



Assessment of Standard Chrysanthemum Genotypes for Morphological and Floral Attributes in Terai Region of West Bengal, India

Dipayan Sarkar ^a, Indrajit Sarkar ^{a*}, Soumen Maitra ^a,
Ranjit Chatterjee ^b, Surajit Khalko ^c and Sankalpa Ojha ^d

^a Department of Floriculture, Medicinal and Aromatic Plants, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal-736165, India.

^b Department of Vegetable Science, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal-736165, India.

^c Department of Plant Pathology, Faculty of Agriculture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal-736165, India.

^d Department of Agricultural Statistics, Faculty of Agriculture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal-736165, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/jabb/2024/v27i101572>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/125197>

Original Research Article

Received: 19/08/2024
Accepted: 21/10/2024
Published: 26/10/2024

*Corresponding author: E-mail: indrajit@ubkv.ac.in;

ABSTRACT

Aims: Chrysanthemum (*Dendranthema grandiflora* Tzvelev) is one of the most economically important and economically favoured floricultural crops used as cut flower, loose flower, potted plants, bedding and border plants, making garlands, flower decoration, bracelet, venis and religious offerings. The present study aimed to evaluate and select suitable large flowering chrysanthemum cultivars for commercial cultivation in Terai region of West Bengal.

Location of the Study: The experiment was conducted in the Instructional Farm, Department of Floriculture, Medicinal and Aromatic Plants, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya during the period of September to February of 2022-23 and 2023-24.

Materials: Thirty five different cultivars of large flowering chrysanthemum were evaluated based on their growth and flowering parameters viz. Angel Bell, Autumn Blaze, Autumn Day Light, Bolare Deo, Cassa Granda Yellow, Chengis Khan, Coronation Gold, Cossak, Diamond Jubilee, Dignity, Dream Castle, Golden Yellow, Green Goddess, Innocence, J.S.Loyed, Jane Sharp, Jessie Hab Good, Kasturba Gandhi, Kenroken Pink, Kenroken White, Kikubiory, Lady Frank Klerk, Phil Houghton, Pink Cloud, Pinkling, Raja, Red Wine, Royal Prince, Royal Purple, Silk Brocade, Snowball, Sonar Bangla, Temptation, Willium Turner and Yellow Reonet.

Methodology: One month old rooted cuttings were planted at a spacing of 40 cm X 30cm (Row to row 40cm and plant to plant 30cm) in 1.6m X 1.2 m raised bed. Total 16 plants were planted in one plot.

Statistical Design: The experiment was laid out in completely randomized block design replicated thrice. Collected data was analyzed by one-way analysis of variance with the help of SPSS software.

Results: Significant variation was observed among the genotypes. Maximum plant spread (N-S) of 36.33±5.90, 39.00±1.55 and 37.67±4.13 cm was observed in Snowball in the year 2022-23, 2023-24 and pooled respectively whereas minimum plant spread (N-S) of 16.42±1.73 cm was observed in Cassa Granda Yellow. The maximum number of flowers per bed 282.74, 291.34 and 287.04 was recorded in Pinkling during the first year, second year, and pooled data, respectively, while the minimum number of flowers per bed (140.60 and 149.55) was observed in Autumn Blaze during the first year pooled data, respectively while in second year Pink Cloud (145.40) recorded the minimum numbers of flowers per bed.

Conclusion: From the study, it may be recommended that the cultivars like Snowball, Sonar Bangla, Pinkling, Temptation are suitable for cut flowers. The cultivars namely Silk Brocade, Pink Cloud, Diamond Jubilee, Coronation Gold, Innocence, Kenroken White and Kenroken Pink may be selected for pot plants and for garden display due to profuse uniform branching and blooming.

Keywords: Chrysanthemum; evaluation; flowers; genotypes.

