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Genetic evaluation of different genotypes of pot chrysanthemum (Dendranthema grandiflora Tzvelev) for mid-hills of Himachal Pradesh

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Abstract

The present investigation, ‘Genetic evaluation of different genotypes of pot chrysanthemum (*Dendranthema grandiflora* Tzvelev) for mid-hills of Himachal Pradesh,’ was conducted at Dr. Y.S. Parmar University, Nauni, Solan, during 2024–2025. Twenty genotypes were evaluated in a Completely Randomized Design (CRD) with three replications under polyhouse conditions. Significant genotypic variability was observed across all parameters. ‘Mount Aubisque Apricot’ attained the maximum plant height (60.57 cm), while ‘Camargo’ exhibited the highest plant spread and flower diameter (7.95 cm). ‘Nova Lime’ was having highest peak flowering (161.53 days). The number of flowers per pot was recorded in ‘Artistic Armin’ (52.17). The ‘Artistic Dark Pink’ having largest flowering duration of 47.07 days and the highest pot presentability score of 94.45. High broad-sense heritability (H^2 > 91%) and substantial genetic gain were noted for flowers per pot and flowering duration, suggesting additive gene action and potential for improvement through direct selection. Correlation and path coefficient analyses identified the number of flowers per plant as the primary determinant of yield. The study concludes that while all genotypes were suitable for cultivation (presentability > 93.50), ‘Artistic Dark Pink’, ‘Nowara Red’, ‘Mario Pink’, ‘Gustavo Sunny’, ‘Flavio’, and ‘Nova Lime’ were identified as superior for their excellent presentability and prolonged flowering (> 37.17 days). These results provide a robust framework for breeders and commercial growers in selecting high-performing ornamental cultivars.

Introduction

Flowers are nature’s exquisite gift, symbolizing purity, peace and beauty. Within the floral kingdom, Chrysanthemum (*Dendranthema grandiflora* Tzvelev) holds a premier global position, ranking second among cut flowers after the rose due to its versatility, long vase life, and year-round availability (Eisa et al. 2022). In India, it is a leading loose flower, second only to marigold, and is essential for religious offerings and decorations.. It is the so-called ‘Glory of the East’ and ‘Autumn Queen’ and belongs to the Asteraceae family. By 2023-24, there were about 23.93 thousand hectares of Indian chrysanthemum in cultivation and 454.20 thousand tonnes of loose flowers were produced. These numbers bring out its commercial significance in such states as Karnataka, Tamil Nadu and Andhra Pradesh. It has won prizes in its diversity of color and form and is used commercially as well as in exhibitions to pot. Among ornamentals, ‘year-round pot mums’ lead the market, with dwarf varieties being ideal for container gardening. Key attributes include an extended blooming period of 45–50 days and high adaptability for off-season production. Cytogenetically, cultivated chrysanthemums are complex allohexaploids (2n = 6x = 54) frequently exhibiting aneuploidy, with somatic chromosome numbers ranging from 47 to 67 (Su J. et al. 2019). Breeding advancements, including photoperiodic control and growth regulators, have transformed them into a year-round crop. Chrysanthemum remains a dominant species in the global pot plant market (Crater GD. 1992). Ideal pot-grown cultivars exhibit a well-shaped, bushy habit, standing 1.5 to 2.5 times taller than their container with dense, dark green foliage. The pot mum must have at least 15–25 large blooms (Uddin et al. 2015). Genetic analysis plays a crucial role in the selection of better genotypes through the knowledge of variability, heritability and genetic gain of such traits as plant height, branching and flower size. This information gives a clue on trait inheritance, speeding up the enhancement by both traditional and molecular breeding (Archana et al. 2019). Consequently, this study evaluates various cultivars to assess their suitability for pot mum production. Therefore, the present investigation was carried out to study genetic evaluation of pot chrysanthemum (*Dendranthema grandiflora* Tzvelev) under mid hills of Himachal Pradesh.

