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Growth and flowering performance evaluation of thirty two chrysanthemum cultivars

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ABSTRACT

An experiment was conducted to evaluate the growth and flowering performance of chrysanthemum cultivars. Thirty two chrysanthemum cultivars coded from V_1 to V_{32} were used in the experiment. Plant height, number of branch per plant, leaf area, number of leaf per branch, chlorophyll content, days to flower bud initiation, days to first petal spread, days to final bloom, number of flower bud per plant, number of flower per branch, number of flower per plant, bud diameter at initiation stage, bud diameter at mature stage, flower head diameter, stalk length and flower durability in plant (days to 50% flower senescence) for different cultivars varied significantly. Number of flowers per plant ranged from 4.3 to 194.6, flower head diameters varied from 2.8 to 17.6 cm and stalk lengths were from 4.4 to 20.1 cm. Amongst the chrysanthemum cultivars V_{15} (BARI chrysanthenum1) was the maximum flower producing cultivar, while V_1 produced the largest flowers and flowers from the V_{21} had the longest shelf-life. These variations might help in classifying chrysanthemum, for pot cultivation and cut flower, based on their flowering quality which will be beneficial for growers.

Keywords: *Chrysanthemum sp., Growth and flower characteristics, species variation*

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I. Introduction

Chrysanthemum (*Chrysanthemum sp.*) belonging to *Asteraceae* family is a highly attractive and charming flowering plant, having number of varieties in the world is reported to be above 2000 (Joshi *et al.*, 2010). Chrysanthemums are used either as cut flowers or grown in pots and the success in cultivation of this plant is principally due to the great diversity of cultivars (Barbosa, 2003). Though the flower yield and quality are primarily varietals characters, they are also greatly influenced by climatic factors. A numerous number of chrysanthemum cultivars are found in Bangladesh. BARI has developed only two chrysanthemum cultivars (BARI, 2011) and rest of the cultivars were brought in by commercial growers from different countries without scientific information. The growth and flowering performance of these cultivars have not been evaluated. Most of the growers do not have overall idea about all of these cultivars. Varietal performance evaluation can be helpful for the

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commercial chrysanthemum grower to choose their preferable one. For searching the good variety/cultivars, varietal performance has previously evaluated on different crops like rose (Shahrin *et al.,* 2015), gerbera (Hossain *et al.,* 2015; Mehraj *et al.,* 2014b; Jamal Uddin *et al.,* 2014b), dendrobium (Mehraj *et al.,* 2014d), bougainvillea (Mehraj *et al.,* 2014e), heliconia (Islam *et al.,* 2013a), anthurium (Islam *et al.,* 2013), lisianthus (Jamal Uddin *et al.,* 2013), strawberry (Ahsan *et al.,* 2014; Hossan *et al.,* 2013); tomato (Nahiyan *et al.,* 2014; Biswas *et al.,* 2014; Mehraj *et al.,* 2014c), chilli (Chowdhury *et al.,* 2015; Mehraj *et al.,* 2014a), asparagus (Jamal Uddin *et al.,* 2014a) and all of these crops showed variations in their performances. It is essential for plant breeders to estimate the type of variation available in the cultivars for easy selection for further breeding of respective crops. The study was conducted to evaluate the performance of the cultivars in respect to their different traits.

II. Materials and Methods

Experimental site: The experiment was conducted at Horticulture Farm of the Sher-e-Bangla Agricultural University, Dhaka, from October 2012 to March 2013.

Planting materials: Growing chrysanthemum plants from a sucker is, the easiest and quickest way to propagate. Suckers of chrysanthemum were collected from the Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka; Krishibid Upokorn Nursery, Agargaon, Dhaka and Barishal Nursery, Savar, Dhaka; Bngladesh. New plant was generated by planting sucker from mother chrysanthemum.

Design of experiment: 32 chrysanthemum cultivars were used. They were Crimson Tide (V_1); Samsan (V_2); White Snowball (V_3); Chandramukhi (V_4); Lexy (V_5); Rose Pink (V_6); Yellow Glow (V_7); Ruby Red (V_8); Gold Apricot (V_9); Sunny Yellow (V_{10}); Lavender Mum (V_{11}); Giant Bronze (V_{12}); Purple Mum (V_{13}); Moon Ball (V_{14}); Yellow Bay (V_{15}); Pink Shasta Daisy (V_{16}); Bernadette Yellow (V_{17}); Mammoth Yellow (V_{18}); Auburn Daisy (V_{19}); Sweet Vase (V_{20}); First Light (V_{21}); Flying Saucer (V_{22}); Zipsy (V_{23}); Gold Mundial (V_{24}); Red Wing (V_{25}); Trendy Time (V_{26}); Rising Sun (V_{27}); BARI chrysanthemum 2 (V_{28}); Rayonnate spider (V_{29}); Flair spider (V_{30}); Wisp of Red (V_{31}) and Satin Ribbon (V_{32}). One sucker was planted in each pot and the size of each pot was 25 cm in diameter (above part) and 20 cm in height. Experiment was laid out in Completely Randomized Design (CRD) with three replications for each cultivar thus comprised to a total of 96 pots.

