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Influence of planting dates on vegetative growth of cut *Chrysanthemum* (*Chrysanthemum morifolium* Ramat.) varieties under naturally ventilated polyhouse conditions

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ABSTRACT

An investigation entitled "Influence of Planting Dates on Vegetative Growth of Cut *Chrysanthemum* (*Chrysanthemum morifolium* Ramat.) Varieties under Naturally Ventilated Polyhouse Conditions" was conducted at the Department of Floriculture and Landscaping, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Maharashtra, during 2023-2024 and 2024-2025. The experiment was carried out in a naturally ventilated polyhouse using a Factorial Randomized Block Design (FRBD) with different planting dates and ten chrysanthemum cultivars replicated two times. The treatment combination P₄V₉ recorded the maximum values for all the vegetative growth parameters evaluated. It produced the highest plant height (102.25 cm and 129.06 cm), number of leaves (40.20 and 62.52), plant spread in the east–west direction (22.94 and 31.43 cm), plant spread in the north–south direction (23.63 and 32.07 cm), average leaf area (16.83 cm² and 29.77 cm²), stem girth (6.99 mm and 7.49 mm), fresh weight (59.23 g), and dry weight (10.55 g) at both 60 and 120 days after planting (DAP), indicating its superior performance over the other treatment combinations.

Keywords: Cut chrysanthemum, Planting dates, Naturally ventilated polyhouse, Vegetative growth

Introduction

Chrysanthemum (*Chrysanthemum morifolium* Ramat.) is one of the most important commercial ornamental crops, because of its wide range of flower colours, shapes, sizes and excellent vase life. It belongs to the Asteraceae family and is the second most cut flower in the world after the rose (Anderson, 2006) [1]. *Chrysanthemum* is used for bouquets, flower arrangement, landscape gardening and for religious and decorative purposes. In India, the use varies from region to region, loose flowers are chiefly used for garlands and floral decorations in southern India and cut flowers are more popular in northern India (Bohra *et al.*, 2014) [2]. The increasing demand of good quality cut flowers has promoted the adoption of protected cultivation, especially naturally ventilated polyhouse for round the year production (Sharma *et al.*, 2015) [3]. Flower yield and quality are largely determined by vegetative growth, which in turn is influenced by environmental factors, including temperature, light, humidity and photoperiod. *Chrysanthemum* is a qualitative short-day plant, therefore the time of planting is an important factor in controlling the vegetative growth and flowering. Besides, varietal differences have a significant impact on plant growth and biomass production in protected cultivation. Therefore, suitable planting dates and varieties are needed to obtain higher productivity and better economic return. Information on performance of cut chrysanthemum varieties under naturally ventilated polyhouse conditions in humid coastal climate of Konkan region is inadequate. Therefore, the present study was conducted to assess the effect of different planting dates on the vegetative growth of cut chrysanthemum varieties under naturally ventilated polyhouse conditions and to identify the suitable combinations of variety and planting date for commercial cultivation.

Materials and methods

The experiment was carried out in a naturally ventilated polyhouse using a Factorial Randomized Block Design (FRBD) with different planting dates comprising 40 treatment combination which include ten chrysanthemum cultivars namely Artic Queen (V₁), Feeling Green Dark (V₂), Lollipop (V₃), Frozen (V₄), Pina Colada (V₅), Champagne Orange (V₆), Candor Pink (V₇), Champagne Yellow (V₈), Onana (V₉) and Prada Purple (V₁₀) and four planting dates i.e. August (P₁), September (P₂), October (P₃) and November (P₄) and replicated twice. Vegetative parameters, namely plant height, number of leaves, plant spread in east–west and north–south, average leaf area, stem girth, fresh weight and dry weight were recorded from five randomly selected plants per treatment. The pooled data of two years were statistically analyzed using analysis of variance as per the method of Panse *et al.* (1967) [4].

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Results and discussion

The data on vegetative parameters viz., plant height, number of leaves, plant spread in east-west and north-south, average leaf area, stem girth, fresh weight and dry weight was influenced by planting dates and different varieties in treatment combination are presented in Table 1-7.