1. INTRODUCTION

Chrysanthemum (*Dendranthema grandiflora* Tzvelev) is one of the most economically important and economically favoured floricultural crops which belongs to family Asteraceae and used as cut flower, loose flower, potted plants, bedding plants, border plants, making garlands, flower decoration, bracelet, venis and religious offerings [1]. It is also known as Queen of East or Autumn Queen and in Hindi it is called as Guldaudi [2]. After rose, it ranked second in the cut flower trade. It was named by Carolus Linnaeus from the Greek prefix "chryos" which means golden and "anthemon" which means flower. It is originated in northern hemisphere (Europe and Asia) but some reported that China

is the native place [3]. In China, Chrysanthemum was first cultivated as a flowering herb back during 15th century BC and then it was introduced to Japan, England, France, United States [4]. Chrysanthemum is the Imperial Emblem of Japan. In India, chrysanthemum is grown commercially and it ranks third in terms of area with 16.63 thousand ha [5]. The genus *Chrysanthemum* consists of about 160 species among which *Chrysanthemum morifolium*. Ramat is most important. About 2000 varieties have been reported around world and 1000 varieties from India [6]. Chrysanthemums are mainly classified as 13 large flowering classes and 10 small flowering classes. Chrysanthemums are also classified as standard and spray types where standards are generally

used as cut flowers while sprays are used as pot mums, cut sprays and loose flowers. The Terai region has notable variations in day and night length which favours for initiation of chrysanthemum flower during the months of October and November. In this sense, considering the neighbouring flower markets of Siliguri, Assam, and North East, Nepal, Bangladesh, and Bhutan, chrysanthemum might be a viable flower crop for West Bengal's Terai region. While choosing suitable cultivars is an important part of export-focused commercial floriculture, there hasn't been much research done in this area. Because the agro-climatic conditions here are distinct, it is imperative that a set of similarly productive chrysanthemum cultivars can be chosen specifically for this region. The present study aimed to evaluate and select suitable large flowering chrysanthemum cultivars for commercial cultivation in Terai region of West Bengal.

2. MATERIALS AND METHODS

The experiment was conducted in the Instructional Farm, Department of Floriculture, Medicinal and Aromatic Plants, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya during the period of September to February of 2022-23 and 2023-24. Thirty five different cultivars of large flowering chrysanthemum were evaluated based on their growth and flowering parameters viz. Angel Bell, Autumn Blaze, Autumn Day Light, Bolare Deo, CassaGranda Yellow, Chengis Khan, Coronation Gold, Cossak, Diamond Jubilee, Dignity, Dream Castle, Golden Yellow, Green Goddess, Innocence, J.S.Loyed, Jane Sharp, Jessie Hab Good, Kasturba Gandhi, Kenroken Pink, Kenroken White, Kikubiory, Lady Frank Klerk, Phil Houghton, Pink Cloud, Pinkling, Raja, Red Wine, Royal Prince, Royal Purple, Silk Brocade, Snowball, Sonar Bangla, Temptation, William Turner and Yellow Reonet. One month old rooted cuttings were planted at a spacing of 40 cm X 30cm (Row to row 40cm and plant to plant 30cm) in 1.6m X 1.2 m raised bed. Total 16 plants were planted in one plot. After 30 days, the plants were pinched to encourage secondary branches and broaden the growth and bamboo sticks were used for stacking. The experiment was laid out in completely randomized block design replicated thrice. Collected data was analyzed by one-way analysis of variance with the help of SPSS software.

3. RESULTS AND DISCUSSION

3.1 Plant Spread (North-South) (cm)

The plant spread can have a considerable impact on its overall aesthetic attractiveness, especially when planted as a bedding plant or in garden displays. Plant spreads that are balanced and well-proportioned are more appealing to gardeners and landscapers. The data presented in the Table 1 revealed that the maximum plant spread (N-S) of 36.33 ± 5.90 , 39.00 ± 1.55 and 37.67 ± 4.13 cm was observed in Snowball in the year 2022-23, 2023-24 and pooled respectively whereas minimum plant spread (N-S) of 16.42 ± 1.73 cm was observed in CassaGranda Yellow followed by Innocence (17.20 ± 0.78 cm) in the year 2022-23, 17.72 ± 1.17 cm and 17.46 ± 0.94 cm was observed in Innocence in the year 2023-24 and pooled respectively. Plant spread may increase owing to the creation of new branches and the genetic composition of the plant. Plant dispersal varies owing to additive gene effects [7,8,9]. Banerji et al. [10] reported that CassaGranda and Snowball exhibited plant spread of 27.01 and 27.71 cm respectively. Priya and Singh [11] found similar plant spread results in their research.