Pot preparation: Soil (approx. 2.5 kg/pot) and cow dung (approx. 1.5 kg/pot) were mixed and pots were filled 7 days before transplanting. Weeds and stubbles were completely removed

Disease and pest management: During the early growing stage powdery mildew and leaf spot were controlled by spraying Dithane M-45. Fungicide was sprayed two times at 15 days interval. Crop was also attacked by aphids during the growing stage. Aphid was controlled by spraying Malathion @ 1.5 ml/L. Insecticides were sprayed two times at seven days interval.

Data collection: Data were collected on plant height; number of branch, leaf area, number of leaf per branch, chlorophyll content, days to flower bud initiation, days to first petal spread, days to final bloom, number of flower bud per plant, number of flower per branch, number of flower per plant, bud diameter at initiation stage, bud diameter at mature stage, flower head diameter, stalk length and flower durability in plant (days to 50% flower senescence). Leaf area, chlorophyll content and flower bud diameter were measured by using CL-202 Leaf Area Meter (USA), SPAD-502 and Digital Caliper-515 (DC-515) respectively. Ten mature leaves and bud from each plant were measured and then average it after that mean was calculated. Flower bud diameter at initiation stage and fully mature stage that are about to open in the next day. The total length from base of the branch to terminal node of flower was taken as stalk length. Flower durability in plant was measured by counting the duration of time in days that flower remains good condition in plant.

Statistical analysis: Data were analyzed using MSTAT-C statistical package and significant difference among the treatment means was determined by the Least Significant Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984). In addition, error bar represents the standard error at 5% level of significance.

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III. Results and Discussion

Plant height: Plant height of chrysanthemum exposed statistically significant variation among 32 cultivars at 30, 40 and 50 days after transplanting (DAT) (Figure 01). The range of plant height was from 71.8 cm to 23.7 cm. The tallest plant was found from V_{13} (71.8 cm) whereas the shortest from V_8 (23.7 cm) at 50 DAT of chrysanthemum cultivars (Table 01). Present study referred that V_{13} (Sunny Yellow) exposed as the tallest plant among the cultivars at mature stage. Kim *et al.* (2014) found a range of 19.3–64.6 cm plant height in 15 Taxa of Korean chrysanthemum species and Ara *et al.* (2012-2013) found a range of 36-70 cm. While Chandragiri *et al.* (2004) recorded maximum 132.16 cm plant height from Solomon Impala variety of chrysanthemum. Some cultivars of chrysanthemum were vigorous in growth and some were less vigorous, this might be caused by varietal characters responsible by a gene. As a genetically controlled factor, plant height varied among the cultivars of chrysanthemum (Kanamadi and Patil, 1993; Barigidad and Patil, 1992 and Baskaran *et al.,* 2010). Similar variation in plant height among varieties was also observed in marigold (Raghuvanshi *et al.,* 2011) and in rose (Hussain and Khan, 2004). The higher plant height obtained from plants could be attributed to increased photosynthetic capacity of the plants in asters (Vrsek *et al.,* 2006).

Number of branches: 32 cultivars showed statistically significant difference at 30, 40 and 50 DAT (Figure 02) for number of branches per plant. Maximum number of branch was recorded from V6 (19.7/plant) while minimum from V2 (2.5/plant) at 50 DAT of chrysanthemum cultivars (Table 02). V_7 cultivar (Yellow Glow) performed best in case number of branches per plant. Chaugule (1985) recorded a maximum 16.56 branches in chrysanthemum. Barigidad and Patil (1992) recorded a range of 2.75 to 18.58 branches in case of chrysanthemum cultivar. Difference in branches among the chrysanthemum cultivars could be due to influence of genetical make up of chrysanthemum cultivars (Hicklenton, 1985; Moe, 1988; Chezhian *et al.,* 1985 and Kanamadi and Patil, 1993). Similar variation for number of branches was also observed in China aster (Munikrishnappa *et al.*, 2013).