Plant height

(cm):

The plant height varies significantly depending on the time of planting and variety. The highest plant height (102.25 cm and 129.06 cm) was observed at 60 and 120 DAP, respectively in treatment combinations P₄V₉ (variety Onana in the first week of November) while, the lowest plant height (70.83 cm and 96.76 cm) was observed at 60 and 120 DAP, respectively in treatment combination P₁V₁₀ (variety Prada Purple in the first week of August). This might be due to genotypic differences in phenotypic expression of plant height and favourable climatic conditions in November month which is favourable for vegetative growth (Jindal *et al.*, 2018) [5]. Shankar and Tiwari (1993) [6] reported that plant height plays a significant role in the selection of chrysanthemum cultivars.

Number of leaves

Number of leaves per plant were significantly affected by planting date and varieties. The maximum number of leaves (40.20 and 62.52, respectively) were recorded in treatment combination P₄V₉ (variety Onana in 1st week of November) at 60 and 120 DAP whereas, the minimum number of leaves (18.57 and 29.31) were observed in treatment combination P₁V₁₀ (variety Prada Purple in 1st week of August) at 60 and 120 DAP, respectively. The differences in the number of leaves of various cut chrysanthemum varieties are primarily attributed to the differences of their genetic makeup (genotype), which controls the growth rate and the total vegetative development. These inherent genetic factors as well as environmental factors particularly congenial climatic conditions such as optimum temperature create a favourable environment for vegetative growth and therefore, significant differences in vegetative attributes among varieties were observed. Similar results were found in chrysanthemum by Thakur *et al.* (2018) [7] and Jindal *et al.* (2018) [5].

Plant spread East-West

(cm):

Among different treatment combinations maximum east-west plant spread (22.94 and 31.43 cm, respectively) was recorded in variety Onana in first week of November (P₄V₉) at 60 and 120 DAP. However, the variety Prada Purple in the first week of August (P₁V₁₀) had the least plant spread east-west (12.55 cm and 21.01 cm) at 60 and 120 DAP, respectively. Variation in plant spread was mainly attributed to genetic differences influencing branching habit and canopy development. Greater plant spread was associated with increased branching and a positive relationship with plant height, while favourable climatic conditions during the optimum planting period further enhanced vegetative growth. Similar findings were reported by Poonam and Kumar (2007) [8], Madhu B. (2015) [9], Kumar *et al.* (2015) [10], Roopa *et al.* (2018) [11], Parmar *et al.* (2019) [12] and Jindal *et al.* (2018) [5] in chrysanthemum.

Plant spread North-South

(cm):

The plant spread north-south per plant differs significantly with respect to time of planting and varieties. The highest north-south plant spread (23.63 cm and 32.07 cm respectively) was found in treatment combination P₄V₉ i.e. (variety Onana in first week of November) at 60 and 120 DAP. However, variety Prada Purple in the first week of August (P₁V₁₀) had the least plant spread east-west (14.56 cm and 20.00 cm) at 60 and 120 DAP, respectively. These differences may be due to inherent genotypic differences in influencing the phenotypic expression and due to moderate temperatures and favorable light conditions that enhance photosynthesis and leaf expansion. Lower heat

and humidity stress in November also promotes nutrient uptake and overall vegetative growth. This corroborates the findings of Parmar *et al.*, (2019) [12] and Jindal *et al.*, (2018) [5] on chrysanthemum.

Average leaf area (cm²):

The maximum average leaf area (16.83 cm² and 29.77 cm²) at 60 and 120 DAP, respectively, were recorded under treatment combination (P₄V₉) i.e. variety Onana in 1st week of November which were significantly superior to all other treatment combinations. In contrast, the minimum values of average leaf area (7.25 cm² and 14.72 cm²) at 60 and 120 DAP, respectively were consistently observed under treatment combination (P₁V₁₀) i.e. variety Prada Purple in 1st week of August. These differences may be attributed to inherent genotypic variations influencing phenotypic expression and due to moderate temperatures and favourable light conditions, which enhance photosynthesis and leaf expansion. The reduced heat and humidity stress during November also improve nutrient uptake and overall vegetative growth. This observation is in line with Parmar *et al.*, (2019) [12] and Jindal *et al.*, (2018) [5] in chrysanthemum.

