Screening of chrysanthemum genotypes for quality traits under Ayodhya regions of Uttar Pradesh

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ABSTRACT

Fifteen chrysanthemum genotypes were screened under pot conditions in a Completely Randomized Design (CRD) with three replications during 2023–2024 at the Main Experiment Station, College of Horticulture and Forestry, Acharya Narendra Deva University, Ayodhya (U.P.). Significant variations were observed among genotypes for morphological, physiological, qualitative, and yield traits. 'Autumn White' recorded maximum plant height (59.33 cm) and inter-nodal length (4.33 cm), while 'Kusum' and 'Phyllis' showed early bud (71 days) and flower initiation (88 days), respectively. 'Sport' produced the highest number of ray florets (322), largest flower diameter (12.52 cm), and highest flower fresh (8.72 g) and dry weight (0.74 g). 'Liliput' had the highest flower count per plant (164), and 'Sunny' showed maximum leaf area (23.82 cm²). 'Phyllis' also had the highest chlorophyll content (0.31 mg/g). 'Zembla' exhibited maximum stem diameter (3.97 mm), flowering duration (30.33 days), and shelf life (6.67 days). These superior genotypes hold potential for use in cut flowers, loose flowers, and pot plant production, and in future breeding programs.

Keywords: Chrysanthemum, genotypes, morphological traits, quality, yield

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflorum* Tzvelev), a key member of the Asteraceae family, holds significant global importance as both a cut flower and a potted ornamental plant. Renowned for its diverse flower forms, vibrant colors, and extended vase life, chrysanthemum ranks second after rose in spray types and seventh among standard cut flowers globally (Anonymous, 2017). Commonly known as "mums" or "chrysanths," it is regionally referred to as *Guldaudi*, *Chandramalika*, *Samanti*, and *Shevanti* across various parts of India. Characterized by a capitulum inflorescence composed of numerous small florets, chrysanthemum is a short-day plant, requiring less than 13.5–14.5 hours of daylight for flower bud initiation. This photoperiodic response restricts natural flowering to a limited seasonal window, typically spanning three months.

In India, chrysanthemum is cultivated over approximately 30.13 thousand hectares, yielding 463.73 thousand metric tons (MT) of loose flowers and 18.60 thousand MT of cut flowers. Chrysanthemum exhibits extensive phenotypic variability influenced by genotype, region, season, and environmental conditions (Singh *et al*. 2017). In Northern India, traditional varieties are favored for ornamental and display purposes, whereas in the south, spray types dominate, primarily for garlands and religious offerings during the festive season.

The commercial value of chrysanthemum has expanded beyond floriculture into industries such as essential oil, perfumery, aromatherapy, cosmetics, natural dyes, and pharmaceuticals. Major constituents in chrysanthemum (*C. indicum*) oil are Camphor, Isoborneol, α- Tepinene and Caryophyllene oxide and *Chrysanthemum morifolium* oil are Comphor, Curcumene, Pentacosane, Borneol. Chrysanthemum oil is extracted through various methods including distillation, soxhlet extraction (Swati *et al*. 2024). Chrysanthemum species contain high levels of phenolic acids and flavonoids including chlorogenic acid, luteolin, rutin, quercetin, and apigenin which confer strong antioxidant and free-radical scavenging activities. *Chrysanthemum indicum* extracts showed IC_{50} values of ~77.2 µg/mL (flowers) and ~101.9 µg/mL (leaves) in DPPH assay, with similarly potent results in ABTS assays (Kim *et al*. 2024). Technological advancements in photoperiodism and genetics now enable year-round production. However, varietal limitations persist, particularly in meeting the growing demand for novel flower traits and enhanced adaptability. To address these gaps, a systematic screening of 15 chrysanthemum genotypes was undertaken at the Department of Floriculture and Landscaping, College of Horticulture & Forestry, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya. The study aimed to assess morphological and physiological traits of selected chrysanthemum varieties and evaluate their quality and yield-related characteristics. This investigation seeks to identify superior genotypes suited for commercial cultivation in Eastern Uttar Pradesh, thereby enhancing productivity, profitability, and cultivar diversity.