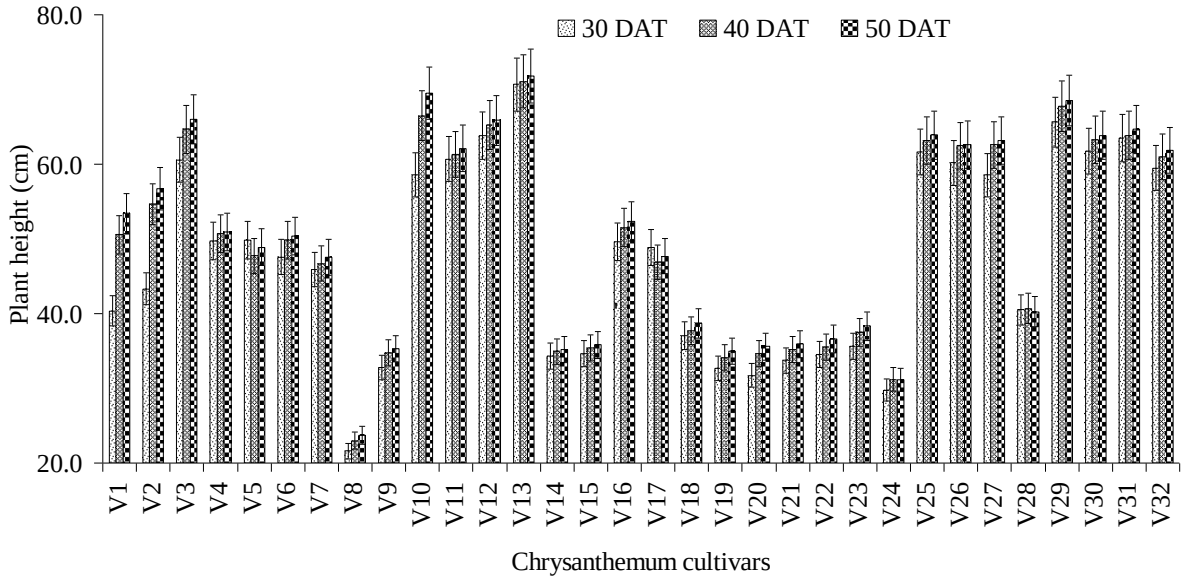

Figure 01. Performance of 32 chrysanthemum cultivars for plant height at different days after transplanting

Number of leaves: Chrysanthemum cultivars showed significant variation for number of leaves per 20 cm branch. Maximum number of leaves was observed from V_{11} (13.3/20 cm branch) and minimum from V_{14} and V_{24} (4.5/20 cm branch) (Table 01). The result referred that V_{11} (Lavender Mum) produced maximum number of leaves per branch (20 cm). Similar result on number of leaves was observed by Barigidad and Patil (1992) in chrysanthemum. Variation in number of leaves was previously reported by Wilfret *et al.* (1973). This difference for number of leaf per branch among cultivars was due to their genetic composition (Charles, 1995).

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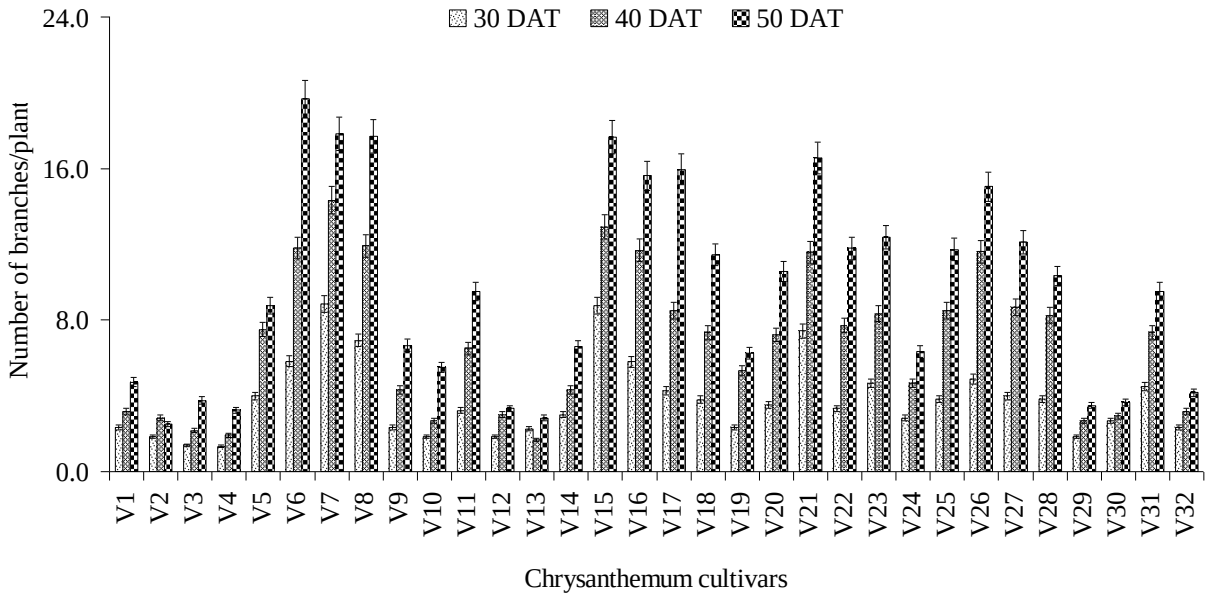

Figure 2. Performance of 32 chrysanthemum cultivars for number of branches per plant at different days after transplanting