Stem girth

(mm):

It is indicated that the maximum stem girth was recorded in variety Onana in 1st week of November (P₄V₉) at 60 and 120 DAP (6.99 mm and 7.49 mm, respectively), however, the minimum stem girth (4.53 mm and 5.14 mm) was recorded under the variety Prada Purple in 1st week of August (P₁V₁₀) at 60 and 120 DAP, respectively. The variation in stem girth among cut chrysanthemum varieties was mainly attributed to genetic differences affecting growth vigour and stem development. November planting recorded thicker stems due to favourable environmental conditions that promoted cambial activity and radial growth, whereas August planting produced thinner stems under high temperature and monsoon conditions. Similar findings were reported by Soni and Godara (2020) [13], Patil *et al.* (2017) [14] in chrysanthemum and Bhagve *et al.* (2020) [15] in China aster.

Fresh weight

(g):

The maximum fresh weight (59.23 g) at 120 DAP was recorded under variety Onana in 1st week of November (P₄V₉), while the minimum value of fresh weight (22.31 g) was consistently observed under variety Prada Purple in 1st week of August (P₁V₁₀). The observed differences among varieties may be attributed to their inherent genetic composition, which governs growth behaviour and biomass accumulation. Additionally, November planting provides favourable temperature, light and photoperiod conditions that enhance photosynthesis, nutrient uptake and prolong the vegetative phase, resulting in higher fresh weight of cut chrysanthemum. These findings are in close agreement with earlier reports by Palai *et al.* (2018) [16] and Thakur *et al.* (2018) [7] in chrysanthemum.

Dry weight

(g):

The maximum dry weight (10.55 g) at 120 DAP was recorded under treatment combination P₄V₉ i.e. variety Onana in 1st week of November, whereas the lowest pooled mean value of 4.34 g was consistently observed under treatment planting of Prada Purple in 1st week of August (P₁V₁₀). The variation in flower dry weight was primarily attributed to the genetic makeup of the chrysanthemum cultivars. November planting recorded significantly higher flower dry weight due to favourable temperature, light intensity and photoperiod, which enhanced photosynthesis and carbohydrate accumulation. In contrast, August planting resulted in lower dry matter production because of high temperature and heavy rainfall. Similar findings were reported by Palai *et al.* (2018) [16] and Thakur *et al.* (2018) [7].

Conclusion

From the present investigation it can be disclosed that vegetative growth, flowering and yield of cut chrysanthemum under polyhouse conditions were significantly influenced by planting dates and vari

eties. The treatment combination P₄V₉ recorded the maximum values for all the vegetative growth, flowering and yield parameters were evaluated. It produced the highest plant height (102.25 cm and 129.06 cm), number of leaves (40.20 and 62.52), plant spread in the east–west direction (22.94 and 31.43 cm), plant spread in the north–south direction (23.63 and 32.07 cm), average leaf area (16.83 cm²

and 29.77 cm²), stem girth (6.99 mm and 7.49 mm), fresh weight (59.23 g), and dry weight (10.55 g) at both 60 and 120 days after planting (DAP), indicating its superior performance over the other treatment combinations making it most suitable for commercial cultivation in Konkan region.

Table 1. Effect of varietal response and planting dates on plant height of cut chrysanthemum at 60 and 120 DAP

