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INFLUENCE OF PLANTING CONTAINERS ON GROWTH ATTRIBUTES OF CHRYSANTHEMUM (*DENDRANTHEMA GRANDIFLORA*) CV. MULTIFLORA UNDER LOW HILLS OF UTTARAKHAND INDIA

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ABSTRACT

A study was conducted to standardize the type of container suitable for planting chrysanthemum. An investigation entitled "Influence of various planting containers on the growth attributes of chrysanthemum (*Dendranthema grandiflora*) cv. 'Multiflora' under low hills of Uttarakhand" was performed during the year 2022-23 at the Horticulture nursery, Horticulture Research Block, Department of Horticulture, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India. The study aimed to standardize the type of container for potted chrysanthemum. The experiment was laid out in a completely randomized design and replicated three times. The treatments included nine different types of containers: T_1: Open land (Control), T_2: Nursery polybag, T_3: Cemented pot, T_4: Ceramic pot, T_5: Earthen pot, T_6: Moss ball, T_7: Plastic pot, T_8: Transparent polybag, T_9: Single use plastic and T_{10}: Plastic can. The plants grown in Plastic can (T_{10}) were found to be most effective in terms of vegetative characteristics, including plant height number of leaves per plant, stem diameter, number of primary branches, plant spread and internodal length. Therefore, the results revealed that the Plastic can significantly outperformed than other containers in terms of vegetative growth.

***Keywords*:** Chrysanthemum, planting containers, ceramic pot, moss ball, single use plastic

Introduction

Chrysanthemum (*Dendranthema grandiflora*) is a popular flowering plant widely cultivated for its aesthetic value in both domestic and commercial floriculture. It is available in vibrant colors and varied forms, making it a popular choice in ornamental horticulture. This species, commonly referred to as the "mum," is celebrated for its aesthetic appeal and versatility in floral arrangements. Native to Asia and northeastern Europe, chrysanthemums have a rich history of cultivation and have become a significant part of the global floriculture industry. Chrysanthemums are believed to have originated in China, where they have been cultivated for over 2,500 years. The name "chrysanthemum" is derived from the Greek words "chrysos" meaning gold and "anthemon" meaning flower, reflecting the plant's early association with golden blooms. Chrysanthemums were introduced to Japan around the 8th century and later made their way to Europe in the 17th century (Anderson, 1987). Their introduction to India came in the 19th century, and since then, they have adapted well to the diverse climatic conditions of the region.

In India, chrysanthemum cultivation has gained prominence due to its suitability for various climatic conditions and its economic potential. The country ranks among the top producers of chrysanthemums, with significant cultivation in states such as Karnataka, Tamil Nadu, Andhra Pradesh, and Uttar Pradesh. Indian farmers appreciate chrysanthemums for their relatively low input requirements and high market value. The flowers are cultivated both for the domestic market and for export, contributing to the floriculture industry's growth. Potted plants occupy a significant share in the floriculture trade, both in global and domestic markets. The indoor plants market was valued at USD 17.93 billion in 2021 and is expected to reach USD 26.23 billion by 2029, growing at a CAGR of 4.87% during the forecast period of 2022-2029 (Nair, 2023). Beyond serving as decorative elements, potted flowering plants have positive effects on human psychology and, when placed indoors, improve air quality. Popular flowering potted plants include chrysanthemum, dahlia, orchids, anthurium, marigold, calendula, petunia, geranium, and others. Among these, chrysanthemum (*Dendranthema grandiflora*) stands out as one of the most attractive, easy to propagate, maintain and popular flowering plants, suitable for growing in both beds and containers. The production of floriferous and well-maintained attractive canopies is crucial for enhancing the aesthetics and consumer appeal of potted plants. The types of containers, significantly impact the growth, flowering, and yield of these plants. Commonly used containers in commercial production include plastic, ceramic, terracotta, metallic, and biodegradable options such as coir pots. According to Anil and Roshan (2022), the plastic segment was the highest contributor to the flower pots and planters market, with a value of $328.1 million in 2020. This segment is projected to reach $479.6 million by 2030, growing at a CAGR of 3.6%.

Consumer acceptance and willingness to purchase are crucial factors for the successful production and marketing of potted plants. The production of potted ornamental plants should align with consumer preferences (Megersa *et al.,* 2018). In light of these considerations, the present study was conducted to standardize container type, in the production of chrysanthemum potted plants.