MATERIALS AND METHODS

The present study was conducted during the 2023–2024 growing season at the main experimental station (Horticulture), Floriculture Unit, Department of Floriculture and Landscaping, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India. The experimental site is geographically situated at 26.47° N latitude, 82.12° E longitude, and an altitude of 113 meters above mean sea level. The region experiences a subtropical climate, characterized by hot summers, moderate monsoons, and cool winters. The soil type of Kumarganj, Ayodhya was silty loam with average fertility level and pH in the range of 7.0 to 8.0.

Fifteen genotypes of chrysanthemum (*Dendranthema grandiflorum* Tzvelev) were selected for screening, *viz.*, Zembla, Sunny, Autumn Pink, Autumn White, Banglore Button, Sport, White Prolific, Liliput, Kusum, Neelima, Diana Orange, Phyllis, Mayur, Lilia Spray and Pusa Chitraksha. The experiment was laid out in a Completely Randomized Design (CRD) with three replications. Uniform, healthy rooted cuttings were transplanted into 10-inch earthen pots containing a standardized growing medium composed of loamy soil, sand, and well-decomposed farmyard manure (FYM) in a 2:1:1 ratio. The water-soluble fertilizers were applied one week after planting NPK (19:19:19) @ 2g per liter of water and same dose weekly was repeated to promote vegetative growth. At the bud initiation stage, NPK @ 10:20:15 was applied 2g per litre of water to enhance the production and quality of flowers, along with micronutrients such as boron and ferrous were applied @ 2 g/l during the flowering stage and irrigation was scheduled based on crop requirements. Pinching was performed 30 days after transplanting to promote lateral shoot. Plants were regularly monitored for signs of pest infestations and disease symptoms, and appropriate phytosanitary measures were taken as needed.

Observations were recorded on a range of morphological, physiological, quality, and yield-related traits. Morphological and physiological parameters included plant height, number of sprays per plant, plant spread, stem diameter, internodal length, days to first bud initiation, days to first flower opening, leaf area, total chlorophyll content (Chlorophyll a and b, were measured using a SPAD meter), fresh flower weight, and dry flower weight. Quality and yield traits comprised number of flowers per plant, flowering duration, number of ray florets per flower, flower diameter, shelf life under ambient conditions, flower yield per plant, flower color (categorized using the RHS color chart), and flower type (classified based on standard horticultural descriptors such as decorative, pompon, or spider forms). All collected data were subjected to statistical analysis using analysis of variance (ANOVA) to determine the significance of differences among the genotypes. The critical difference (CD) at 5% probability level was calculated to compare treatment means where applicable.

RESULTS AND DISCUSSION

Morphological and physiological traits

The present study revealed highly significant variability among the fifteen evaluated chrysanthemum genotypes for all the morphological and physiological traits (Table 1), underscoring the influence of genotypic constitution and environmental interactions on plant performance under the agro-climatic conditions of Eastern Uttar Pradesh. Among the genotypes, 'Autumn White' exhibited the highest plant height (59.33 cm), whereas 'Phyllis' recorded the shortest stature (32.00 cm). These variations are indicative of differential growth vigour and are consistent with previous reports by Suvija *et al*. (2016), who emphasized the role of both genetics and micro-environmental factors in determining plant architecture. Similarly, significant variation was observed in the number of leaves per plant, with 'Mayur' producing the highest number (72.67), while 'Bangalore Button' produced the fewest (22.33). Such differences highlight the potential for selecting genotypes with superior vegetative growth for enhanced photosynthetic capacity and overall productivity, as also noted by Thakur *et al*. (2018). Similarly, Lisianthus showed variations in number of leaves among cultivars leaves are the functional unit of photosynthesis, which greatly influenced the growth and flower yield of the crop recorded by Bindhu *et al*. (2024).