3.2 Total Number of Leaves per Plant

The perusal of data depicted in the Table 1 reflected that the large flowering chrysanthemum cultivars varied significantly with respect to total number of leaves per plant. Among the thirty five cultivars the maximum total number of leaves per plant of 795.34 ± 28.66 and 785.11 ± 31.03 was observed in William Turner in first year and pooled respectively while in second year Snowball reported the maximum number of leaves per plant (818.04 ± 24.17). The minimum number of leaves per plant (149.37 ± 7.73 , 147.84 ± 8.41 and 148.61 ± 7.27) was observed in Raja in first year, second year and pooled respectively. The explanation for variation in the number of leaves per plant might be related to variations in genotype genetic makeup, since both vegetative and floral qualities are primarily influenced by genotype genetic constitution and their interactions with environment [12]. A similar finding spread for number of leaves per plant has been reported by Poonam and Kumar [13]. They had discussed correlation between plant height and plant spread. These factors causing increased plant height might be due to production of increased number of branches

Table 1. Plant spread (North-South) (cm) and number of leaves per plant of large flowering Chrysanthemum cultivars in Terai Region of West Bengal

Genotypes	Plant spread (North-South) (cm)			Number of leaves per plant		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
Angel Bell	23.45±2.36	23.17±1.01	23.31±1.63	252.27±14.89	231.01±14.37	241.64±17.51
Autumn Blaze	17.30±1.60	18.10±0.36	17.70±1.13	378.07±68.36	361.95±35.96	370.01±49.64
Autumn Day Light	26.88±0.64	28.54±1.94	27.71±1.58	479.69±55.20	515.99±60.46	497.84±55.46
BolareDeo	21.03±1.49	21.53±0.64	21.28±1.06	405.63±18.18	376.05±23.22	390.84±24.70
CassaGranda Yellow	16.42±1.73	21.22±2.28	18.82±3.19	152.74±24.97	164.50±20.61	158.62±21.47
Chengis Khan	23.30±1.48	23.64±0.15	23.47±0.96	233.33±12.19	223.28±8.18	228.31±10.79
Coronation Gold	24.30±2.43	25.12±0.40	24.71±1.62	246.29±31.04	251.24±20.70	248.77±23.75
Cossak	19.23±1.46	18.83±1.39	19.03±1.29	248.71±37.05	230.29±19.38	239.50±28.30
Diamond Jubilee	35.30±2.06	34.92±0.99	35.11±1.46	410.21±37.81	397.93±19.61	404.07±27.76
Dignity	29.78±1.94	30.40±0.28	30.09±1.29	291.86±29.97	309.82±20.65	300.84±25.03
Dream Castle	21.63±0.44	23.97±1.29	22.80±1.54	204.70±8.26	199.41±9.88	202.06±8.64
Golden Yellow	23.35±1.53	23.91±0.65	23.63±1.09	233.08±33.60	251.68±33.72	242.38±31.79
Green Goddess	20.20±1.43	18.26±0.92	19.23±1.51	366.55±6.88	390.90±4.26	378.73±14.28
Innocence	17.20±0.78	17.72±1.17	17.46±0.94	239.02±32.42	235.71±18.48	237.37±23.67
J.S.Loyed	29.18±1.31	29.62±0.70	29.40±0.97	390.66±16.35	404.30±17.51	397.48±16.89
Jane Sharp	19.92±0.77	21.12±0.71	20.52±0.93	234.38±19.86	235.95±11.71	235.17±14.60
Jessie Hab Good	30.93±0.87	33.93±1.54	32.43±1.98	389.60±14.93	372.05±9.86	380.83±14.85
Kasturba Gandhi	29.15±0.80	31.87±1.65	30.51±1.98	218.23±16.66	211.45±13.67	214.84±14.12
Kenroken Pink	30.25±1.28	29.61±0.28	29.93±0.90	299.29±66.83	291.47±35.00	295.38±47.91
Kenroken White	23.08±1.19	25.74±1.56	24.41±1.91	315.32±17.80	342.05±16.93	328.69±21.35
Kikubiory	24.95±0.89	24.95±0.40	24.95±0.62	403.44±45.72	397.03±8.29	400.23±29.59
Lady Frank Klerk	26.48±1.20	25.94±0.83	26.21±0.97	296.64±12.75	276.35±7.93	286.49±14.62
Phil Houghton	29.50±2.43	27.92±1.76	28.71±2.08	160.77±15.67	159.97±5.91	160.37±10.60
Pink Cloud	19.47±1.66	20.75±0.56	20.11±1.31	272.82±24.54	287.91±24.82	280.36±23.57
Pinkling	24.60±1.39	24.34±0.17	24.47±0.89	348.21±22.86	348.79±26.64	348.50±22.20
Raja	20.40±2.48	20.62±0.58	20.51±1.61	149.37±7.73	147.84±8.41	148.61±7.27
Red Wine	21.95±1.78	22.13±0.29	22.04±1.14	391.20±37.86	444.59±41.52	417.90±46.02
Royal Prince	26.78±1.94	26.68±0.21	26.73±1.23	328.26±63.69	325.52±36.97	326.89±46.60
Royal Purple	20.02±1.22	19.36±0.35	19.69±0.88	187.35±18.03	195.23±16.59	191.29±16.09
Silk Brocade	20.62±1.59	21.08±0.54	20.85±1.09	407.35±3.51	418.96±5.37	413.16±7.55
Snowball	36.33±5.90	39.00±1.55	37.67±4.13	728.05±52.92	818.04±24.17	773.05±61.51
Sonar Bangla	34.60±1.43	32.60±0.98	33.60±1.55	433.89±32.04	439.69±21.42	436.79±24.58