Materials and Methods

The investigation, ‘Genetic evaluation of different genotypes of pot chrysanthemum (*Dendranthema grandiflora* Tzvelev) for mid-hills of Himachal Pradesh,’ was conducted during 2024–2025 at the Research Farm of the Department of Floriculture and Landscape Architecture, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) (30˚5'10" N latitude, 77˚11'30" E longitude; 1276 m elevation). This mid-hill zone features a sub-temperate to sub-tropical climate with moderate rainfall (1000–1300 mm). Healthy and disease-free planting material of twenty genotypes was supplied by Florance Flora, Bangalore in well-packed boxes and delivered to the university. The plants were carefully unpacked and checked for uniformity and overall health. Twenty genotypes (‘Artistic Armin’, ‘Artistic Dark Pink’, ‘Aurelio White’, ‘Camargo’, ‘Cesar’, ‘Cesar

Apricot', 'Flavio', 'Givilando', 'Gustavo Sunny', 'Isidro', 'Mario Pink', 'Mount Aubisque Apricot', 'Mount Aubisque Salmon', 'Mount Juno', 'Mount Kenya', 'Mount Pleasant', 'Mount Tourmalet', 'Nova Lime', 'Nowara Red' and 'Willian') were evaluated in a Completely Randomized Design (CRD) with three replications. Rooted cuttings were transplanted on May 2, 2024, into 8-inch pots containing a 1:1:1 (v/v) ratio of soil, sand and farmyard manure, with three plants per pot. Standard intercultural operations, including hoeing, weeding and pest management (Imidacloprid @ 0.5 ml/l for Aphid and white flies), were performed. A double pinching technique was applied: the first at the 10–14 leaf stage (15–20 days post-transplanting) and the second 15–20 days later to encourage lateral branching. Nutritional requirements were met through fortnightly applications of water-soluble NPK (19:19:19) at 2 g/l from pinching until flowering.

Quantitative observations were recorded for plant height, plant spread, days taken to visible bud initiation, days taken to peak flowering, flower diameter and number of flowers per plants, number of flowers per pot and duration of flowering. Pot presentability was done by using a 100-point scoring system modified from Conover (1986), evaluating appearance of whole plant, colour, form (balance between plant dimensions and pot size) and flowering. Statistical analysis was performed using MS-Excel and OPSTAT as per Gomez and Gomez (1984). Genetic parameters, including genotypic and phenotypic coefficients of Variation (GCV and PCV), were calculated following Burton and De-Vane (1953) and categorized according to Cherian (2000). Broad-sense heritability (H^2) and genetic advance (GA) were estimated per Allard (1960) and Johnson et al. (1955), where GA was calculated at a 5% selection intensity (K = 2.06). Genotypic and phenotypic correlation coefficients (r_g and r_p) were determined according to Al-Jibouri et al. (1958) and tested against Fisher and Yates (1963) tables. Finally, path coefficient analysis was employed following Dewey and Lu (1959) to partition correlations into direct and indirect effects, accounting for residual variation via the determination coefficient formula.

Results and Discussion

Variability Studies

Morphological evaluation in Table 1 revealed that plant height was maximum for 'Mount Aubisque Apricot' (60.57 cm) and mimimum for 'Flavio' (31.37 cm). Similar phenotypic variations in *Dendranthema grandiflora* have been previously documented by Vandana et al. (2024). The plant spread was maximum in 'Camargo' (44.97 cm) and minimum plant spread was recorded in genotype 'Willian' (31.50 cm). Bhaskaran et al. (2009) reported that such variation offers considerable scope for selecting genotypes with desirable canopy architecture, a trait that is essential for enhancing ornamental appeal and market value. Days taken for visible bud formation was minimum for 'Givilando' (122.43 days), whereas days taken for visible bud formation was recorded highest for 'Gustavo Sunny' (147.37 days). Days taken to peak flowering was minimum for 'Nova Lime' (161.53 days) and maximum for chrysanthemum genotype 'Gustavo sunny' (184.60 days). Flower diameter was found to be maximum in 'Camargo' (7.95 cm) and minimum flower diameter was recorded in 'Isidro' (4.33 cm). Number of flowers per plant was found maximum for the chrysanthemum genotype 'Artistic Armin' (17.10), while the minimum number of flowers per plant was recorded in the genotype 'Mount Aubsique Apricot' (7.90). Number of flowers per pot was found highest for the genotype 'Artistic Armin' (52.17), whereas least number of flowers per pot was recorded in the genotype 'Mount Aubisque Apricot' (23.43). Similar results were observed by Archana et al. (2019) and Tomar et al. (2022) in chrysanthemum. The duration of flowering was found to be maximum for the chrysanthemum genotype 'Artistic Dark Pink' (47.07 days) and it was found to be minimum for 'Givilando' (24.43 days). Similar results are found by Abhishek and Bala (2023), Visen et al. (2023) and Nakano et al. (2020) in chrysanthemum. The pot presentability score among the twenty was highest for 'Artistic Dark Pink' (94.45) and the lowest pot presentability score was recorded for 'Mount Aubisque Salmon' (82.23).