Treat-ments	Plant height (cm)									
	60 DAP					120 DAP				
	P ₁	P ₂	P ₃	P ₄	Mean	P ₁	P ₂	P ₃	P ₄	Mean
V ₁	71.93	73.60	75.16	77.73	74.61	97.61	99.98	102.81	105.38	101.44
V ₂	74.88	76.93	78.72	80.97	77.87	101.91	104.69	107.54	109.83	105.99
V ₃	76.57	78.33	81.07	83.68	79.91	103.90	106.64	109.37	112.37	108.07
V ₄	82.24	84.63	87.36	90.02	86.06	110.06	113.01	116.09	119.48	114.66
V ₅	78.64	80.01	82.43	84.31	81.34	106.85	110.20	111.65	113.81	110.63
V ₆	73.26	75.26	76.52	80.47	76.37	101.12	102.73	106.01	108.89	104.68
V ₇	78.94	81.12	83.70	85.89	82.41	108.95	110.74	113.14	116.63	112.36
V ₈	82.79	85.33	87.66	90.36	86.53	113.24	115.43	117.76	121.48	116.98
V ₉	92.50	95.42	98.53	102.25	97.17	122.24	124.16	125.99	129.06	125.36
V ₁₀	70.83	72.20	74.17	76.66	73.46	96.76	99.15	101.95	104.90	100.69
MEAN	78.26	80.28	82.53	85.23		106.26	108.67	111.23	114.18	
	P	V	P X V			P	V	P X V		
Result	SIG	SIG	SIG			SIG	SIG	SIG		
SEm±	0.051	0.081	0.162			0.083	0.131	0.262		
CD	0.066	0.104	0.209			0.237	0.375	0.749		

Table 2. Effect of varietal response and planting dates on number of leaves of cut chrysanthemum at 60 and 120 DAP

Treat-ments	Number of leaves									
	60 DAP					120 DAP				
	P ₁	P ₂	P ₃	P ₄	Mean	P ₁	P ₂	P ₃	P ₄	Mean
V ₁	21.68	22.38	23.17	23.81	22.76	30.36	31.86	33.29	34.57	32.52
V ₂	23.91	24.75	25.53	26.19	25.09	31.82	33.20	35.97	38.82	34.95
V ₃	30.10	30.77	31.50	32.31	31.17	39.30	40.46	41.31	43.05	41.03
V ₄	32.40	33.31	34.39	35.15	33.81	49.42	51.19	52.34	53.48	51.61
V ₅	30.39	31.15	32.88	34.28	32.17	41.05	42.49	44.08	45.28	43.22
V ₆	22.21	22.83	23.60	24.36	23.25	31.83	33.23	34.79	36.25	34.02
V ₇	32.22	32.87	33.56	34.50	33.29	43.00	44.32	45.79	47.47	45.14
V ₈	33.24	33.93	34.73	35.49	34.35	52.30	54.00	55.23	57.22	54.69
V ₉	37.88	38.69	39.26	40.20	39.01	57.18	58.34	59.65	62.52	59.42
V ₁₀	18.57	19.31	19.86	21.58	19.83	29.31	30.51	31.60	32.51	30.98
MEAN	28.26	29.00	29.85	30.78		40.55	41.96	43.40	45.11	
	P	V	P X V			P	V	P X V		
Result	SIG	SIG	SIG			SIG	SIG	SIG		
SEm±	0.024	0.037	0.074			0.081	0.128	0.255		
CD	0.067	0.106	0.213			0.231	0.365	0.731		

Table 3. Effect of varietal response and planting dates on plant spread east-west of cut chrysanthemum at 60 and 120 DAP

Treat-ments	Plant spread (cm) East-West									
	60 DAP					120 DAP				
	P ₁	P ₂	P ₃	P ₄	Mean	P ₁	P ₂	P ₃	P ₄	Mean
V ₁	18.44	18.97	19.46	19.89	19.19	23.49	23.9	24.33	24.80	24.13
V ₂	19.34	19.94	20.48	21.01	20.20	26.38	26.69	27.07	27.51	26.92
V ₃	19.52	20.12	20.70	21.40	20.43	26.89	27.43	27.76	28.31	27.60
V ₄	20.59	21.20	21.56	22.15	21.38	27.35	27.81	28.42	28.92	28.13