Materials and Methods

The study comprised of ten different treatments *viz*; T_1: Open land (control), T_2: Nursery polybag, T_3: Cemented pot, T_4: Ceramic pot, T_5: Earthen pot, T_6: Moss ball, T_7: Plastic pot, T_8: Transparent polybag, T_9: Single use plastic and T_{10}: Plastic can. Transplanting of Chrysanthemum cultivar "Multiflora" was done in various types of containers in a completely randomized design with three replications and nine pots per replication at the Horticulture nursery, Horticulture Research Block, Department of Horticulture, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India. The plants having good appearance and were free from disease and insect infestation used for transplanting. One month old seedlings @ one seedling per pot were transplanted in the center of the pot. Need based watering was done at regular intervals. To encourage canopy spread through induction of more lateral branches, first pinch was done one month after transplanting and it was followed by the second pinching of the lateral branches. Prophylactic sprays of plant protection chemicals was done to check infestation of pest and diseases. All recommended practices were followed to ensure the healthy growth of the plants. Table 1 revealed the schedule of all the cultural operations performed during experimental trial. Observations were recorded on the growth attributes were recorded at 60, 90, 180 Days after transplanting (DAT) and At Final Harvest during the cropping period. The observations recorded on various growth parameters were subjected to analysis of variance (ANOVA) using completely randomized design (Gomez and Gomez, 1984) under the OPSTAT statistical package (Sheoran *et al.,* 1998).

Table 1: Cultural operation details

Operations	***Date***
Nursery bed preparation	19/11/2022
Planting of cuttings	21/11/2022
Preparation of Potting media mixture	08/12/2022
Container filling	12/12/2022 to 13/12/2022
Transplanting	14/12/2022
First irrigation	15/12/2022
Flower harvesting	14/02/2023 to 28/07/2023

Table 2: Treatment details

Treatment	Type of Container
T_1	Open land (control)
T_2	Nursery polybag
T_3	Cemented pot
T_4	Ceramic pot
T_5	Earthen pot
T_6	Moss ball
T_7	Plastic pot
T_8	Transparent polybag
T_9	Single use plastic
T_{10}	Plastic can

Results and Discussion

The various growth characters were significantly influenced by types of planting container used during the course of investigation. The data presented in Table-3, 4 and 5 were showed that the significant improvement was noticed when various types of planting container used as compared to control. The findings of the present investigation were recorded and are thoroughly discussed below:

Plant height (cm)

The data pertaining to plant height at different growth stages are presented in the Table 3 and depicted in Fig 1. The data on plant height was recorded at 60, 90 and 180 days after transplanting (DAT) as well as at the final harvest stage and were statistically analysed. The results revealed significant differences among the treatments. At 60 DAT, the maximum plant height was observed in treatment T_9 (9.96 cm), which was statistically at par with treatments T_{10} (9.07 cm) and T1 (8.84 cm). Significant differences were recorded with treatments T_7 (8.71 cm), T_8 (8.32 cm), T_6 (7.62 cm), T_2 (7.52 cm) and T_5 (6.17 cm), while the minimum plant height was recorded in treatment T_4 (5.11 cm). At 90 DAT, the maximum plant height was found in treatment T_7 (13.25 cm), which was at par with treatments T_6 (12.92 cm) and T_2 (12.90 cm). Significant differences were noted with treatments T_{10} (12.83 cm), T_9 (12.61 cm), T_1 (12.28 cm), T_8 (11.48 cm), T_4 (10.18 cm) and T_5 (9.19 cm). The minimum plant height was recorded in treatment T_3 (8.86 cm). At 180 DAT, the maximum plant height was recorded in treatment T_3 (19.63 cm), which was at par with treatments T_7 (19.06 cm) and T_5 (19.017 cm). Significant differences were observed with treatments T_1 (18.57 cm), T_9 (17.64 cm), T_8 (17.55 cm), T_6 (17.12 cm), T_2 (17.09 cm) and T_4 (15.07 cm), while the minimum plant height was noted in treatment T_{10} (13.89 cm). At the final harvest stage, the maximum plant height was recorded in treatment T_8 (28.42 cm), which was comparable with treatments T_9 (26.84 cm) and T_7 (25.64 cm). Significant differences were found with treatments T_5 (23.92 cm), T_{10} (23.04 cm), T_6 (23.02 cm), T_1 (22.31 cm), T_2 (22.24 cm) and T_3 (20.55 cm). However, the minimum plant height was recorded in treatment T4 (18.68 cm). Overall, the significant differences in plant height among the treatments across various stages of growth demonstrate the importance of selecting appropriate planting containers in *Chrysanthemum* cultivation. The results suggest that containers providing better root environment management, including moisture regulation and aeration are crucial for maximizing plant height and overall growth potential. Similar, results were obtained by Kousika *et al.* (2021).

