Original Research Article

Genetic Evaluation of Gerbera (*Gerbera jamesonii* Bolus ex. Hooker F.) Under Naturally Ventilated Polyhouse in Prayagraj

ABSTRACT:

An investigation was carried out in nine genotypes for eleven quantitative characters of gerbera to examine genetic variability, heritability, genetic advance, correlation, path coefficient during 2021-2022 in Randomized block design at Research field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P). The results revealed that the genotype Cut T/C Pink (5.67) was identified best for flower yield per plant and flower yield per square meter. Analysis of variance showed significant difference among nine genotypes, indicating ample scope for selection of promising genotypes. Highest PCV and GCV were recorded for length of stalk (cm) (49.06 and 48.45 respectively) followed by plant height (cm) (47.56 and 46.95 respectively). Lowest PCV and GCV were recorded by vase life (18.67 and 16.26 respectively) followed by diameter of disc (24.185 and 23.487 respectively). High heritability (h^2) coupled with high genetic advance were observed for the characters like days to first flower bud initiation (95.31 & 52.73), length of stalk (97.52 & 33.04), plant height (97.45 & 28.79) and plant spread (95.31 & 52.73). Number of leaves and flowers per plant showed significant positive correlation. Plant height, plant spread, number of leaves, days to first flower bud initiation and flower per plant had direct positive effect on flower yield per meter square.

Keywords: *Gerbera, Genetic variability, Genetic Advance, Heritability, Correlation, Path Coefficient*

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UNDER PEER REVIEW

INTRODUCTION

Comment [s4]: The introduction is too short to be clear. Add new reference on Gerbera Genetic Evaluation

Gerbera (*Gerbera jamesonii* Bolus ex. Hooker F.) is commonly known as Transvaal daisy or Barberton daisy or African daisy. It is an important cut flower crop. It belongs to the Asteraceae family and originates from Southern Africa and Asia. Genus *Gerbera L.* consists of approximately 45 species. It is the most popular cut flower in the Netherlands, Germany and the United States of America and is among the top 10 cut flowers in the world. The major producing states in India are Karnataka, Maharashtra, Tamil Nadu, West Bengal, Himachal Pradesh, Jammu & Kashmir and Gujarat.

Gerbera plants are stemless and tender perennial herbs, leaves are radical, petioled, lanceolate and deeply lobed. Flower heads are solitary; many flowered with conspicuous ray florets in one or two rows. Based on flower head types or forms they are grouped into single, double and semi double cultivars. The flower stalks are long, thin hollow and leafless, this character made gerbera very popular in the market for preparation of bouquets.

Nowadays, gerbera is gaining popularity because of its long lasting nature, graceful appearance, hardiness, ability to stand the vigor of transportation admirably and has good export potential. It also occupies a tremendous place under protected cultivation. During the past three decades, improvement of gerbera has evolved into a multibillion dollar industry. Though the crop could be cultivated in moderately warmer areas in open sunny conditions, performance of the crop has enhanced when grown under protected or semi protected conditions. To get longer stems, brighter flower color, high productivity per unit area, better consumer acceptance and to sustain competition, it is essential to adopt appropriate production technologies and an efficient crop management technique. The market demand for cut flowers is very specific and it could be met consistently, when the crop is grown under protected conditions.

Genetic variability in a group of germplasm is a prerequisite for a successful breeding programme. Since, most of the characters influencing yield are polygenic, it is essential for plant breeders to estimate the type of variation available in the germplasm. The type of breeding programme for developing suitable varieties depends largely on the availability of genetic variability in a given species. Heritability estimated, gave a measure of transmission of characters from one generation to the other, as consistency in the performance of the selection depends on the heritable portion of the variability **(Falconer., 1981)**. Thus, the variation and the estimates of the heritability and genetic advance are the important parameters on which the success of selection lies.

With this background in view, the present research was undertaken to assess and estimate the magnitude of variation among 9 genotypes of gerbera with respect to various vegetative, flower, quality and yield attributes.