Leaf area: Leaf area showed significant variation among chrysanthemum cultivars. Maximum leaf area was found from V_1 (52.9 cm^2) whereas minimum from V_{29} (5.9 cm^2) which scored lowest after flowering (Table 01). Results showed that V_1 (Crimson Tide) provided maximum leaf area. Mitra and Paul (2008) recorded 47.2 cm^2 leaf areas in un-pinched single stem cultivar of chrysanthemum. Greater leaf area may lead to more dry matter accumulation, which resulted in the accumulation of maximum photosynthates that contributed to produce bigger sized flower or more number of flowers. Similar variation in leaf area among cultivars was found in carnation (Gharge *et al.*, 2009; Shiragur *et al.*, 2004). Variation in leaf area indicates additive gene effects would be effective in gerbera (Nair and Shiva, 2003), dahlia (Vikas *et al.*, 2011) and in chrysanthemum (Barigidad and Patil, 1992). Leaf area was found to be positively related with flower yield in carnation (Mahesh *et al.*, 1996).

Chlorophyll content: Chlorophyll content varied significantly among chrysanthemum cultivars. Maximum chlorophyll content was obtained from V_{10} (59.0 %) and lowest was obtained from V_{29} (23.9 %) at mature stage (Table 01). This finding referred that V_{10} (Sunny Yellow) produced maximum chlorophyll percentage. Similar findings were obtained in wheat by Hamblin *et al.* (2014). This variation in chlorophyll percentage might be attributed to genetically differences. This variation might be due to the varietals characters as reported by (Thomas and Lekharani, 2008) in orchid. Chlorophyll content in leaf enhanced photosynthetic activity, which produce carbohydrates. Carbohydrates serve as energy source for growing bud, flower opening and longevity. The ultimate effect of all these factors resulted into strong and long flower stalks, large sized buds or flower (Tarannum, 2014).

Table 01. Performance of 32 chrysanthemum cultivars on plant height, number of branch, number of leaf per 20cm branch, leaf area and chlorophyll content[Y]

Variety[X]	at 50 DAT		No. of leaf/branch (20 cm)	Leaf area (cm^2)	Chlorophyll content (%)
	Plant height (cm)	Number of branch/plant			
V_1	53.4 h	4.7 m	6.3 ghijk	52.9 a	48.7 l
V_2	56.8 g	2.5 q	5.8 ijklm	50.0 b	47.8 n
V_3	66.0 c	3.8 no	5.3 lmno	23.8 gh	52.2 gh
V_4	50.9 ij	3.3 op	5.6 klmno	42.2 c	49.0 l
V_5	48.9 kl	8.8 j	6.9 efg	20.9 l	41.8 q
V_6	50.4 jk	19.7 a	9.4 c	10.8 r	48.5 lm

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V_7	47.6	l	17.8	b	9.5	c	35.8	e	55.9	c
V_8	23.7	r	17.7	b	10.4	b	15.9	q	53.7	ef
V_9	35.3	op	6.7	k	6.5	ghij	31.2	f	57.7	b
V_{10}	69.5	b	5.5	l	4.8	op	18.6	m	59.0	a
V_{11}	62.1	f	9.5	i	13.3	a	20.8	l	45.6	o
V_{12}	65.9	c	3.3	op	6.3	ghijk	20.6	l	50.5	j
V_{13}	71.8	a	2.8	pq	6.5	ghij	49.7	b	50.3	jk
V_{14}	35.2	op	6.6	k	4.5	p	18.0	mn	50.6	j
V_{15}	35.8	op	17.7	b	12.8	a	15.8	q	49.7	k
V_{16}	52.3	hi	15.6	de	5.7	jklmn	22.2	k	43.0	p
V_{17}	47.7	l	16.0	cd	7.4	de	17.2	op	40.4	r
V_{18}	38.7	n	11.5	g	7.7	d	17.6	no	51.6	hi
V_{19}	35.0	p	6.2	k	6.7	efgh	7.3	s	30.3	t
V_{20}	35.6	op	10.6	h	6.5	ghij	7.2	st	31.0	s
V_{21}	36.0	op	16.6	c	6.0	hijkl	6.5	tu	28.7	u
V_{22}	36.6	o	11.8	fg	8.8	c	24.2	g	55.0	d
V_{23}	38.3	n	12.4	f	6.6	fghi	15.6	q	54.4	de
V_{24}	31.1	q	6.3	k	4.5	p	7.4	s	28.6	u
V_{25}	63.9	de	11.7	fg	7.5	de	39.4	d	50.9	ij
V_{26}	62.6	ef	15.0	e	6.3	ghijk	16.7	p	47.8	mn
V_{27}	63.2	def	12.1	fg	5.7	jklmn	22.4	jk	53.5	f
V_{28}	40.3	m	10.3	h	5.9	ijkl	23.1	hi	57.0	b
V_{29}	68.5	b	3.5	nop	5.8	ijklm	5.9	u	23.9	v
V_{30}	63.9	de	3.7	no	5.1	mnop	23.0	ij	52.5	g
V_{31}	64.7	cd	9.5	i	5.0	nop	23.2	hi	52.4	g
V_{32}	61.9	f	4.2	mn	7.3	def	23.9	g	51.8	gh
CV%	*0.6*		*4.4*		*7.0*		*1.9*		*0.9*	
$LSD_{(0.05)}$	*1.5*		*0.7*		*0.8*		*0.7*		*0.7*	