Genotypes	Plant spread (North-South) (cm)			Number of leaves per plant		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
Temptation	27.67±0.85	31.33±1.83	29.50±2.38	704.82±55.28	704.84±15.18	704.83±36.26
William Turner	31.50±2.38	32.16±0.30	31.83±1.56	795.34±28.66	774.89±35.66	785.11±31.03
Yellow Reonet	19.52±1.03	22.84±1.66	21.18±2.20	163.11±2.25	160.84±4.08	161.98± 3.20
SEm (±)	0.902	0.591	0.539	15.008	12.098	9.639
CD (P=0.05)	2.545	1.668	1.507	42.353	34.141	26.957

Table 2. Total number of flowers per bed and fresh weight of flower (g) of large flowering Chrysanthemum cultivars in Terai Region of West Bengal

Cultivars	Total Number of Flowers Per Bed			Fresh Weight of Flower (g)		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
Angel Bell	189.29 ± 31.79	229.09 ± 3.97	209.19 ± 29.76	13.44 ± 0.94	14.92 ± 0.38	14.18 ± 1.03
Autumn Blaze	211.76 ± 20.51	223.98 ± 2.59	217.87 ± 14.69	5.42 ± 0.28	5.27 ± 0.33	5.35 ± 0.28
Autumn Day Light	165.13 ± 29.14	234.85 ± 6.44	199.99 ± 42.60	12.48 ± 0.78	13.37 ± 0.43	12.93 ± 0.74
BolareDeo	168.24 ± 21.72	241.53 ± 8.76	204.89 ± 42.79	5.92 ± 0.80	7.03 ± 0.35	6.48 ± 0.82
CassaGranda Yellow	147.70 ± 34.25	237.09 ± 7.42	192.39 ± 53.74	6.92 ± 1.67	9.25 ± 0.47	8.09 ± 1.68
Chengis Khan	209.22 ± 21.68	224.79 ± 2.63	217.00 ± 16.23	20.78 ± 0.60	23.18 ± 0.49	21.98 ± 1.40
Coronation Gold	185.99 ± 33.07	231.63 ± 5.10	208.81 ± 32.75	6.16 ± 0.28	6.50 ± 0.33	6.33 ± 0.33
Cossak	212.73 ± 19.67	222.25 ± 2.53	217.49 ± 13.58	9.10 ± 1.51	9.56 ± 1.02	9.33 ± 1.18
Diamond Jubilee	191.83 ± 30.56	228.29 ± 3.66	210.06 ± 27.89	21.98 ± 0.96	23.17 ± 0.67	22.58 ± 0.99
Dignity	206.68 ± 22.86	225.59 ± 2.73	216.14 ± 17.87	11.91 ± 0.65	13.03 ± 0.43	12.47 ± 0.79
Dream Castle	155.02 ± 34.16	238.08 ± 7.84	196.55 ± 50.61	17.03 ± 0.57	18.84 ± 0.35	17.94 ± 1.08
Golden Yellow	203.40 ± 25.27	225.46 ± 2.62	214.43 ± 20.10	18.78 ± 0.83	21.72 ± 0.58	20.25 ± 1.73
Green Goddess	161.31 ± 45.52	237.89 ± 7.78	199.60 ± 51.11	17.80 ± 1.22	18.47 ± 1.16	18.14 ± 1.13
Innocence	182.76 ± 11.79	172.77 ± 5.63	177.77 ± 9.91	8.93 ± 0.35	9.34 ± 0.55	9.14 ± 0.47
J.S.Loyed	140.60 ± 6.32	158.50 ± 24.86	149.55 ± 18.95	10.70 ± 1.02	11.76 ± 1.49	11.23 ± 1.28