The parameters of genetic variability showed that phenotypic coefficients of variation (PCV) were greater than genotypic coefficients (GCV) of all the characters, with the largest coefficients being those of flowers per pot (PCV 20.91%; GCV 20.87%). Broad-sense heritability (H2) was very high in all traits with a range of 91.87 (days taken to peak flowering) to 99.77 (duration of flowering). High heritability coupled with high genetic gain was observed for flowers per pot (42.92%), duration of flowering (40.98%) and plant height (34.58%), indicating the predominance of additive gene action. All these results are in conformity with the findings of Patil et al. (2004) and Archana et al. (2019) in chrysanthemum.

Table 1
Comparative performance of different genotypes for vegetative growth, floral characters and pot presentability

Genotypes	Plant height (cm)	Plant spread (cm)	Days taken to visible bud formation	Days taken to peak flowering	Flower diameter (cm)	Number of flowers per plant	Number of flowers per pot (3 Plants)	Duration of flowering	Pot presentability
Artistic Armin	49.17	42.10	132.73	171.40	5.39	17.10	52.17	31.50	93.35
Artistic Dark Pink	41.27	36.10	146.77	181.27	6.60	11.47	32.73	46.13	94.45
Aurelio White	42.00	37.47	127.47	176.53	7.27	11.27	31.50	37.73	91.04
Camargo	52.33	44.97	127.37	183.90	7.95	13.80	31.23	28.83	88.97
Cesar	60.53	38.93	133.53	181.03	7.57	12.67	42.73	31.73	90.06
Cesar Apricot	47.30	34.53	128.07	166.17	6.51	11.63	33.10	33.17	91.10
Flavio	31.37	37.57	123.07	167.30	6.26	13.93	43.10	43.23	93.80
Givilando	41.03	31.57	122.43	172.77	5.65	13.67	42.47	24.43	89.90
Gustavo Sunny	40.77	36.33	147.37	184.60	4.34	13.87	43.53	36.40	93.89
Isidro	42.90	35.33	125.67	166.67	4.33	16.13	51.80	26.80	90.20
Mario Pink	43.63	43.20	127.70	182.17	6.55	12.77	42.10	43.20	94.10
Mount Aubisque Apricot	60.57	36.83	133.50	182.20	6.31	7.90	23.43	37.10	88.48
Mount Aubisque Salmon	59.37	34.03	145.47	172.77	5.37	12.20	30.47	27.53	82.23
Mount Juno	59.17	34.03	145.63	183.47	7.42	11.60	33.77	29.37	89.50
Mount Kenya	44.53	43.87	133.30	182.43	7.21	13.17	41.50	31.07	93.20
Mount Pleasant	59.47	34.10	146.07	176.60	5.37	13.13	41.53	27.23	82.97
Mount Tourmalet	54.07	31.97	146.17	176.17	6.59	11.40	32.53	31.47	87.96
Nova Lime	45.40	42.07	131.60	161.53	7.33	11.57	31.40	47.07	93.50
Nowara Red	50.30	35.97	146.77	183.30	6.55	8.27	27.17	37.17	94.20
Willian	40.83	31.50	132.30	176.17	5.50	11.47	34.93	27.97	90.22
$CD_{0.05}$	**3.06**	**0.80**	**1.50**	**3.40**	**0.10**	**0.51**	**0.76**	**0.52**	**1.07**

PCA Bi-Plot

Principal component analysis (PCA) revealed substantial multivariate variation among chrysanthemum genotypes, with the first two principal components (PC1 and PC2) explaining 39.6% and 22.3% of the total variability, respectively, cumulatively accounting for 61.9% of the observed variation. PC1 (39.6%) was primarily associated with flowering and vegetative trais, as indicated by strong positive loadings for number of flowers per plant, number of flowers per pot, plant spread, and duration of flowering. In contrast, days to flowering, days to visible bud formation, plant height, and flower diameter showed negative loadings along PC1 axis, suggesting an inverse relationship between earliness and floral productivity. PC2 (22.3%) further differentiated genotypes based on flowering behavior and temporal traits, with positive contributions from flowers per pot, flowers per plant, and duration, while flower diameter and duration of flowering contributed negatively, indicating a secondary axis of variation contrasting flower size and longevity (Fig. 1).

Findings revealed clear trait associations, where number of flowers per plant and number of flowers per pot were closely aligned, confirming their strong positive correlation and reinforcing their suitability as important criteria. Conversely, flower diameter and duration of flowering were opposite in directions, to flowering intensity traits, indicating a resource allocation and relation between flower size/longevity and flower number. Genotypic distribution across quadrants highlighted distinct trait profiles. Genotypes such as Isidro, Flavio, and Artistic Armin were positioned along the positive side of PC1, indicating superior performance for flowering intensity traits. In contrast, genotypes like Mount Juno, Nowara Red, and Mount Aubisque Apricot were associated with negative PC1 values, reflecting comparatively lower floral productivity but potential advantages in earliness or flower size. Meanwhile, Novalime and Camargo were distinctly separated along negative PC2, suggesting divergence in traits related to flowering duration and flower diameter.