[X]Chrysanthemum cultivars; [Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Days to flower bud initiation: Significant variation was found (visual observation) among 32 chrysanthemum cultivars for the number of days to the emergence of flower bud (from days after transplantation of chrysanthemum suckers). Late flower bud initiation was found in V_9 (52.7 days) while earlier in V_3 (17.8 days) (Table 02). This findings referred that V_3 (White Snowball) was early flower bud initiating cultivar. Difference in number of days for flower bud initiation, number of days for flowering among different cultivars might be due to presence of sufficient genetic variability. Similar findings were obtained in Dahlia by Mishra and Saini (1997).

Days to first petal spread: Significant variation was found among the chrysanthemum cultivars in respect of days taken to first petal spread (from days after transplantation of chrysanthemum suckers). The shortest period was required for first petal spread in V_3 (39.5 days) while the longest period in V_4 (71.6 days) (Table 02). The result showed that V_3 cultivar (Sweet Vase) required minimum days for first petal spreading. Chrysanthemum required maximum 74.2 days for flower initiation (Wilfret, 1973) and minimum 31.25 days for first flower initiation (Joshi *et al.*, 2010). This difference was due to genetical makeup of the cultivars. Similar variation was found in chrysanthemum (Baskaran *et al.*, 2010) and China aster (Zosiamliana *et al.*, 2012).

Days to final bloom: Significant difference was found among the chrysanthemum cultivars for the days taken from planting to final bloom. The shortest period was required for final bloom in V_6 (52.8 days) while the longest period in V_4 (77.5 days) which was statistically identical with V_{10} (77.3 days) ,V_1 (77.2 days),V_9 (76.7 days) and V_{30} (76.7 days) (Table 02). The result showed that V_6 (Rose Pink) was early blooming cultivar. Flowering period was ranged from 50.59 to 132.99 days in chrysanthemum (Barigidad and Patil, 1996), which resulted late and early flowering habits among cultivars Flowering times in chrysanthemum are affected by varietal characters, habitat and species type (Kim *et al.*, 2014 and Rajashekaran *et al.*, 1985).

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Number of flower bud: Significant difference was observed for cumulative number of flower buds per plant in chrysanthemum cultivars at 30, 40 and 50 DAT (Figure 03). Maximum cumulative number of flower bud was found from V_{15} (199.0/plant) whereas minimum was found from V_2 (4.3/plant) at 50 DAT of chrysanthemum cultivars (Table 02). V_{15} cultivar (Yellow Bay) showed the best result in case of number of flower bud per plant.

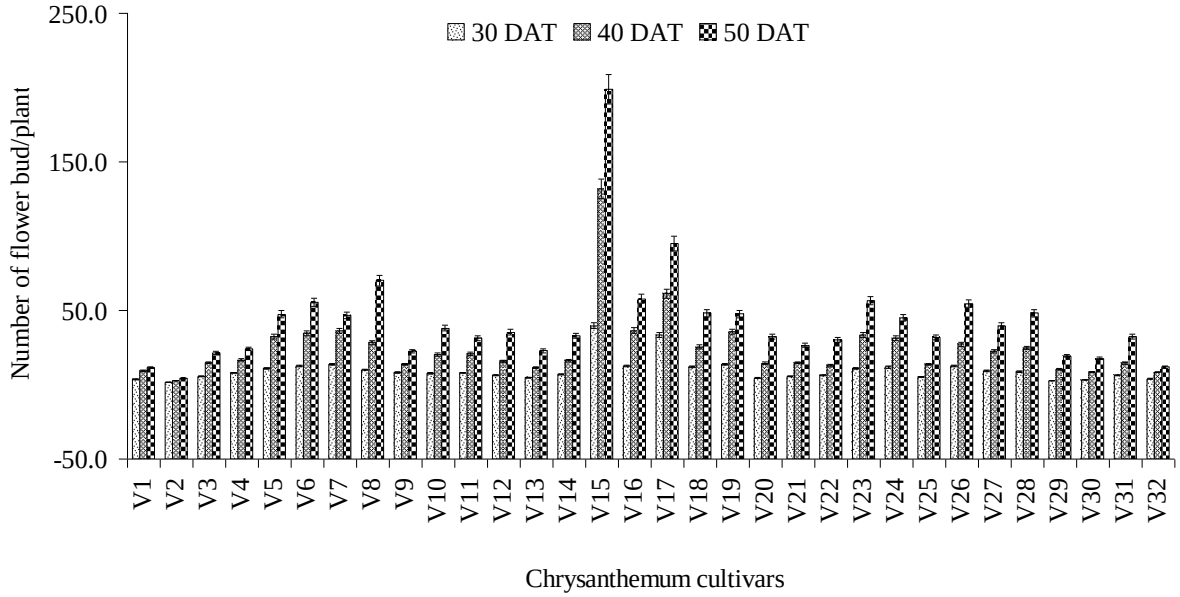

Figure 3. Performance of 32 chrysanthemum cultivars for number of flower bud per plant at different days after transplanting