Jane Sharp	234.37 ± 30.90	230.46 ± 16.27	232.41 ± 22.19	22.26 ± 0.19	24.11 ± 0.69	23.19 ± 1.11
Jessie Hab Good	196.92 ± 28.12	226.69 ± 3.08	211.81 ± 24.21	20.09 ± 0.97	20.73 ± 2.15	20.41 ± 1.53
Kasturba Gandhi	161.27 ± 38.47	241.74 ± 8.78	201.50 ± 50.65	8.65 ± 0.37	9.28 ± 0.60	8.96 ± 0.56
Kenroken Pink	170.80 ± 40.48	236.46 ± 7.14	203.63 ± 44.38	12.84 ± 0.59	14.26 ± 0.41	13.55 ± 0.90
Kenroken White	172.39 ± 38.79	235.10 ± 5.95	203.75 ± 42.38	20.95 ± 0.36	21.83 ± 0.50	21.39 ± 0.62
Kikubiory	194.38 ± 29.33	227.49 ± 3.35	210.94 ± 26.03	15.34 ± 0.81	16.85 ± 0.50	16.09 ± 1.02
Lady Frank Klerk	166.93 ± 22.81	243.35 ± 9.51	205.14 ± 44.68	12.05 ± 1.55	13.18 ± 0.75	12.61 ± 1.25
Phil Houghton	158.13 ± 46.72	240.50 ± 8.93	199.32 ± 54.22	20.62 ± 1.04	21.35 ± 0.44	20.99 ± 0.82
Pink Cloud	156.03 ± 7.22	145.10 ± 9.74	150.57 ± 9.73	12.92 ± 1.97	13.99 ± 2.55	13.45 ± 2.12
Pinkling	282.74 ± 15.48	291.34 ± 17.57	287.04 ± 15.54	18.62 ± 1.13	18.97 ± 0.67	18.79 ± 0.85

Cultivars	Total Number of Flowers Per Bed			Fresh Weight of Flower (g)		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
Raja	156.48 ± 34.35	244.96 ±10.23	200.72 ± 53.50	6.23 ± 0.33	6.93 ± 0.36	6.58 ± 0.49
Red Wine	198.66 ± 27.01	227.59 ± 3.62	213.13 ± 23.42	21.50 ± 1.12	22.94 ± 0.45	22.22 ± 1.10
Royal Prince	245.93 ± 16.30	218.79 ±15.34	232.36 ± 20.53	6.86 ± 0.33	6.21 ± 0.88	6.54 ± 0.70
Royal Purple	217.27 ± 18.73	220.30 ± 2.22	218.79 ± 12.04	8.27 ± 0.33	7.53 ± 0.88	7.90 ± 0.72
Silk Brocade	164.39 ± 24.03	244.16 ± 9.87	204.28 ± 46.68	17.51 ± 0.49	18.26 ± 0.53	17.89 ± 0.61
Snowball	196.43 ± 39.40	245.33 ±11.11	220.88 ± 37.25	15.52 ± 0.67	16.33 ± 0.43	15.93 ± 0.67
Sonar Bangla	192.94 ± 38.32	245.55 ±10.58	219.25 ± 38.24	17.87 ± 0.70	17.30 ± 0.95	17.59 ± 0.81
Temptation	202.01 ± 25.70	225.09 ± 2.58	213.55 ± 20.66	18.47 ± 2.05	19.79 ± 0.62	19.13 ± 1.53
William Turner	183.82 ± 33.86	232.05 ± 5.54	207.93 ± 34.19	19.08 ± 0.82	19.45 ± 0.76	19.26 ± 0.74
Yellow Reonet	178.40 ± 36.76	234.12 ± 5.06	206.26 ± 38.50	13.90 ± 0.88	15.02 ± 0.65	14.46 ± 0.92
SEm (±)	10.971	4.429	5.916	0.554	0.495	0.371
CD (P=0.05)	30.960	12.499	16.695	1.563	1.397	1.047