Varietal Evaluation

The variation in genotypes in this study is an outcome of interaction between the genetic composition and environmental factors. Table 2 data consistently indicated that phenotypic coefficients of variability (PCV) exceeded genotypic coefficients (GCV) of all characters analyzed. Although this gap tends to become thin and brings out the environmental role in trait expression, a trend that has previously been observed in chrysanthemum by Hebbal et al. (2024), Shingala et al. (2023), Gurung et al. (2023) and Sharma et al. (2024). In particular, the number of flowers per pot had high PCV and GCV (20.91% and 20.87%, respectively). The moderate PCV values were observed in flowering period (19.94%), plant height (17.65%), number of flowers per plant (17.44), flower diameter (16.34%), and plant spread (11.23%), indicating that these characteristics have a great potential to be enhanced. Conversely, minimal differences in days to visible bud formation (6.66% PCV; 6.62% GCV) and days to peak flowering (4.07% PCV; 3.90% GCV) suggest that these traits are very stable across genotypes, leaving less room to change genetically rapidly. These results are consistent with Patil et al. (2019) and Archana et al. (2019), which prove the heterogeneity of the experimental material as a given fact.

Broad-sense heritability is an important genetic parameter that quantifies the proportion of phenotypic variance attributable to genetic factors, thereby reflecting the transmissibility of traits to the next generation. In this study, heritability estimates were exceptionally high across the board, ranging from 91.87% for days to peak flowering to a peak of 99.77% for flowering duration. High values were also noted for flower diameter (99.66%), number of flowers per pot (99.65%), and plant spread (98.60%). Such robust heritability suggests that genetic factors, rather than environmental noise, predominantly govern these traits, making direct selection a reliable strategy. This high-heritability trend is well-supported by the work of Patil et al. (2019), Sharma et al. (2024), Gangwar et al. (2024) and Vandana et al. (2024), all of whom validated these traits as dependable markers for breeding programs.

Analysis showed genetic advance ranging from a low of 2.12% to a moderate 18.34%. High heritability coupled with moderate genetic advance (as a percentage of mean) was observed for days to visible bud formation (18.34%), plant height (16.70%) and number of flowers per pot (15.95%) (Fig. 2). This combination is indicative of additive gene action, i.e., these traits can be optimally enhanced by hybridization and direct selection, as implied by Baskaran et al. (2009) and Shingala et al. (2023). The characteristics such as flower diameter (2.12) and flowers per plant (4.41) were highly heritable but less genetic progressive and thus their expression may be more complicated or non-additive effects where heterosis breeding may be more effective.

The genetic gain of flowers per pot and flowering duration was high at 42.92 and 40.98 respectively. The high heritability and high genetic gain in these traits confirms they are governed by additive gene action, making them the most suitable for improvement. Meanwhile, the low genetic gain in days to peak flowering (7.69%) suggests that selection for this specific trait would not be as effective as recent assessments by Gurung et al. (2023) and Vandana et al. (2024).

Table 2
Estimates of mean, genotypic and phenotypic coefficient of variability, heritability, genetic advance and genetic gain among twenty chrysanthemum (*Dendranthema grandiflora* Tzvelev) genotypes

Characters	Mean ± S.E. (m)	Range	Coefficient of variability		Heritability (%)	Genetic advance	Genetic gain (%)
			PCV	GCV			
Plant height (cm)	48.30 ± 1.08	31.37–60.57	17.65	17.21	95.13	16.70	34.58
Plant spread (cm)	37.12 ± 0.53	31.50-44.97	11.23	11.15	98.60	8.47	22.81
Days taken to visible bud formation	135.17 ± 1.14	122.43-147.37	6.66	6.62	98.96	18.34	13.57
Days taken to peak flowering	176.42 ± 0.91	161.53–184.60	4.07	3.90	91.87	13.57	7.69
Flower diameter (cm)	6.30 ± 0.13	4.33–7.95	16.34	16.31	99.66	2.12	33.55
Number of flowers per plant	12.45 ± 0.28	7.90–17.10	17.44	17.31	98.48	4.41	35.39
Duration of flowering	33.96 ± 0.86	24.43–47.07	19.94	19.92	99.77	13.92	40.98
Number of flowers per pot	37.16 ± 0.99	23.43–52.17	20.91	20.87	99.65	15.95	42.92

Correlation Studies

Correlation coefficient analysis shows mutual relationships between plant characters which is helpful for breeders in selecting component traits that drive genetic improvement. In this study, correlation coefficients were evaluated at both phenotypic and genotypic levels. As shown in Table 3, genotypic correlation coefficients generally exceeded their phenotypic coefficient, suggesting a strong inherent genetic association between the traits that is slightly affected by environmental factors in field observations.