Number of flower: Significant variation was found among the chrysanthemum cultivars in case of number of flower per branch. Maximum number of flower was found in V_{15} (9.4/ 20 cm branch) while minimum from V_1, V_2, V_{10}, V_{21}, V_{24}, V_{30} and V_{31}, (1.0/20 cm branch) (Table 02). This findings referred that V_{15} (Yellow Bay) produced maximum number of flower per branch. Numbers of maximum potential flowers per lateral branches were recorded, ranged from 6 to 8 (Wilfret *et al.,* 1973). The highest number of flowers/branch (10.43) was produced by genotype White Anemone followed by Gauri (9.08) and Appu (7.66) (Punetha *et al.*, 2011). Variation in number of flowers per plant is related to recurrent blooming habit due to their genetic makeup (Nadeem *et al*., 2011). Variation in flower yield was also observed previously in China aster (Negi and Raghava, 1985), in chrysanthemum (Chezhian *et al.,* 1985) and marigold (Howe and Waters, 1991).

Number of flower: Significant variation was recorded among chrysanthemum cultivars performance in respect to the number of flower per plant. Maximum number of flower was found from V_{15} (194.6/plant) whereas minimum was recorded form V_2 (4.3/plant) (Table 02). The result showed that V_{15} (Yellow Bay) performed as maximum flower producing cultivar. Chrysanthemum flower number was ranged from 25.0 to 100.0/plant (Wilfret *et al.,* 1973) and 66.0 to 301.0 /plant (Punetha *et al.,* 2011). Cultivar Button Type Local recorded the highest number of flowers per plant (287.00), whereas cv. Cass recorded the lowest (37.00) (Baskaran *et al.,* 2010). In an experiment Ara *et al.* (2012-13) recorded maximum 70 flowers per plant in Chrysanthemum. Variation in number of flowers per plant was also observed previously in chrysanthemum (Chezhian *et al.,* 1985) and in gerbera (Mahmood *et al*., 2013). Further these genotypes had fairly high dry matter accumulation which might have contributed for increase flower yield. Similar results were obtained in chrysanthemum (Negi and Raghava, 1985) and in marigold (Arora and Singh, 1980) and in gerbera (Nair and Mehedi, 2004). Higher yield might be due to increase in morphological parameters like plant height, number of leaves and leaf area which might have contributed in production of more photosynthates resulting in greater accumulation of dry matter which in turn leads to production of more number of flowers per plant (Ramzan *et al.*, 2014).

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Table 02. Performance of 32 chrysanthemum cultivars on days to flower bud initiation, days to first petal spread, days to final bloom, number of flower bud/plant, number of flower/branch (20 cm) and number of flower/plant[Y]

Variety[X]	Days to flower bud initiation	Days to first petal spread	Days to final bloom	No. of flower bud/plant at 50 DAT	No. of flower /branch (20 cm)	No. of flower /plant
V_1	49.3 b	66.6 de	77.2 a	11.7 x	1.0 k	10.3 t
V_2	38.8 c	58.7 kl	73.5 d	4.3 **y**	1.0 k	4.3 v
V_3	17.8 r	39.5 v	59.9 o	21.4 u	2.8 i	20.3 q
V_4	34.4 de	71.6 a	77.5 a	24.3 s	2.8 i	22.6 p
V_5	31.7 f	55.3 o	68.7 jk	47.5 hi	5.1 e	46.7 f
V_6	26.5 lm	44.0 t	52.8 r	55.5 f	8.5 b	54.7 d
V_7	24.8 n	52.7 pq	64.5 m	46.8 i	6.8 d	45.6 g
V_8	33.7 e	58.3 lm	70.3 hi	70.2 c	7.9 c	67.6 c
V_9	52.7 a	67.4 cd	76.7 a	22.5 t	2.8 i	20.3 q
V_{10}	29.3 gh	69.5 b	77.3 a	38.1 l	1.0 k	36.3 j
V_{11}	27.6 jk	56.6 n	72.6 e	31.4 p	6.5 d	29.3 m
V_{12}	32.5 f	62.7 f	72.4 ef	35.3 m	3.0 hi	30.7 k
V_{13}	23.8 o	62.5 fg	74.5 bc	22.8 t	3.8 f	20.5 q
V_{14}	29.3 gh	57.5 m	71.5 fg	33.2 n	3.5 fg	30.3 kl
V_{15}	28.2 ij	60.2 ij	74.6 bc	199.0 a	9.4 a	194.6 a
V_{16}	22.7 p	48.0 r	73.8 cd	58.0 d	1.8 j	55.5 d
V_{17}	23.9 no	55.4 o	69.2 j	95.0 b	3.6 f	92.0 b
V_{18}	24.4 no	46.0 s	54.6 q	48.2 h	3.1 ghi	45.9 g
V_{19}	28.8 hi	53.6 p	69.2 j	47.6 h	3.4 fgh	45.4 g
V_{20}	28.4 ij	42.2 u	56.6 p	32.6 n	3.0 hi	29.7 lm
V_{21}	31.9 f	52.8 pq	65.2 m	26.6 r	1.0 k	26.7 o
V_{22}	28.0 ijk	67.6 c	74.4 bc	30.3 q	3.0 hi	27.6 n
V_{23}	26.6 lm	61.6 gh	74.3 bcd	56.4 e	3.0 hi	55.3 d
V_{24}	25.8 m	55.7 no	67.7 l	44.8 j	1.0 k	42.4 h
V_{25}	28.5 hi	59.4 jk	68.0 kl	31.8 op	3.5 fg	29.7 lm
V_{26}	34.8 d	60.9 hi	71.8 efg	54.7 g	3.0 hi	51.7 e
V_{27}	34.3 de	65.7 e	74.9 b	39.6 k	2.0 j	38.5 i
V_{28}	19.1 q	52.4 q	62.0 n	48.2 h	2.9 i	45.8 g
V_{29}	21.2 kl	59.3 jk	71.0 gh	19.5 v	1.8 j	17.5 r
V_{30}	29.3 gh	61.8 g	76.7 a	17.7 w	1.0 k	14.5 s
V_{31}	30.2 g	57.7 m	69.5 ij	32.5 no	1.0 k	30.5 kl
V_{32}	30.0 g	55.7 o	69.4 j	11.8 x	3.0 hi	9.5 u
CV%	*1.8*	*1.0*	*0.8*	*1.1*	*8.1*	*1.2*
$LSD_{(0.05)}$	*0.9*	*0.9*	*0.9*	*0.8*	*0.4*	*0.8*