Number of leaves

The data pertaining to number of leaves per plant at different growth stages are presented in the Table 3 and Fig 2. The observation of the number of leaves was recorded at 60, 90 and 180 days after transplanting as well as at the final harvest, revealed significant differences among the treatments. At 60 DAT, the highest number of leaves was recorded in treatment T_2 (126.19) while the lowest was observed in treatment T_9 (98.85). By 90 DAT, the maximum number of leaves was obtained in treatment T_2 (159.49), which were statistically at par with treatments T_3 (154.23) and T_{10} (151.42). Significant differences were also noted with treatments T_8 (147.03), T_5 (142.87), T_7 (139.83), T_6 (138.76), T_9 (134.52) and T_1 (133.19), while the lowest number of leaves was recorded in treatment T_4 (130.73). At 180 DAT, treatment T_9 produced the maximum number of leaves (200.08), which was statistically at par with treatments T_{10} (199.09) and T_8 (189.30). Significant differences were observed with treatments T_6 (180.28), T_7 (178.95), T_2 (161.78), T_3 (158.44), T_5 (157.06) and T_1 (153.34), while the lowest number of leaves was recorded in treatment T_4 (147.94). At the final harvest, treatment T_{10} recorded the highest number of leaves (297.71), showing significant differences from treatments T_9 (247.54), T_8 (239.96), T_6 (231.36), T_7 (226.83), T_5 (213.36), T_3 (210.13) and T_2 (209.91). The lowest number of leaves at harvest was recorded in treatment T_1 (202.19). This corroborates the findings of Krol (2011) in pot marigold and Parya *et al.* (2017).

Internodal length (cm)

Data pertaining to intermodal length was recorded at 60, 90, 180 DAT and at final harvest stage were statistically analyzed and presented in Table 3 and depicted in Fig. 3. At 60 DAT, the highest internodal length was recorded in treatment T_3 (2.46 cm), which was at par with T_2 (1.86 cm) and T_4 (1.74 cm). Significant differences were observed with treatments T_5 (1.71 cm), T_8 (1.55 cm), T_9 (1.54 cm), T_7 (1.37 cm), T_{10} (1.45 cm) and T_1 (1.37 cm), while the minimum internodal length (1.36 cm) was recorded in treatment T6. At 90 DAT, the maximum internodal length was observed in treatment T_3 (6.26 cm), which was at par with T_4 (5.28 cm) and T_5 (5.09 cm). Significant differences were noted with treatments T_2 (4.99 cm), T_7 (4.09 cm), T_8 (4.07 cm), T_1 (4.03 cm), T_6 (3.98 cm) and T_{10} (3.96 cm), while the minimum internodal length was recorded in treatment T_9 (3.95 cm). At 180 DAT, the maximum internodal length was recorded in T_3 (9.72 cm), which was at par with T_4 (8.47 cm), T_5 (7.89 cm) and T_2 (7.75 cm). Significant differences were observed with treatments T_1 (6.28 cm), T_6 (6.17 cm), T_7 (6.16 cm), T_8 (6.04 cm) and T_9 (5.85 cm), while the minimum internodal length (5.77 cm) was recorded in treatment T_{10}. At the final harvest, the maximum internodal length was observed in treatment T_3 (12.62 cm), which was at par with T_4 (11.17 cm). Significant differences were recorded with treatments

T_5 (10.85 cm), T_2 (10.36 cm), T_9 (10.23 cm), T_{10} (9.95 cm), T_7 (9.57 cm), T_6 (9.55 cm) and T_8 (9.44 cm), while the minimum internodal length (8.42 cm) was observed in treatment T_1. In plastic pots, lesser permeability of the container walls, leading to better water and nutrient retention in the media, might have influenced the rhizosphere environment, contributed to better uptake of water and nutrients and thereby to better growth and development of the plant as compared to pots. This is in line with the findings of Evan and Hensley (2004) in *Vinca rosea.* Similar observations were also made by Suvalaxmi *et al.* (2016).