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Plant spread (cm) East-West										
V ₅	19.94	20.47	21.01	21.61	20.76	27.06	27.55	27.92	28.42	27.74
V ₆	19.13	19.74	20.24	20.54	19.92	24.34	24.78	25.23	25.75	25.03
V ₇	20.11	20.81	21.20	21.85	21.00	27.24	27.68	28.28	28.78	28.00
V ₈	20.98	21.53	21.93	22.51	21.73	27.51	27.96	28.72	29.27	28.37
V ₉	21.53	21.91	22.46	22.94	22.21	29.37	29.87	30.54	31.43	30.30
V ₁₀	12.55	13.03	13.41	13.75	13.19	21.01	21.40	21.82	22.34	21.65
MEAN	19.21	19.77	20.25	20.77		26.07	26.51	27.01	27.56	
	P	V		P X V		P	V		P X V	
Result	SIG	SIG		SIG		SIG	SIG		SIG	
SEm±	0.017	0.026		0.052		0.013	0.021		0.041	
CD	0.047	0.075		0.149		0.037	0.059		0.118	

Table 4. Effect of varietal response and planting dates on plant spread north-south of cut chrysanthemum at 60 and 120 DAP

Plant spread (cm) North-South										
Treat-ments	60 DAP					120 DAP				
	P ₁	P ₂	P ₃	P ₄	Mean	P ₁	P ₂	P ₃	P ₄	Mean
V ₁	17.27	17.78	18.42	19.03	18.13	24.06	24.53	25.00	25.46	24.76
V ₂	19.07	19.42	20.00	20.32	19.70	26.09	26.55	27.03	27.75	26.85
V ₃	19.31	20.51	20.14	20.67	20.16	26.92	27.42	27.84	28.39	27.64
V ₄	20.35	20.83	21.62	22.14	21.23	27.92	28.38	29.08	29.70	28.77
V ₅	19.61	19.91	20.49	20.81	20.20	27.07	27.49	28.09	28.56	27.80
V ₆	18.32	18.70	19.26	19.67	18.99	24.39	24.52	24.97	25.26	24.78
V ₇	19.77	20.38	21.04	21.43	20.65	27.69	28.12	28.51	29.07	28.35
V ₈	21.10	21.49	21.99	22.38	21.74	28.46	28.99	29.61	30.27	29.33
V ₉	22.06	22.51	23.07	23.63	22.82	30.42	30.92	31.46	32.07	31.22
V ₁₀	14.56	14.99	15.44	15.79	15.19	20.00	21.38	21.90	22.32	21.40
MEAN	19.14	19.65	20.14	20.58		26.30	26.83	27.35	27.88	
	P	V		P X V		P	V		P X V	
Result	SIG	SIG		SIG		SIG	SIG		SIG	
SEm±	0.046	0.073		0.145		0.013	0.020		0.040	
CD	0.131	0.208		0.415		0.036	0.057		0.115	

Table 5. Effect of varietal response and planting dates on average leaf area of cut chrysanthemum at 60 and 120 DAP

Average leaf area (cm ²)										
Treat-ments	60 DAP					120 DAP				
	P ₁	P ₂	P ₃	P ₄	Mean	P ₁	P ₂	P ₃	P ₄	Mean
V ₁	7.85	8.10	8.34	8.61	8.22	15.71	16.23	16.52	16.87	16.33
V ₂	9.03	9.32	9.52	9.76	9.40	19.00	19.32	19.78	20.25	19.58
V ₃	11.04	11.34	11.59	11.84	11.45	22.62	22.99	23.37	23.78	23.19
V ₄	13.92	14.22	14.51	14.75	14.35	25.34	25.71	26.24	26.53	25.95
V ₅	12.80	13.03	13.35	13.59	13.19	23.46	23.82	24.09	24.50	23.97
V ₆	8.34	8.55	8.75	9.02	8.66	17.92	18.22	18.67	18.48	18.32
V ₇	13.82	14.05	14.39	14.63	14.22	23.50	24.05	24.36	24.72	24.16
V ₈	14.93	15.22	15.57	15.85	15.39	26.65	27.05	27.47	27.98	27.29
V ₉	15.77	16.05	16.35	16.83	16.25	28.38	28.76	29.27	29.77	29.04
V ₁₀	7.25	7.45	7.68	7.76	7.53	14.72	15.06	15.35	15.66	15.20
MEAN	11.47	11.73	12.00	12.26		21.73	22.12	22.51	22.85	
	P	V		P X V		P	V		P X V	
Result	SIG	SIG		SIG		SIG	SIG		SIG	
SEm±	0.006	0.010		0.020		0.027	0.043		0.086	
CD	0.018	0.029		0.058		0.078	0.123		0.247	