[X]Chrysanthemum cultivars; [Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

Bud diameter at initiation stage: Bud diameter of chrysanthemum cultivars varied significantly at initiation stage. Maximum bud diameter was obtained from V_4 and V_{10} (7.1 mm) cultivars whereas minimum was obtained from V_{19} and V_{24} (1.7 mm) cultivars at initiation stage (Table 03). This result showed that V_4 (Chandramukhi) and V_{10} (Sunny Yellow) provided maximum bud diameter at initiation stage.

Bud diameter at mature stage: Significant variation was observed among chrysanthemum cultivars in terms of bud diameter at mature stage. Maximum bud diameter was found from V_1 (19.1 mm) whereas minimum was found from V_{24} (6.3 mm) which was statistically identical with V_{15} (6.5 mm) and V_8 (6.9 mm) (Table 03). The findings referred that V_1 (Crimson Tide) provided maximum bud diameter at mature stage. Small sized flowers are produced due to the less number of petals in its flower bud and large sized flowers are produced due to more number of petals in flower bud. Similar findings were found in carnation by (Maitra and Roychowdhury, 2014)

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Flower head diameter: Flower head diameter showed significant variation among the chrysanthemum cultivars after blooming. Maximum flower diameter was recorded from V_1 (17.6 cm) while minimum from V_{14} (2.8 cm) which was statistically identical with V_{15} (2.9) (Table 03). This result indicated that V_1 (Crimson Tide) cultivar produced maximum flower diameter. Flower diameter of chrysanthemum ranged from 8.0 to 12.4 cm (Kunigunda, 2004) whereas 1.9 to 15.4 cm (Wesenberg *et al*., 1964) and 2.5 to 7.8 cm (Ara *et al*., 2012-13). The maximum diameter of 'Crimson Tide' might be due to inherent character of individual cultivars. Similar variations have been reported previously in Chrysanthemum (Kanamadi and Patil, 1993 and Rajashekaran *et al.,* 1985), in Gerbera (Mahmood *et al*., 2013).

Stalk length: Significant variation was recorded for stalk length among chrysanthemum cultivars. The longest stalk of chrysanthemum flower was found from V_1 (20.1 cm) which was statistically identical with V_{13} (19.8 cm) and V_2 (19.7 cm) while the shortest was found from V_{11} (4.4 cm) which was statistically identical with V_5 (4.5 cm), V_6 (4.7 cm), V_9 (4.7 cm), V_{19} (4.8 cm), V_{24} (4.8 cm), V_{23} (4.9 cm) and V_{26} (5.0 cm) (Table 03). The result indicated that V_1 (Crimson Tide) cultivar performed as the longest stalk length producing cultivar. This difference in stalk length could be attributed to a genetic factor which is expected to vary among cultivars. Similar findings were found in gerbera (Sarkar and Ghimaray, 2004). It was observed that the cultivars with higher plant height produced the longer flower stalk as compared to cultivars with smaller plant heights. Similar findings were reported in rose (Ramzan *et al*., 2014; Mantur *et al*., 2005; Fascella and Zizzo, 2005) and in snapdragon (Shafique *et al*., 2011).