± indicates the Standard Deviation values, CD indicates critical difference and SEm indicates standard error of means

Table 3. Colour of large flowering chrysanthemum cultivars (as per RHS colour chart)

Sl.No.	Name of Genotypes	Colour of flower	Sl.No.	Name of Genotypes	Colour of flower
1.	Angel Bell	Red Purple 65 C	19.	Kenroken Pink	Purple Group 75-B
2.	Autumn Blaze	Greyed Orange 168 C	20.	Kenroken White	White Group NN 155 D
3.	Autumn Day Light	Yellow Orange Group 22A	21.	Kikubiory	Yellow Group 11 A
4.	BolareDeo	Red Gr 46 A	22.	Lady Frank Klerk	Yellow Group 3 A
5.	CassaGranda Yellow	Yellow Gr 3-D	23.	Phil Houghton	Yellow Group 3 D
6.	Chengis Khan	Greyed -Red grp 180A	24.	Pink Cloud	Red Purple Group 69-D
7.	Coronation Gold	Orange Red 34 C	25.	Pinkling	Purple Group 76 B
8.	Cossak	Greyed Red 180 A	26.	Raja	Red Purple Group 58 A
9.	Diamond Jubilee	Orange Red N-34 C	27.	Red Wine	Red Group 53A
10.	Dignity	Red Purple Gr 67 D	28.	Royal Prince	Red Purple Group N 74 -C
11.	Dream Castle	Red Purple Group 68 B	29.	Royal Purple	Red Purple Group 71 -A
12.	Golden Yellow	Yellow Gr 3 A	30.	Silk Brocade	Red Purple Group 70-A
13.	Green Goddess	White Group N N155 D	31.	Snowball	White Group NN 155 D
14.	Innocence	White Group N N 155D	32.	Sonar Bangla	Yellow Group 3 A
15.	J.S.Loyed	Purple gr 75 C	33.	Temptation	Red Purple Group 71A
16.	Jane Sharp	Red Group 53 -A	34.	William Turner	White Group NN 155 D
17.	Jessie Hab Good	Yellow Group 3- C	35.	Yellow Reonet	Yellow Group 7A
18.	Kasturba Gandhi	White Group N N155 D			

along with stem diameter. Variation of leaf number among different germplasm was also observed by Barigidad and Patil [14], Charles [15], Pralhad [16], Kumar et al. [17] in different flowering plants.

3.3 Total Number of Flowers per Bed

The total number of flowers per bed showed significant variation across cultivars. The maximum number of flowers per bed 282.74, 291.34 and 287.04 was recorded in Pinkling during the first year, second year, and pooled data, respectively, while the minimum number of flowers per bed (140.60 and 149.55) was observed in Autumn Blaze during the first year pooled data, respectively while in second year Pink Cloud (145.40) recorded the minimum numbers of flowers per bed (Table 2). Flower production is a great indication for plant characterization for a variety of uses. Higher yield might be attributed to an increase in morphological characteristics such as plant height, plant spread, and number of branches, which could have led to the generation of more photosynthates, resulting in the production of more flowers per plant [18]. The largest flower number per bed might be linked to the commencement of more branches per plant, which eventually results in the development of more flower buds per plant, resulting in an increase in yield [19].

3.4 Fresh Weight of Flower

The fresh weight of flowers showed significant variation across cultivars. The maximum fresh weight of 22.26 g, 24.11 g, and 23.19 g was recorded in Jane Sharp during the first year, second year, and pooled data, respectively, while the minimum fresh weight (5.42 g, 5.27 g, and 5.35 g) was observed in Autumn Blaze during the first year, second year, and pooled data, respectively (Table 2). The variance in floral weight character across types was mostly attributable to increased flower size with conspicuous centre disc florets and the presence of a relatively greater number of mature ray florets [20]. The difference in yield (g) might be explained by the additive gene effect [21]. Banerji et al.[10] found similar results of fresh weight of flower. Variation in average weight of flower among the varieties was also reported by Joshi et al. [22], Gantait and Pal [23] and Baskaran et al. [9].