Plant spread (cm)

Data pertaining to plant spread was recorded at 60 DAT, 90 DAT, 180 DAT and at final harvest stage were statistically analyzed and presented in table 4 and depicted in Fig. 4. At 60 DAT, the highest plant spread was observed in treatment T_{10} (30.79 cm), which was at par with T_4 (24.64 cm) and T_3 (24.39 cm). Significant differences were noted with T_5 (23.62 cm), T_6 (21.20 cm), T_8 (21.01 cm), T_9 (18.06 cm), T_2 (16.06 cm) and T_1 (15.70 cm), while the minimum plant spread was recorded in T_7 (13.53 cm). At 90 DAT, treatment T_{10} continued to show the maximum plant spread (41.23 cm). Significant differences were observed with T_5 (32.36 cm), T_6 (30.27 cm), T_8 (29.58 cm), T_9 (26.76 cm), T_2 (25.39 cm) and T_1 (24.72 cm), with the minimum plant spread recorded in T_7 (22.46 cm). At 180 DAT, treatment T_{10} exhibited the greatest plant spread (57.38 cm). Treatments T_4 (46.30 cm), T_3 (44.91 cm), T_5 (44.83 cm) and T_8 (44.76 cm) were at par with each other. Significant differences were observed in T_6 (41.74 cm), T_9 (39.14 cm), T_2 (38.87 cm) and T_1 (35.04 cm), while the minimum plant spread was noted in T_7 (34.07 cm). At the final harvest, treatment T_{10} had the largest plant spread (70.32 cm). Significant differences were noted with T_4 (61.57 cm), T_5 (59.63 cm), T_3 (59.40 cm), T_6 (55.52 cm), T_9 (52.38 cm), T_2 (51.37 cm), and T_1 (46.60 cm), with T_7 showing the minimum plant spread (45.31 cm). This result was supported by Sakamoto *et al.* (2001).

Number of primary branches

Data pertaining to number of primary branches was recorded at 60, 90, 180 DAT and at final harvest stage were statistically analyzed and presented in Table 4 and depicted in Fig. 5. The observation of primary branches recorded at 60, 90, 180 days after transplanting and at final harvest showed significant differences among the treatments. At 60 DAT, the highest number of primary branches was observed in treatment T_2 (15.80), which were at par with T_3 (14.16) and T_1 (13.15). Significant differences were noted with T_5 (12.56), T_8 (11.57) and T_6 (11.32), while the minimum number of primary branches (10.80) was recorded in T_4. At 90 DAT, treatment T_2 exhibited the maximum number of primary branches (19.06) which was at par with T_1 (17.46) and T_3 (17.32). Significant differences were observed with T_9 (16.26), T_5 (15.90) and T_6 (14.30). However, the minimum number of primary branches recorded in T_9 (14.44). Whereas at 180 DAT, the highest number of primary branches was noted in T_{10} (25.66), which was at par with T_8 (24.84), T_2 (24.69) and T_9 (24.56). Significant differences were observed with T_3 (24.18) and T_6 (23.31), while the minimum number of primary branches (22.59) was recorded in T_4. At the final harvest, treatment T_{10} continued to show the maximum number of primary branches (35.78) which was at par with T_8 (34.18). Significant differences were noted with T_9 (33.63), T_5 (32.61), and T_1 (31.01), while the minimum number of primary branches was observed in T_4 (30.79). These results were in accordance with Evans *et al.* (2004).

Stem diameter (cm)

The data on stem diameter at various growth stages are presented in Table 4 and Fig. 6. Observations recorded at 60, 90, 180 days after transplanting and at the final harvest stage revealed significant differences among the treatments. At 60 DAT, the largest stem diameter was observed in treatment T_9 (0.61 cm), while the smallest diameter (0.45 cm) was recorded in treatment T_4. At 90 DAT, treatment T_{10} exhibited the maximum stem diameter (1.22 cm), which was at par with T_8 (1.21 cm) and T_9 (1.18 cm). Significant differences were observed with treatments T_2 (1.15 cm), T_7 (1.13 cm), T_1 (1.07 cm), T_3 (1.05 cm), T_5 (0.97 cm) and T_4 (0.91 cm). The minimum stem diameter (0.88 cm) was recorded under treatment T_5. At 180 DAT, the largest stem diameter was again observed in treatment T_{10} (2.01 cm), which was at par with T_2 (1.93 cm) and T_7 (1.92 cm). Significant differences were noted with treatments T_9 (1.92 cm) and T_6 (1.80 cm), while the smallest stem diameter (1.73 cm) was recorded in treatment T_4. At the final harvest, T_{10} continued to show the maximum stem diameter (2.22 cm), comparable to T_9 (2.12 cm) and T_2 (2.11 cm). Significant differences were observed with treatments T_5 (2.09 cm), T_6 (2.08 cm), T_8 (2.07 cm), T_3 (2.06 cm) and T_4 (2.01 cm), while the minimum stem diameter was obtained in treatment T_1 (1.94 cm). This corroborates the findings of Keever *et al.* (1985) and Cole *et al.* (1998).