MATERIAL AND METHODS

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The present investigation was conducted at research field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P) during the year November, 2021- March, 2022. Nine genotype of gerbera *viz.,* Sisal, Martyana, Salsa, Berta, Berenika, Cut T/C Yellow, Cut T/C Rose red, Cut T/C White and Cut T/C Pink were raised in a

UNDER PEER REVIEW

naturally ventilated polyhouse (NVP) at the spacing of 30 × 30 cm in Randomized Block Design (RBD) with 3 replications. The beds were irrigated thoroughly to maintain the optimum soil moisture condition. Uniform cultural practices were imposed on all the genotypes to ensure good growth of the crop.

The average was worked out and results were used to study genetic parameters on various vegetative growth, flowering and yield characters as per genotypes. The genotypic and phenotypic coefficients of variation were estimated according to the methods of **Panse and Sukhatme (1967)**. Parameters of variability were calculated as per the formula given by **Burton (1952)**. Heritability, genetic advance and expected genetic gain were calculated by the formula suggested by **Johnson *et al*. (1955)**. Path coefficient analysis was calculated by the technique given by **Goulden (1949).** The mean and standard errors were worked out as per standard methods and coefficients of variations were computed.

RESULTS AND DISCUSSION

Comment [s6]: The results and discussion explain that each separate parameter is discussed from table 1, table 2, table 3, table 4, table 5, and table 6 separately. Discussed with appropriate and up-to-date references

The results indicated the existence of sufficient genetic variability among all the genotypes of gerbera. In Table-1 the mean performance of genotypes gives an overall view of performance of genotypes. The maximum numbers of flowers per plant were observed in Cut T/C pink (5.67) followed by Cut T/C yellow (5.33). The maximum stalk length was observed in Salsa (50.94cm) followed by Martyana (47.32 cm). The maximum flower diameter was observed in Martyana (10.39 cm) followed by Sisal (10.14 cm) and Berenika (10.03 cm). The maximum flower disc was observed in Salsa (2.18cm) followed by Martyana (2.03cm). The maximum girth of stalks was observed in Martyana (2.64 cm) followed by Sisal (2.53cm). The maximum numbers of flowers per square meter were observed in Cut T/C pink (51) followed by Cut T/C yellow (48). The maximum vase life was observed for Cut T/C pink (8.42 days) followed by Martyana (8.17 days) and Sisal (7.42 days).

In the Table-2 Higher estimates of phenotypic and genotypic variance were observed for days to first flower bud initiation followed by length of stalk, plant height, plant Spread, flowers per meter square, number of leaves, diameter of flower, vase life, diameter of disc and girth of stalk.

Table-2 revealed that higher value of phenotypic coefficient of variation over genotypic coefficient of variation indicated the influence of environment on these characters. Phenotypic and genotypic coefficient of variation was highest for length of stalk followed by plant height, days to first flower bud initiation, plant spread, number of leaves, flower per meter square, flower per plant, girth of stalk, diameter of flower, diameter of disc and vase life. Similar findings were reported by **Chobe *et al.,* (2010), Kumari *et al*., (2011), Senapati *et al.,* (2013)** and **Islam *et al*., (2021).**

Heritability estimates were high for all the characters. High heritability for all the characters is due to close correspondence between the genotype and phenotype. Estimates of genetic advance ranged from 52.733 (days to first flower bud initiation) to 0.759 (diameter of disc). High heritability (h^2) coupled with high genetic advance were observed for the characters like days to first flower bud initiation (95.317 & 52.733), length of stalk (97.524 & 33.049), plant height (97.454 & 28.79) and plant spread (95.317 & 52.733) which indicated additive gene action. Similar finding were reported by **Kumari *et al*., (2011), Senapati *et al.,* (2013)** and **Islam *et al*., (2021).**

UNDER PEER REVIEW

Table 3 &4 shows that among all the characters, number of leaves (0.825**) and flowers per plant (0.824**) showed significant positive correlation where as vase life (0.3499 days) showed non significant positive correlation with number of flower per plant at genotypic level and at phenotypic level number of leaves (0.757**) and flowers per plant (0.911**) showed significant positive correlation with number of flower per meter square. Similar findings were reported by **Nair *et al.,* (2003)** in gerbera and **Kumar *et al.,* (2011)** in chrysanthemum.