3.5 Flower Colour (as per RHS Colour Chart)

Flower colours were measured with the help of Royal Horticulture Society colour chart (Anonymous, 1966) inside the departmental laboratory. The results revealed that among the thirty five cultivars eight cultivars reflected yellow colour, seven cultivars showed white colour, ten cultivars purple colour group, four orange colour group and six red colour group. The shades of colour were shown in the Table 3. Similar observations were also recorded by various workers on varietal evaluation of chrysanthemum cultivars on the basis of colour of the flower [24,25,26] also concluded that the variation in flower colour among chrysanthemum cultivars is due to genetic makeup and colouring pigments present in a particular genotype. Red colour flower is due to anthocyanin pigment, yellow colour flower is due to chalcones and auronones. The white colour of flower is due to flavonols and carotenoid pigment, while purplish colour is due to cyanidin pigment. Brar et al. [27], Kaushal and Bala [28] and Asha et al.[29] characterized genotypes according to the colour with the assistance of an R.H.S colour chart and listed them with their corresponding colour group. In a similar study, Abhishek and Bala [30] reported that Kikubiory, Autumn Blaze, Snowball and Sonar Bangla reflected Yellow group (6-A), Orange Red group (31-A), White group (155-A) and Yellow White group (158-C) respectively. Banerji et al. [10] also reported the colour of Snowball was White Group 155C fan 4. Dwivedi and Banerji [31] reported that Changes Khan, Dignity, CassaGranda (W), Silk Brocade, Diamond Jubilee, J.S.Loyed, Red Wine, Yellow Rayonet, Kikubiory, Snowball and Sonar Bangla exhibited Bronze & Orange colour, red, white, pink, yellow, creamy yellow, red, yellow, deep yellow, white and yellow colour shades respectively which justify the present result.

4. CONCLUSION

Based on the observations and data analysis, it is possible to conclude that thirtyfive large flowering chrysanthemum cultivars differed significantly. These cultivars can be further classified based on their features. Furthermore, these cultivars might be recommended as cut flower, potted flowering plants for exhibition purposes and bedding flowering plants for making herbaceous border. As a result, these morphological and floral attributes will be a

valuable resource for breeders and researchers in identifying new characteristics in future flower traits development and proposing better cultivars to the farming communities who are associated with commercial cultivation of flowers in the Terai region of West Bengal. From the study, it may be recommended that the cultivars like Snowball, Sonar Bangla, Pinkling, Temptation are suitable for cut flowers. The cultivars namely Silk Brocade, Pink Cloud, Diamond Jubilee, Coronation Gold, Innocence, Kenroken White and Kenroken Pink may be selected for pot plants and for garden display due to profuse uniform branching and blooming.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

ACKNOWLEDGEMENTS

Authors would like to acknowledge to the Departmental Laboratory of Floriculture, Medicinal and Aromatic Plants, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bohra M, Kumar A. Studies on effect of organic manure and bio-inoculants on vegetative and floral attributes of chrysanthemum cv. Little Darling. The Bioscan. 2014;9(3):1007-1010.
2. Koley S, Sarkar MM. Measurement of PAR and its impact on chrysanthemum (*Chrysanthemum morifolium* Ramat). The Bioscan. 2013;8(1):169-172.
3. Carter GD. Potted chrysanthemums. In: Larson R A (ed) Introduction to Floriculture. Academic Press Inc., New York; 1980.
4. Anderson NO. Flower breeding and genetics: Issues, challenges and opportunities for the 21st century. Springer Science & Business Media; 2006.
5. Janakiram T, Rao TM. Chrysanthemum. Indian Institute of Horticulture Research, Bangalore. 2001;36.
6. Kumar R, De LC, Baiswar P. Production of chrysanthemum under greenhouse condition; 2019.
7. Vidalie HI, Laffaire MI, Rivere LM, Charperitier S. First result on the performance of gerbera cultivated on rockwool. Revue Horticole. 1985;262:13-18.
8. Sirohi PS, Behera TK. Genetic variability in chrysanthemum. J Orn Hort. 2000;3(1):34-36.
9. Baskaran V, Jayanthi R, Janakiram T, Abirami K. Studies on genetic variability, heritability and genetic advance in chrysanthemum. J Hortic Sci. 2010;4(2):174-176.
10. Banerji BK, Batra A, Dwivedi AK. Morphological and biochemical characterization of chrysanthemum. J Hort Sci. 2012;7(1):51-55.
11. Priya A, Singh D. Germplasm characterization of chrysanthemum (*Dendranthema grandiflora* Tzevlev) genotypes under Bihar conditions. Ann Agric Res New Series. 2022;43(2):232-236.
12. Sujija NV, Suresh J, Kumar SR, Kannan M. Evaluation of chrysanthemum (*Chrysanthemum morifolium* Ramat) genotypes for loose flower, cut flower and pot mums. Int J Innov Res Adv Std. 2016;3(4):101-104.
13. Poonam, Kumar. 'Garden Beauty' – A promising chrysanthemum (*Dendranthema grandiflora* Tzevlev) cultivar for garden decoration. J Orn Hort. 2007;10(3):165-168.
14. Barigheid H, Patil AA. Relative performance of chrysanthemum cultivars under transitional tract of Karnataka. Karnataka J Agric Sci. 1997;10(1):98-101.
15. Charles G. Floriculture design and merchandising. Delmar Publisher, Washington, DC. 1995;394-399.
16. Pralhad GC. Evaluation of carnation (*Dianthus caryophyllus* L.) varieties under greenhouse condition. M.Sc. thesis, University of Agricultural Sciences, Dharwad, India; 2009.
17. Kumar R, Deka BC, Roy AR. Evaluation of orchid species under sub-tropical mid hills of Meghalaya. Hortflora Res Spectrum. 2012;1(1):24-28.
18. Singh S, Kumar R, Poonam. Evaluation of chrysanthemum (*Dendranthema grandiflora* Tzevlev) open pollinated seedlings for vegetative and floral characters. J Ornamental Hort. 2009;11(4):271-274.