Branching behaviour, as measured by the number of sprays per plant, also varied significantly. 'Liliput' showed the highest number of sprays (9.00), while both 'Sunny' and 'Phyllis' showed limited branching with only 3.00 sprays per plant. These observations support the findings of Jamaluddin *et al*. (2015), who reported genotypic differences in lateral shoot formation, which is a desirable trait for increasing the number of flowering stems in ornamental crops. Plant spread ranged from a maximum of 47.00 cm in 'Nilima' to a minimum of 15.67 cm in 'Bangalore Button'. A wider plant spread is advantageous in landscaping and bedding uses, and this variability corroborates earlier findings by Arora *et al.* (1999), suggesting the importance of genotype selection for plant architecture traits.

Variation in stem diameter was evident, with the thickest stems recorded in 'Zembla' (3.97 mm) and the thinnest in 'Liliput' (2.97 mm). Stem robustness is a key trait influencing the plant's ability to support flowers and withstand mechanical stresses, and its genotypic control was similarly highlighted by Rajiv *et al*. (2007). The internodal length, another growth parameter linked to plant compactness, showed considerable variation from 4.33 cm in 'Autumn White' to 1.40 cm in 'Lilia Spray', indicating that genotypic background significantly affects node elongation, a result consistent with Pasha *et al*. (2015).

Phenological traits such as days to bud initiation and flowering also varied significantly among genotypes. 'Kusum' initiated budding the earliest (71 days), whereas 'Phyllis' was the earliest to flower (88 days). Early flowering genotypes are especially valuable for floriculture markets targeting specific festival or sale windows, and these results align with the observations of Behera *et al*. (2002).

In terms of photosynthetic traits, 'Sunny' exhibited the highest leaf area (23.82 cm²), while 'Diana Orange' showed the lowest (7.19 cm²). Leaf area is closely tied to light interception and photosynthetic potential, and its variability indicates potential selection for genotypes with superior photosynthetic efficiency under regional conditions. The content of total chlorophyll content also varied, with ‘Liliput’ having the highest concentration (0.22 mg g^{-1}) and ‘Pusa Chitraksha’ the lowest (0.09 mg g^{-1}), suggesting that physiological efficiency in terms of light harvesting and photosynthetic activity differs significantly across genotypes. Anitha *et al*. (2000) similarly highlighted the role of chlorophyll concentration in plant productivity.

Flower biomass, both fresh and dry, followed a similar genotypic pattern. ‘Sport’ produced the heaviest flowers (8.72 g fresh and 0.74 g dry), whereas ‘Liliput’ recorded the lightest flowers in both fresh and dry form. These results indicate strong genetic control over biomass partitioning and flower development, supporting previous studies by Baskaran *et al*. (2010). Overall, the significant genotypic variability observed in morphological and physiological parameters provides a valuable base for identifying elite genotypes for commercial cultivation and breeding programs targeted to the specific agro-ecological conditions of Eastern U.P.

Qualitative and yield traits

Analysis of quality and yield traits (Table 2) revealed wide genotypic variation, confirming that significant potential exists within the screened germplasm for improvement of floral traits important for commercial floriculture. Among the genotypes, ‘Liliput’ stood out with the highest number of flowers per plant (164), making it a promising candidate for mass flowering applications, while ‘Diana Orange’ recorded the fewest flowers (12.33). These findings are in line with earlier studies by Kavitha *et al*. (2019) and Kumar *et al*. (2015), which also reported genotype-dependent flower productivity in chrysanthemum.

Floral morphology showed substantial variation as well. The number of ray florets per flower was highest in ‘Sport’ (322), followed by ‘Zembla’ (282), suggesting their suitability for use as attractive cut flowers due to their dense floret arrangement. In contrast, ‘Liliput’, with its compact and minimal floret structure, may be better suited for decorative or potted purposes. Flower diameter also varied greatly among genotypes, ranging from 12.52 cm in ‘Sport’ to just 2.41 cm in ‘Liliput’, illustrating the diversity in floral size preferences among market segments. These differences reflect underlying genetic factors and agree with Baskaran *et al*. (2016), who reported genotype-driven variations in flower morphology.