In Table 5, at genotypic level, length of stalk (1.4705), flower per plant (1.3142), days to first flower bud initiation (0.7952), girth of stalk (0.7869) and number of leaves (0.2445) had direct positive effect on flower yield per meter square and in Table 6, at phenotypic level, flower per plant (0.6597), girth of stalk (0.5062), length of stalk (0.3815), diameter of disc (0.3565), plant spread (0.2528) and number of leaves (0.1613) had direct effect on number of flower per meter square.

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Table 1- Mean performance of genotype for different characters of gerbera

Sl. No.	Genotype	Plant height (cm)	Plant spread (cm)	Numbers of leaves	Number of days taken for 1st flower bud initiation	Length of stalk (cm)	Diameter of flower (cm)	Diameter of disc (cm)	Girth of stalk (cm)	Flower per plant	Flower per meter square	Vase life (Days)
1	**Sisal**	35.93	35.69	11.67	80.25	41.95	10.14	1.38	2.53	3.00	27.00	7.42
2	**Martyana**	43.86	43.20	9.25	77.58	47.32	10.39	2.03	2.64	3.67	33.00	8.17
3	**Salsa**	42.94	39.64	12.58	83.75	50.94	9.19	2.18	1.89	3.17	28.50	6.50
4	**Berta**	43.46	49.20	16.17	78.42	40.36	8.63	1.65	2.37	3.83	33.42	5.67
5	**Berenika**	37.24	43.62	11.92	87.58	46.31	10.03	1.81	2.19	3.42	30.75	7.33
6	**Cut T/C Yellow**	14.08	22.81	24.50	27.83	13.58	6.39	1.34	1.42	5.33	48.00	6.17
7	**Cut T/C Rose Red**	6.99	12.38	13.00	24.75	9.53	4.45	0.95	1.05	3.17	28.50	4.83
8	**Cut T/C Red**	31.15	33.94	15.83	61.58	37.39	9.48	1.79	1.90	3.00	27.00	6.67
9	**Cut T/C Pink**	15.68	23.18	20.08	29.33	14.38	6.09	1.42	1.79	5.67	51.00	8.42
Mean		30.15	33.74	15.00	61.23	33.53	8.31	1.62	1.98	3.81	34.13	6.80
CV		7.59	6.14	5.72	9.49	7.72	8.50	5.77	5.23	8.97	8.85	9.19
SEm		1.32	1.20	0.50	3.36	1.49	0.41	0.05	0.06	0.20	1.74	0.36
CD at 5%		3.96	3.58	1.48	10.06	4.48	1.22	0.16	0.18	0.59	5.23	1.08
CD at 1%		5.46	4.94	2.05	13.86	6.17	1.69	0.22	0.25	0.81	7.20	1.49

UNDER PEER REVIEW

Table 2: **Genetic variability of parameters for quantitative characters of gerbera**

Sl No.	Characters	Phenotypic Variance	Genotypic Variance	PCV	GCV	h^2(bs)	GA at 5%	GA as % of mean 5%
1	Plant height (cm)	205.652	200.417	47.568	46.959	97.454	28.79	95.497
2	Plant Spread (cm)	146.898	142.609	35.923	35.395	97.08	24.238	71.841
3	Number of leaves	23.199	22.463	32.11	31.597	96.829	9.607	64.049
4	Days to first flower bud initiation	721.252	687.477	43.86	42.821	95.317	52.733	86.121
5	Length of stalk (cm)	270.62	263.918	49.063	48.451	97.524	33.049	98.566
6	Girth of stalk (cm)	0.278	0.268	26.702	26.186	96.169	1.045	52.899
7	Diameter of flower (cm)	4.885	4.386	26.593	25.197	89.777	4.088	49.182
8	Diameter of disc (cm)	0.153	0.144	24.185	23.487	94.315	0.759	46.988
9	Flowers per plant	1.088	0.972	27.411	25.902	89.293	1.919	50.421
10	Flowers per meter square	87.992	78.864	27.485	26.02	89.627	17.319	50.745
11	Vase life (Days)	1.611	1.221	18.675	16.26	75.806	1.982	29.163