Conclusion

Based on the present experimental research on the "Influence of various Planting Containers on the Growth Attributes of Chrysanthemum (*Dendranthema grandiflora*) under the Low Hills of Uttarakhand" in the cultivar 'Multiflora,' it can be concluded that among the different container treatments, the Plastic can (T_{10}) was the most effective in enhancing plant height, number of leaves per plant, main stem diameter, number of primary branches, plant spread and internodal length.

Table 3: Effect of growing containers on plant height, number of leaves and internodal length of chrysanthemum at different harvest intervals

Treatment	Plant height (cm)				Number of leaves per plant				Internodal length (cm)			
	60 DAS	90 DAS	180 DAS	At Final harvest	60 DAS	90 DAS	180 DAS	At Final harvest	60 DAS	90 DAS	180 DAS	At Final Harvest
T_1	8.84	12.28	18.57	22.31	105.26	133.19	153.34	202.19	1.37	4.03	6.28	8.42
T_2	7.52	12.90	17.09	22.24	126.19	159.49	161.78	209.91	1.86	4.99	7.75	10.36
T_3	8.78	8.86	19.63	20.55	125.28	154.23	158.44	210.13	2.46	6.26	9.72	12.62
T_4	5.11	10.19	15.07	18.68	99.13	130.73	147.94	200.81	1.74	5.28	8.47	11.17
T_5	6.17	9.19	19.02	23.92	111.35	142.87	157.06	213.73	1.71	5.09	7.89	10.85
T_6	7.62	12.92	17.12	23.02	100.92	138.76	180.28	231.36	1.36	3.98	6.17	9.55
T_7	8.71	13.25	19.06	25.64	101.18	139.83	178.95	226.83	1.54	4.10	6.18	9.57
T_8	8.32	11.48	17.55	28.42	103.08	147.03	189.30	239.96	1.55	4.07	6.04	9.44
T_9	9.96	12.61	17.64	26.84	98.85	134.52	200.08	247.54	1.54	3.95	5.85	10.23
T_{10}	9.07	12.83	13.89	23.04	108.47	151.42	199.09	297.71	1.45	3.96	5.78	9.95
C.D $_{(0.05\%)}$	4.88				23.92				0.76			
SE(m) ±	1.67				8.20				0.26			
SE(d) ±	2.36				11.59				0.37			
C.V.	5.43				10.07				8.95			

Table 4: Effect of growing containers on plant spread, number of primary branches and stem diameter of chrysanthemum at different harvest intervals

Treatment	Plant spread (cm)				Number of primary branches				Stem diameter (cm)			
	60 DAS	90 DAS	180 DAS	At Final harvest	60 DAS	90 DAS	180 DAS	At Final harvest	60 DAS	90 DAS	180 DAS	At Final Harvest
T_1	15.70	24.720	35.037	46.603	13.150	17.460	23.807	31.013	0.543	1.070	1.843	1.943
T_2	16.06	25.390	38.870	51.373	15.800	19.063	24.687	32.030	0.587	1.150	1.927	2.107
T_3	24.39	33.947	44.913	59.403	14.160	17.317	24.177	32.140	0.577	1.047	1.870	2.063
T_4	24.64	33.635	46.295	61.570	10.800	14.303	22.593	30.793	0.453	0.913	1.730	2.007
T_5	23.62	32.357	44.833	59.627	12.560	15.997	23.963	32.613	0.497	0.973	1.863	2.090
T_6	21.20	30.267	41.740	55.520	11.323	14.833	23.307	32.297	0.443	0.877	1.807	2.077
T_7	13.53	22.460	34.070	45.315	11.357	15.020	23.980	33.210	0.583	1.137	1.923	2.057
T_8	21.01	29.585	44.760	59.540	11.570	15.790	24.843	34.177	0.573	1.207	1.897	2.070
T_9	18.06	26.765	39.145	52.385	11.417	14.443	24.560	33.627	0.613	1.187	1.920	2.117
T_{10}	30.79	41.235	57.380	70.315	12.173	16.260	25.657	35.777	0.610	1.223	2.010	2.217
C.D (0.05%)	2.05				1.70				0.07			
SE(m) ±	0.70				0.58				0.03			
SE(d) ±	0.99				0.82				0.04			
C.V.	3.75				5.45				3.66			

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