Flowering duration, an essential trait for commercial floriculture, also differed significantly, with ‘Zembla’ flowering the longest (30.33 days) and ‘Phyllis’ the shortest (17.00 days). Long flowering duration is advantageous for extended market availability and landscape use, and this variation is likely due to both genetic makeup and environmental adaptation, similar to findings by Srilatha *et al*. (2015).

Post-harvest longevity or flower shelf life, ranged from 1.67 days in ‘Kusum’ to 6.67 days in ‘Zembla’, underscoring genotypic differences in post-harvest physiology. Longer shelf life is a critical trait for cut flower markets, and these results are consistent with the work of Roopa *et al*. (2018), who emphasized the need to select genotypes with improved vase life for better marketability.

In terms of flower yield per plant, ‘Sport’ again emerged as the highest-yielding genotype (206.24 g), followed by ‘Nilima’ (194.40 g), while ‘Bangalore Button’ produced the lowest (18.18 g). This trait is a direct indicator of commercial value, and such marked variability provides opportunities for genetic enhancement of yield, as also reported by Singh and Dadlani (1989).

The diversity in flower color and type (Plate 1) was notable across the evaluated genotypes, ranging from white, yellow, orange, pink, red, and purple hues to an array of forms including decorative, pompom, incurve, single Korean, double Korean, and anemone types. Based on the RHS colour chart, white-flowered genotypes included 'Zembla', 'Sunny', 'Autumn White', and 'White Prolific'; red shades were represented by 'Lilia Spray'; dark red by 'Pusa Chitraksha'; yellow by 'Bangalore Button', 'Liliput', 'Kusum', 'Phyllis', and 'Mayur'; orange by 'Diana Orange'; light orange by 'Sport'; light pink by 'Autumn Pink'; and dark purple by 'Nilima'. Such diversity in ornamental features is critical for aesthetic appeal and consumer preferences and aligns with previous observations by Mishra *et al*. (1999).

The observed range of flower types included Anemone ('Mayur'), Pompom ('Zembla', 'Autumn White', 'Diana Orange'), Incurve ('Autumn Pink'), Decorative ('Bangalore Button', 'Sport', 'White Prolific', 'Nilima'), Single Korean ('Kusum', 'Pusa Chitraksha'), and Double Korean ('Sunny', 'Lilia Spray'). These traits greatly influence consumer preferences and are often used as selection criteria in breeding programs. The significant variation observed across all these parameters highlights the potential for targeted breeding and selection to develop improved varieties suited to both market and climatic requirements of the Eastern U.P. region.

CONCLUSION

The study revealed significant variability among chrysanthemum genotypes, identifying 'Autumn White', 'Zembla', and 'Sport' as promising for cut flower production, while varieties like 'Phyllis', 'Sunny', and 'White Prolific' showed potential for loose flowers and pot culture. These genotypes offer valuable traits for breeding and commercial cultivation under Eastern Uttar Pradesh conditions.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1: Effect of genotypes screening for morphological and physiological traits