Flower durability (days to 50% flower senescence): Chrysanthemum cultivars showed significant variation in terms of days taken to 50% flower senescence. Late flower senescence was recorded in V_{21} (20.7 days) which was statistically identical with V_{11} (19.8 days) while early flower senescence was observed in V_{24} (11.3 days) (Table 03). The result indicated that V_{21} (First Light) and V_{11} (Lavender Mum) cultivars performed best in case of flower durability. It was found that durability of potted chrysanthemum varied greatly according to the cultivars. Generally being ethylene non-sensitive flower the difference in days taken to flower senescence may be due to varietal characteristics of different chrysanthemum cultivars. Similar findings were found in rose (Tabassum *et al*., 2002) and in gerbera (Nair and Mehedi, 2004).

Table 03. Performance of 32 chrysanthemum cultivars on bud diameter at initiation stage and mature stage, flower head diameter, stalk length and days to 50% flower senescence

Variety[x]	Bud diameter at initiation stage (mm)	Bud diameter at mature stage (mm)	Flower head diameter (cm)	Stalk length (cm)	Days to 50% flower senescence
V_1	4.8 d	19.1 a	17.6 a	20.1 a	13.9 jk
V_2	4.6 de	18.1 b	16.0 b	19.7 a	13.7 k
V_3	2.8 kl	16.9 c	14.6 c	16.6 de	15.3 ghi
V_4	7.1 a	16.0 d	13.6 d	16.1 e	16.3 def
V_5	1.9 mn	8.6 p	3.7 pq	4.5 o	15.9 defg
V_6	2.6 jk	8.9 op	4.7 lmn	4.7 no	15.8 efg
V_7	2.8 j	10.5 lm	4.9 lm	5.7 lm	17.8 b
V_8	3.2 i	6.9 r	5.0 l	5.2 mn	17.7 bc
V_9	2.4 kl	11.9 ij	7.8 i	4.7 no	16.8 cd
V_{10}	7.1 a	14.7 e	6.8 jk	16.8 d	18.3 b
V_{11}	1.8 mn	10.0 mn	8.8 g	4.4 o	19.8 a
V_{12}	4.2 fg	14.2 e	8.7 g	19.0 b	14.5 ijk
V_{13}	4.4 ef	18.0 b	9.8 f	19.8 a	14.2 jk
V_{14}	2.9 j	12.6 gh	2.8 r	7.5 jk	14.7 hij
V_{15}	3.0 j	6.5 r	2.9 r	11.6 g	17.7 bc
V_{16}	2.7 jk	11.6 jk	6.9 j	18.0 c	17.7 bc
V_{17}	3.9 gh	9.5 no	4.6 mn	9.7 h	16.5 de

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V_{18}	2.1	lm	7.6	q	4.0	p	5.7	lm	17.8	b
V_{19}	1.7	n	7.7	q	3.9	p	4.8	no	17.7	bc
V_{20}	1.9	mn	8.7	p	4.1	op	6.9	k	18.4	b
V_{21}	2.1	lm	8.9	op	3.8	p	8.3	i	20.7	a
V_{22}	2.9	j	8.7	p	4.7	lmn	6.0	l	14.4	ijk
V_{23}	2.0	lm	7.5	q	4.9	lm	4.9	no	16.7	de
V_{24}	1.7	n	6.3	r	3.3	q	4.8	no	11.3	l
V_{25}	6.7	b	13.0	fg	6.6	jk	7.6	j	15.9	efg
V_{26}	5.2	c	13.6	f	4.4	no	5.0	no	15.8	efg
V_{27}	6.6	b	13.3	f	6.4	k	11.6	g	13.7	k
V_{28}	2.1	lm	11.0	kl	6.7	jk	5.7	lm	18.3	b
V_{29}	4.6	de	12.3	hi	8.1	hi	7.8	ij	15.5	fgh
V_{30}	3.8	hi	11.4	jk	8.2	h	7.9	ij	16.0	defg
V_{31}	4.4	ef	13.3	f	7.9	hi	13.5	f	13.7	k
V_{32}	3.9	gh	15.8	d	11.3	e	17.7	c	14.5	ijk
CV%	*6.1*		*3.0*		*3.5*		*3.9*		*3.5*	
$LSD_{(0.05)}$	*0.4*		*0.6*		*0.4*		*0.6*		*0.9*	

[X]Chrysanthemum cultivars; [Y]In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

IV. Conclusion

Chrysanthemum cultivars showed wide range of variations in their growth and flowering characteristics. Maximum number of flower was found in V_{15} (9.4/ 20 cm branch and 194.6/plant). Large flower (17.6 cm flower head diameter) with longest stalk (20.1 cm) was found in V_1. On the other hand, late flower senescence from the plant was recorded in V_{21} (20.7 days). Breeders can easily select the desirable characters from this wide range of variation for the development of the chrysanthemum flowers.

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