system. Our findings are in close agreement with the earlier work of Biermann (1982)^[4] in

cyclamen, Vernieri *et al.* (2003)^[20] in sunflower and Dilta *et al.* (2019)^[7] in potted azaleas.

The interaction effect of different potting mixture and pot size on plant spread was found to be significant.

Effect of potting mixture and pot size on flowering parameters

Days to first flower bud initiation: The data presented in Table 2 reveal that minimum days to first flower bud

initiation (34.85 days) were recorded in potting mixture Garden soil + FYM + Vermicompost + Cocopeat. Whereas, maximum days to first flower bud initiation (72.69 days) was observed in Garden soil + Sand + Cocopeat (2:1:1). 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 Barreto and Jagtap (2002) [3] in gerbera and Thakur *et al.* (2013) [17].

Minimum days to first flower bud initiation (47.68 days) was recorded in 12.5 cm height × 12.5 cm diameter pot size and maximum days to first flower bud initiation (51.13 days) was recorded in 17.5 cm height × 17.5 cm diameter pot size. As the pot size increases, days to flower bud initiation increases linearly mainly due to the fact that the plants grown in large containers could put up more vegetative growth particularly lateral shoots which required more time for development of reproductive buds hence delay in production of flower buds. Similar findings have also been reported by Vernieri *et al.* (2003) [20] in sunflower, Gupta (2013) [8] in *primula malacoides* Franch.

The interaction effect of different potting mixture and pot size on days to first flower bud initiation was found to be significant.

Days to opening of flower from bud emergence:

Significantly minimum days to opening of flower from bud emergence (7.62 days) was recorded in potting mixture of Garden soil + FYM + Vermicompost + Cocopeat (2:1:1:1) and maximum days to opening of flower from bud emergence (12.11 days) was recorded in Garden soil + Sand + Cocopeat (2:1:1). The present findings might be due to the same treatments recorded early flower bud initiation rather than others. Similar results were also observed by Kumar (2007) [13] and Chauhan *et al.* (2014) [6] in gerbera.

Minimum days to opening of flower from bud emergence (9.56 days) was recorded 12.5 cm height × 12.5 cm diameter pot size and maximum days to opening of flower from bud emergence (10.84 days) was recorded in 17.5 cm height × 17.5 cm diameter pot size. This might be due to the reason that the plants grown in smaller pots failed to put up vigorous vegetative growth and as a result there was early induction of reproductive buds which later turns into flowering. Schenk and Brundert (1979) [16] have also opined that in small size pots growth was less vigorous, hence occurrence of early flowering. Similar findings of results were also reported by Gupta (2013) [8] in *primula malacoides* Franch.

The interaction effect of different potting mixture and pot size on days to opening of flower from bud emergence was found to be significant.

Days to 50 per cent flowering: Significantly minimum days for 50 per cent flowering (54.69 days) was recorded in potting mixture Garden soil + FYM (2:1:) and maximum days to 50 per cent flowering (86.53 days) was recorded in Garden soil + Sand + Cocopeat (2:1:1). Similar finding of results were also reported by Jawaharlal *et al.* (2001) [10] in anthurium.

Significantly minimum days to 50 per cent flowering (68.52 days) was recorded in pot size of 12.5 cm height × 12.5 cm diameter and maximum days to 50 per cent flowering (73.68 days) was recorded in 17.5 cm height × 17.5 cm diameter pot size. This might be due to more number of flowers produced in larger pots as compared to relatively smaller pots which resulted in more number of flowers remaining open at a time.

It is a well proven fact that there is a linear relationship between pot size, vegetative growth and flowering of plants. As the pot size increases, there is a corresponding increase in the growth and flowering attributes of plant and vice versa.

Data presented in the table 2 revealed that, the interaction effect due to potting mixture and pot size on days to 50 per cent flowering was found non-significant.

Table 2: Effect of potting mixture and pot size on flowering parameters of calendula

Treatments	Days to first flower bud initiation (days)	Days to opening of flower from bud initiation (days)	Days to 50 per cent flowering (days)
Potting mixture (M)			
M ₁	53.79	11.38	77.04
M ₂	52.57	11.13	74.13
M ₃	42.61	9.78	54.69
M ₄	36.07	7.93	68.24
M ₅	66.23	12.04	85.04
M ₆	43.59	10.16	58.16
M ₇	42.04	9.16	65.69
M ₈	72.69	12.27	86.53
M ₉	34.85	7.62	71.42
F Test	Sig.	Sig.	Sig.
S.E. (m) ±	0.36	0.12	0.30
C D at 5%	1.02	0.35	0.87
Pot size (S)			
S ₁	47.68	9.56	68.52
S ₂	49.34	10.09	71.45
S ₃	51.13	10.84	73.68
F test	Sig.	Sig.	Sig.
S.E. (m) ±	0.20	0.07	0.17
CD at 5%	0.58	0.20	0.50
Interaction M X S			
F test	Sig.	Sig.	N.S.
S.E. (m) ±	0.76	0.26	0.65
CD at 5%	2.16	0.74	-

Conclusion

From the present study, it may be concluded that different potting mixtures and pot size has significantly affected growth and flowering parameters of calendula. Garden soil + FYM + Vermicompost + Cocopeat (2:1:1:1) with big pot size 17.5 cm height × 17.5 cm diameter attained maximum plant height, leaves plant⁻¹, leaf area, branches plant⁻¹ and plant spread. Whereas, Garden soil + FYM + Vermicompost + Cocopeat (2:1:1:1) with small pot size of 12.5 cm height × 12.5 cm diameter recorded minimum days to first flower bud initiation, days to opening of flower from bud initiation and days to 50 per cent flowering.

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