At the phenotypic level, the height of the plant showed a strong positive relationship with days to visible bud formation (0.459), but it was negatively correlated with flowering period (-0.379) and total number of flowers per pot (-0.334) and number of flowers per plant (-0.294). This implies that tall plants in this population might require a longer time to initiate budding but eventually yield less flowers over a shorter period of time. Similarly, days taken to visible bud formation showed a strong positive relation with days taken to peak flowering (0.472) but was negatively correlated with flowering duration (-0.540) and plant spread (-0.314). Flower diameter had a moderate positive relationship with plant spread (r = 0.265), but a negative relationship with number of flowers per pot (r = -0.449) and number of flowers per plant (r = -0.384), which suggests a resource allocation trade-off between the size of individual flower and reproductive output.

Table 3
Analysis of phenotypic and genotypic coefficients of correlation among different characters in twenty chrysanthemum (*Dendranthema grandiflora* Tzvelev) genotypes

Characters	Plant height (cm)	Plant spread (cm)	Days taken to visible bud formation	Days taken to peak flowering	Flower diameter (cm)	Number of flowers per plant	Duration of flowering	Number of flowers per pot
Plant height (cm)		-0.074	0.459**	0.217	0.179	-0.294*	-0.379**	-0.334**
Plant spread (cm)	-0.073		-0.313*	-0.202	0.262*	0.150	0.129	0.154
Days taken to visible bud formation	0.472**	-0.314*		0.456**	-0.100	-0.314*	-0.540**	-0.301*
Days taken to peak flowering	0.241	-0.206	0.475**		0.234	-0.313*	-0.868**	-0.182
Flower diameter (cm)	0.181	0.265*	-0.102	0.244		-0.384**	-0.065	-0.449**
Number of flowers per plant	-0.302*	0.153	-0.318*	-0.322*	-0.390**		0.196	0.933**
Duration of flowering	-0.388**	0.130	-0.543**	-0.908**	-0.065	0.196		0.053
Number of flowers per pot	-0.344**	0.155	-0.304*	-0.189	-0.451**	0.941**	0.054	

**Significant at 5% level of significance; ** Significant at 1% level of significance*

A key finding of commercial relevance was the strong positive correlation between number of flowers per plant and number of flowers per pot (r = 0.933), which implies that the selection of either trait would lead to a corresponding enhancement of the other. This observation is consistent with earlier reports by Beeralingappa et al. (2019) and Vandana et al. (2024). Conversely, flowering period was mainly controlled by negative relationships, especially with days to peak flowering (r = -0.908) and days to visible bud formation (r = -0.543) indicating an inverse relationship between earliness and flowering persistence. The positive interrelationships between flowering intensity traits (flowers per plant and per pot) are strong and therefore emphasize their usefulness as effective selection indices of commercial yield whereas the negative relationships, e.g., between plant height and flower number, indicate possible physiological trade-offs with vegetative growth. All these relationships give a strong foundation to the indirect selection strategies that are meant to enhance genetic gain and breeding efficiency.

Association studies showed that genotypic correlation coefficients were generally higher than phenotypic ones. The number of flowers per pot exhibited a strong significant positive correlation (r = 0.941) with the number of flowers per plant. Path coefficient analysis further partitioned these associations, revealing that the number of flowers per plant exerted the maximum positive direct effect (0.865) on flowers per pot, followed by plant spread (0.052) and days to peak flowering (0.026).

Path Coefficient Analysis

The path coefficient analysis was employed across the twenty chrysanthemum genotypes. This method allows for the partitioning of correlation coefficients into direct and indirect effects, providing a clearer picture of which characters truly drive

the yield, specifically the number of flowers per pot. As detailed in Table 4 the diagonal values represent the direct influence of each trait. The number of flowers per plant (0.865) exerted the maximum positive direct effect on the number of flowers per pot, followed by plant spread (0.052) and days taken to peak flowering (0.026). These positive direct paths suggest that these traits are the primary determinants of floral yield and should be the focal points for selection in any improvement program.