19. Prabhu G, Thamaraiselvi SP, Aruna P, Sudhakar R. Evaluation of chrysanthemum (*Dendranthema grandiflora*Tzevlev) cultivars for loose flower production under Coimbatore conditions. Int J Chem Stud. 2018;6:1618-21.
20. Kireeti A, Ravindrababu M, Ramadevi P. Evaluation of chrysanthemum (*Dendranthema grandiflora* Tzevlev) varieties in humid coastal zone of Andhra Pradesh. J Horticult Sci. 2017;3:370-72.
21. Behera TS, Sirohi PS, Anand P. Assessment of *Chrysanthemum germplasm* for commercial cultivation under Delhi conditions. J Ornamental Hort. 2002;5(2):11-14.
22. Joshi M, Verma LR, Masu MM. Performance of different varieties in the transitional tracts of Karnataka. South Indian Horticult. 2009;41:58-60.
23. Gantait SS, Pal P. Correlation studies in spray chrysanthemum (*Chrysanthemum morifolium* Ramat) under polyhouse and open field. Environ Ecol. 2009;27(3):1070-1072.
24. Wilfert GJ, Harbaugh BK. Mini pot garden chrysanthemum cultivar characteristics and consumer preference. Proc Flor Sta Hort Soc. 1980;92:317-19.
25. Chaudhary R. Development and evaluation of chrysanthemum (*Dendranthema grandiflora*Tzevlev) hybrids for pot culture. M.Sc. thesis, Punjab Agricultural University, Ludhiana, India; 1997.
26. Singh LJ, Khangjarkpam G, Shadukan R, Dhua RS. Quality characterization of new chrysanthemum cultivars. J Pharmacogn Phytochem. 2019;8:1611-1617.
27. Brar PK, Bala M. Morphological descriptors and quality parameters in chrysanthemum (*Chrysanthemum morifolium* Ramat) for dustesting. Agric Res J. 2022;59(2):313-317.
28. Kaushal S, Bala M. DUS characterization of chrysanthemum (*Chrysanthemum morifolium* Ramat) genotypes suitable for pot culture. J Ornamental Hort. 2018;21(3&4):102-108.
29. Asha KM, Sane A, Kumar R. Characterization of chrysanthemum (*Dendranthema grandiflora*) genotypes as per DUS guidelines. Indian J Agric Sci. 2016;86(1):103-112.
30. Abhishek K, Bala M. Morphological characterization of standard chrysanthemum (*Chrysanthemum morifolium* Ramat). J Horticult Sci. 2023; 18(1):240-243.
31. Dwivedi AK, Banerji BK. Chrysanthemum: An ocean of beauty. National Conference on Forest Biodiversity: Earth's Living Treasure. 2011; 119-124.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/125197>