Treatments	Plant height (cm)	No. of leaves/ plant	No. of spray/ plant	Spread of plant (cm)	Stem diameter (mm)	Inter-nodal length (cm)	Days to first bud initiation	Days to first flower initiation	Leaf area (cm^2)	Total chlorophyll ($mg\ g^{-1}$)	Fresh weight of flower (g)	Dry weight of flower (g)
Zembla	46.33	36.33	4.00	32.00	3.97	2.00	79.67	96.33	15.69	0.21	8.57	0.73
Sunny	33.33	47.33	3.00	30.67	3.25	2.33	74.00	95.00	23.82	0.22	2.14	0.32
Autumn Pink	47.67	33.67	3.00	30.00	3.31	3.17	81.00	96.33	13.32	0.16	6.84	0.53
Autumn White	59.33	62.33	6.67	39.00	2.88	4.33	81.33	104	10.95	0.26	3.97	0.37
Bangalore Button	38.67	22.33	3.33	15.67	3.56	2.17	78.33	98.00	14.39	0.21	1.43	0.14
Sport	44.33	45.33	4.33	25.00	3.64	2.83	88.00	102.00	11.85	0.26	8.72	0.74
White Prolific	50.67	30.33	4.67	27.33	3.22	3.40	78.67	91.33	10.19	0.26	2.74	0.25
Liliput	37.67	43.33	9.00	28.67	2.97	3.00	92.00	104.00	10.85	0.28	0.52	0.09
Kusum	50.67	33.67	5.00	31.67	3.19	2.93	71.00	98.33	23.09	0.21	1.44	0.19
Nilima	53.67	37.33	5.00	47.00	3.86	3.23	73.00	100.00	22.57	0.15	3.30	0.37
Diana Orange	43.33	27.67	3.33	20.33	3.28	3.83	81.33	97.00	7.19	0.21	4.58	0.41
Phyllis	32.00	53.00	3.00	34.33	3.17	2.17	72.33	88.00	10.58	0.31	1.04	0.14
Mayur	32.33	72.67	3.33	24.00	2.87	1.83	72.00	97.67	10.03	0.25	1.12	0.15
Lilia Spray	33.33	65.67	4.00	25.33	3.32	1.40	72.67	96.33	11.16	0.19	0.91	0.11
Pusa Chitraksha	44.33	48.00	4.67	32.33	3.67	2.73	105.67	121.67	14.23	0.13	1.00	0.12
S Em $\pm$	2.67	3.69	0.83	1.17	0.07	0.36	1.41	2.18	1.33	0.018	0.31	0.007
CD@5%	7.76	10.72	2.42	3.41	0.45	1.00	4.11	6.33	3.85	0.053	0.91	0.13

Table 2: Effect of genotypes screening for quality and yield traits

Treatment	No. of flowers/ plant	No. of ray florets/ flower	Diameter of flower (cm)	Flowering duration (days)	Shelf life (days)	Flower yield/ plant(g)	Flower colour	Flower type
Zembla	15.33	282.00	8.44	30.33	6.67	126.79	White	Pompom
Sunny	41.00	118.00	5.98	25.00	3.33	84.76	White	Double Korean
Autumn Pink	22.00	143.67	7.64	28.33	4.67	149.86	Light pink	Incurve
Autumn White	40.33	178.33	6.21	23.00	3.33	155.74	White	Pompom
Bangalore Button	13.00	34.67	5.22	20.00	3.33	18.17	Yellow	Decorative
Sport	23.67	322.00	12.32	29.33	6.00	206.24	Light orange	Decorative
White Prolific	42.33	274.67	5.83	28.00	3.33	113.49	White	Decorative
Liliput	164.00	126.67	2.41	27.67	2.33	86.93	Yellow	Pompom
Kusum	52.33	68.00	7.54	19.67	1.67	76.93	Yellow	Single Korean
Nilima	58.67	153.33	7.47	22.33	2.67	194.40	Dark purple	Decorative
Diana Orange	12.33	150.00	5.54	29.00	3.33	53.26	Orange	Pompom
Phyllis	63.67	121.33	5.29	17.00	2.00	66.76	Yellow	Double Korean
Mayur	87.00	32.33	4.09	20.67	3.67	95.12	Yellow	Anemone
Lilia Spray	83.00	68.33	5.32	21.00	3.00	76.93	Red	Double Korean
Pusa Chitraksha	85.00	35.00	5.70	27.00	2.67	86.77	Dark red	Single Korean
S Em ±	3.47	5.52	0.19	1.28	0.36	11.06		
CD@5%	10.08	16.02	0.55	3.73	1.06	32.11		

Plate: 1 Flowers photograph of screened fifteen chrysanthemum genotypes