Conversely, several traits exhibited negative direct effects on the number of flowers per pot, including duration of flowering (-0.199), flower diameter (-0.143), days taken to visible bud formation (-0.107), and plant height (-0.087). However, the intricate nature of these plants is revealed through their indirect effects. For instance, while plant height had a negative direct impact, it contributed positively through indirect routes via duration of flowering (0.077) and days taken to peak flowering (0.006). Similarly, plant spread support yield indirectly through its relationship with the number of flowers per plant (0.133) and days to visible bud formation (0.034).

The analysis further showed that duration of flowering contributed substantial indirect positive effects through the number of flowers per plant (0.169) and days taken to visible bud formation (0.058). Flower diameter, showed minor positive indirect contributions via plant spread (0.014) and flowering duration (0.013). Ultimately, the findings suggest that to maximize the number of flowers per pot, selection criteria must prioritize the number of flowers per plant, plant spread and the timing of peak flowering. These findings, highlight the dominance of flower count per plant defining overall yield, are in close agreement with the results recorded by Kamashwari et al. (2015) and Prakash et al. (2017) in chrysanthemum. This understanding of trait influence ensures that breeding efforts are directed toward the most physiologically impactful characters for commercial success.

Table 4
Estimates of direct and indirect effects of different characters on number of flowers per pot among twenty chrysanthemum (*Dendranthema grandiflora* Tzvelev) genotypes

Characters	Plant height (cm)	Plant spread (cm)	Days taken to visible bud formation	Days taken to peak flowering	Flower diameter (cm)	Number of flowers per plant	Duration of flowering
Plant height (cm)	-0.087	-0.004	-0.051	0.006	-0.026	-0.261*	0.077
Plant spread (cm)	0.006	0.052	0.034	-0.005	-0.038	0.133	-0.026
Days taken to visible bud formation	-0.041	-0.016	-0.107	0.012	0.015	-0.275*	0.108
Days taken to peak flowering	-0.021	-0.011	-0.051	0.026	-0.035	-0.279*	0.181
Flower diameter (cm)	-0.016	0.014	0.011	0.006	-0.143	-0.337**	0.013
Number of flowers per plant	0.026	0.008	0.034	-0.008	0.056	0.865**	-0.039
Duration of flowering	0.034	0.007	0.058	-0.024	0.009	0.169	-0.199

Conclusion

The investigation entitled 'Genetic evaluation of different genotypes of pot chrysanthemum (*Dendranthema grandiflora* Tzvelev) for mid-hills of Himachal Pradesh' was conducted during 2024–2025 at the Research Farm of the Department of Floriculture and Landscape Architecture, Nauni, Solan. The study evaluated twenty genotypes for growth and flowering parameters, alongside estimates of variability, correlation and path coefficients. The study concludes that all twenty evaluated genotypes are suitable for pot cultivation in the mid-hill zone of Himachal Pradesh. However, 'Artistic Dark Pink', 'Nowara Red', 'Mario

Pink', 'Gustavo Sunny', 'Flavio' and 'Nova Lime' are identified as superior genotypes due to their excellent pot presentability scores and prolonged flowering durations (exceeding 37.17 days). The significant variation observed in vegetative and floral traits provides a basis for the selection and further genetic improvement of chrysanthemum cultivars for pot culture.

Abbreviations

CRD
Completely Randomized Design
GCV
Genotypic Coefficient of Variation
PCV
Phenotypic Coefficient of Variation
H^2
Broad—sense Heritability
GA
Genetic Advance
PCA
Principal Component Analysis
NPK
Nitrogen, Phosphorus and Potassium
RBD
Randomized Block Design

Declarations

Ethics approval and consent to participate

Ethics approval was not applicable to this study because the research involved the evaluation of plant genotypes and did not involve human participants, human data, or animals.

Consent for publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

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Author Contribution

1. Nishant Thakur: Conceived and planned the study, conducted the experiment, collected and analyzed the data, interpreted the results, and prepared the original manuscript draft.2. Suman Bhatia: Guided the research work, supervised the study, contributed to the experimental design, critically reviewed the manuscript, and approved the final version.3. Puja Sharma:

Assisted in data analysis and interpretation and contributed to reviewing and improving the manuscript.4. Sapna Kaushal: Assisted in conducting the experiment, data recording, and reviewing the manuscript.5. R. K. Dogra: Provided technical guidance during the research and assisted in the interpretation of the findings and manuscript review.6. Anju Sharma: Assisted with statistical analysis, validated the results, and reviewed the manuscript.7. Poonam Sharma: Contributed to conducting the experiment, data collection, and manuscript review.

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Availability of data and materials

The datasets generated and/or analysed during the present study are available from the corresponding author on reasonable request.