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Table 6. Effect of varietal response and planting dates on stem girth of cut chrysanthemum at 60 and 120 DAP

Treat-ments	Stem girth (mm)									
	60 DAP					120 DAP				
	P ₁	P ₂	P ₃	P ₄	Mean	P ₁	P ₂	P ₃	P ₄	Mean
V ₁	4.73	4.94	5.12	5.36	5.03	5.28	5.52	5.68	5.84	5.58
V ₂	4.00	4.19	4.45	4.65	4.32	5.62	5.77	5.95	6.13	5.87
V ₃	5.10	5.28	5.49	5.73	5.40	5.71	5.92	6.06	6.25	5.98
V ₄	5.53	5.71	5.96	6.21	5.85	6.06	6.22	6.35	6.56	6.30
V ₅	5.20	5.41	5.53	5.65	5.44	5.87	6.02	6.23	6.38	6.12
V ₆	4.84	4.99	5.21	5.45	5.12	5.50	5.62	5.76	5.91	5.69
V ₇	5.33	5.51	5.71	5.98	5.63	5.96	6.10	6.28	6.42	6.19
V ₈	6.07	6.24	6.48	6.72	6.38	6.67	6.93	7.05	7.25	6.98
V ₉	6.28	6.46	6.67	6.99	6.60	6.93	7.12	7.29	7.49	7.21
V ₁₀	4.53	4.70	4.87	5.07	4.79	5.14	5.30	5.37	5.59	5.35
MEAN	5.16	5.34	5.55	5.78		5.87	6.05	6.20	6.38	
	P	V	P X V			P	V	P X V		
Result	SIG	SIG	SIG			SIG	SIG	SIG		
SEm±	0.006	0.009	0.018			0.004	0.006	0.013		
CD	0.016	0.025	0.050			0.011	0.018	0.036		

Table 7. Effect of varietal response and planting dates on fresh and dry weight of cut chrysanthemum at 120 DAP

Treat-ments	Fresh and Dry weight (g-plant)									
	Fresh weight (g)					Dry weight (g)				
	P ₁	P ₂	P ₃	P ₄	Mean	P ₁	P ₂	P ₃	P ₄	Mean
V ₁	25.16	25.59	26.20	27.00	25.99	4.56	4.97	5.31	5.69	5.13
V ₂	40.48	41.46	41.81	42.74	41.62	6.89	7.21	7.47	7.96	7.38
V ₃	41.31	41.67	42.26	43.00	42.06	7.07	7.33	7.71	8.13	7.56
V ₄	48.39	49.03	49.75	50.91	49.52	7.89	8.10	8.47	8.89	8.34
V ₅	43.63	44.86	45.71	46.67	45.21	7.60	7.94	8.21	8.57	8.08
V ₆	26.95	27.63	28.37	29.19	28.03	4.76	5.18	5.46	6.01	5.35
V ₇	44.22	45.09	46.42	47.10	45.70	7.72	8.04	8.35	8.71	8.20
V ₈	48.59	49.26	50.06	51.44	49.84	7.99	9.31	9.76	10.14	9.30
V ₉	55.74	56.51	57.09	59.23	57.14	9.58	9.93	10.20	10.55	10.06
V ₁₀	22.31	22.88	23.46	23.90	23.14	4.34	4.65	4.65	5.07	4.67
MEAN	39.68	40.40	41.11	42.11		6.84	7.26	7.56	7.97	
	P	V	P X V			P	V	P X V		
Result	SIG	SIG	SIG			SIG	SIG	SIG		
SEm±	0.039	0.062	0.123			0.012	0.020	0.040		
CD	0.112	0.177	0.353			0.036	0.057	0.113		

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