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Figures

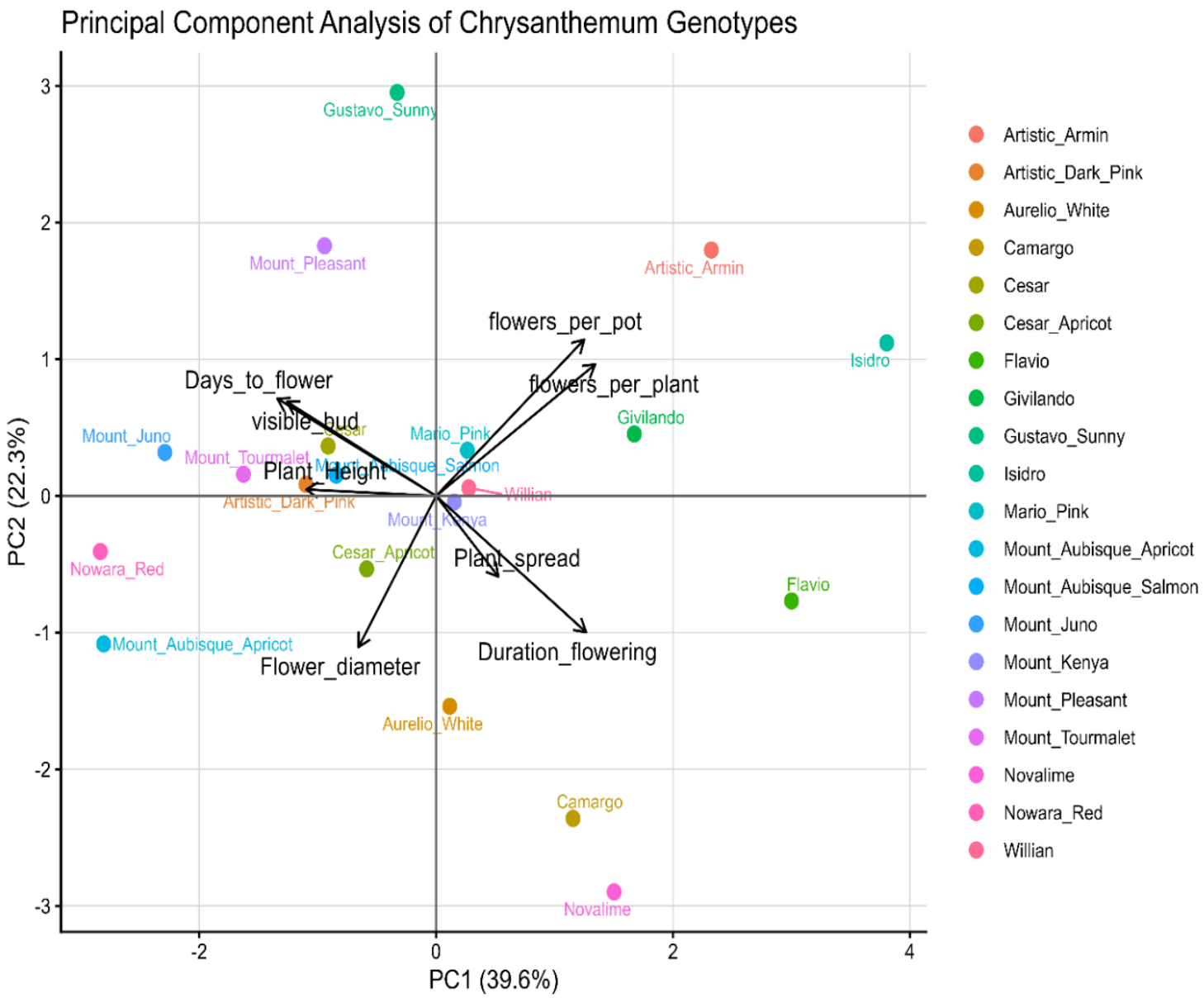


Figure 1

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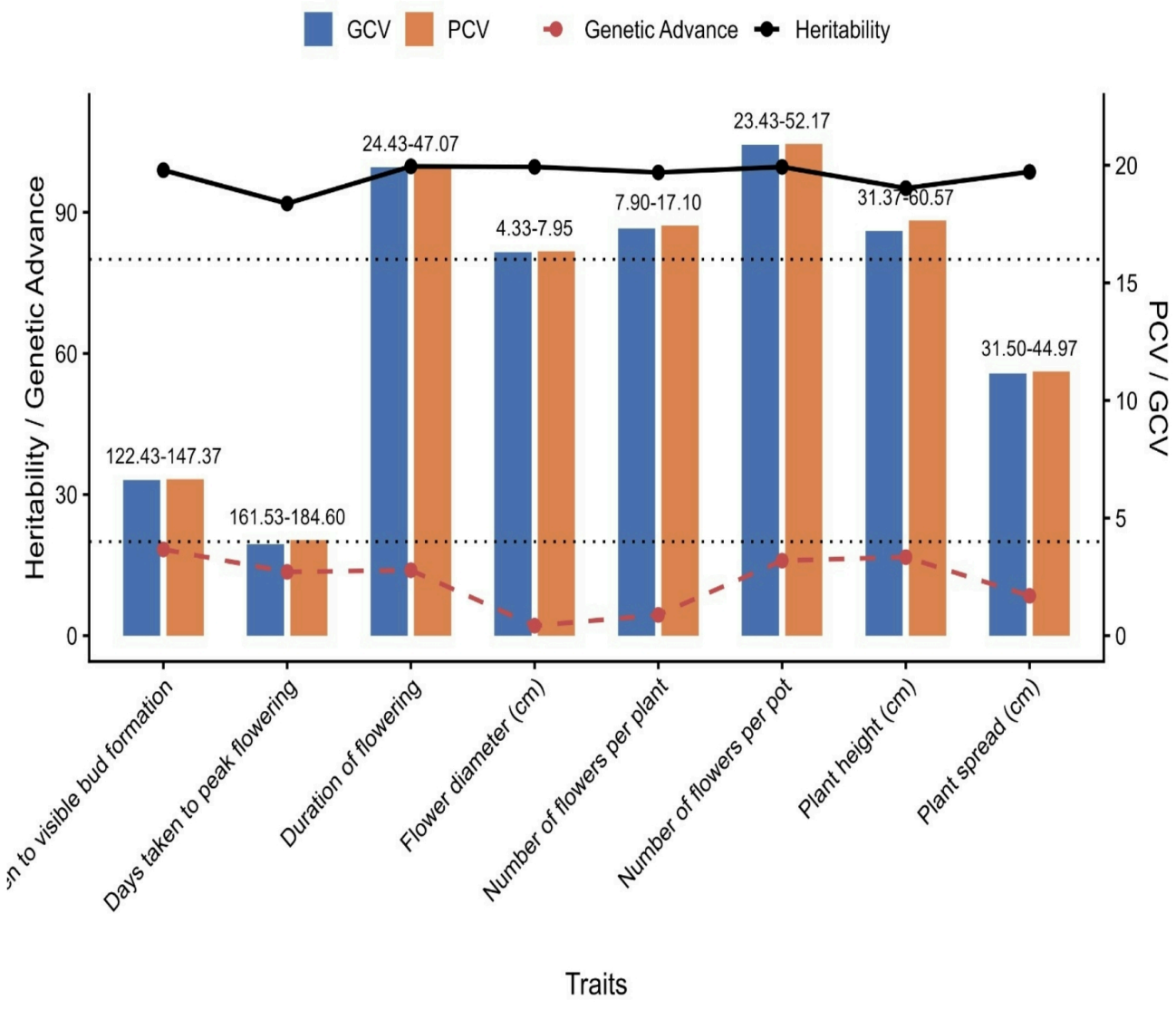


Figure 2

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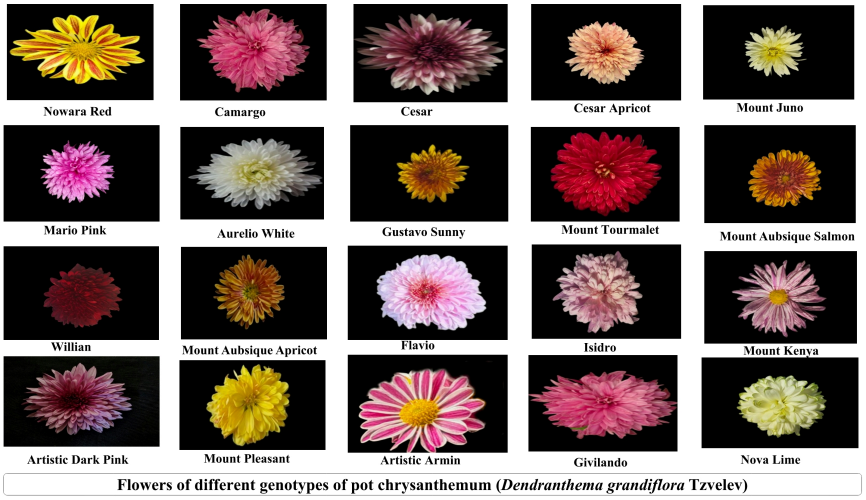


Figure 3

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