GCV- Genotypic coefficient of variation GA- Genetic advance

PCV- Phenotypic coefficient of variation

UNDER PEER REVIEW

Table 3 - Genotypic correlation matrix for flower yield

Genotypic Correlation Matrix											
	Plant height (cm)	**Plant Spread (cm)**	**Number of leaves**	**Days to 1st flower bud initiation**	**Length of stalk (cm)**	**Girth of stalk (cm)**	**Diameter of flower (cm)**	**Diameter of disc (cm)**	**Flowers per plant**	**Vase life (Days)**	**Flowers per meter square**
Plant height (cm)	1.0000	0.971**	-0.584*	0.966**	0.977**	0.867**	0.937**	0.842**	-0.498*	0.3088	-0.505*
Plant Spread (cm)		1.0000	-0.449*	0.928**	0.909**	0.865**	0.895**	0.791**	-0.3477	0.2970	-0.3724
Number of leaves			1.0000	-0.676**	-0.677**	-0.514*	-0.578*	-0.384*	0.834**	-0.1550	0.825**
Days to first flower bud initiation				1.0000	0.997**	0.821**	0.949**	0.755**	-0.634**	0.2652	-0.634**
Length of stalk (cm)					1.0000	0.809**	0.967**	0.858**	-0.610**	0.3219	-0.624**
Girth of stalk (cm)						1.0000	0.904**	0.598**	-0.2741	0.610**	-0.2755
Diameter of flower (cm)							1.0000	0.778**	-0.516*	0.535*	-0.521*
Diameter of disc (cm)								1.0000	-0.2618	0.420*	-0.2753
Flowers per plant									1.0000	0.3228	0.824**
Vase life (Days)										1.0000	0.3499
Flowers per meter square											1.0000

, * significant at 5% and 1% respectively

UNDER PEER REVIEW

Table 4 - Phenotypic correlation matrix for flower yield

Phenotypic Correlation Matrix											
	Plant height (cm)	**Plant Spread (cm)**	**Number of leaves**	**Days to 1st flower bud initiation**	**Length of stalk (cm)**	**Girth of stalk (cm)**	**Diameter of flower (cm)**	**Diameter of disc (cm)**	**Flowers per plant**	**Vase life (Days)**	**Flowers per meter square**
Plant height (cm)	1.0000	0.950**	-0.573*	0.944**	0.955**	0.849**	0.854**	0.804**	-0.440*	0.2821	-0.467*
Plant Spread (cm)		1.0000	-0.429*	0.901**	0.893**	0.842**	0.813**	0.744**	-0.3305	0.2711	-0.3390
Number of leaves			1.0000	-0.669**	-0.654**	-0.502*	-0.541*	-0.382*	0.750**	-0.1111	0.757**
Days to first flower bud initiation				1.0000	0.951**	0.813**	0.870**	0.725**	-0.559*	0.2455	-0.586*
Length of stalk (cm)					1.0000	0.783**	0.889**	0.810**	-0.577*	0.2782	-0.568*
Girth of stalk (cm)						1.0000	0.826**	0.561*	-0.2387	0.554*	-0.2687
Diameter of flower (cm)							1.0000	0.736**	-0.463*	0.3667	-0.460*
Diameter of disc (cm)								1.0000	-0.2607	0.3761	-0.2405
Flowers per plant									1.0000	0.2277	0.911**
Vase life (Days)										1.0000	0.2184
Flowers per meter square											1.0000

*, ** significant at 5% and 1% respectively

UNDER PEER REVIEW

Table 5 - Genotypic path matrix of Flowers per meter square

PATH matrix of Flowers per plant											
	Plant height (cm)	**Plant Spread (cm)**	**Number of leaves**	**Days to 1st flower bud initiation**	**Length of stalk (cm)**	**Girth of stalk (cm)**	**Diameter of flower (cm)**	**Diameter of disc (cm)**	**Flowers per plant**	**Vase life (Days)**	**Flowers per meter square**
Plant height (cm)	-0.4203	-0.4080	0.2453	-0.4059	-0.4105	-0.3642	-0.3936	-0.3539	0.2093	-0.1298	-0.505*
Plant Spread (cm)	-1.0146	-1.0451	0.4691	-0.9702	-0.9499	-0.9039	-0.9356	-0.8266	0.3634	-0.3104	-0.3724
Number of leaves	-0.1427	-0.1098	0.2445	-0.1654	-0.1656	-0.1256	-0.1414	-0.0940	0.2039	-0.0379	0.825**
Days to first flower bud initiation	0.7680	0.7382	-0.5379	0.7952	0.7928	0.6532	0.7548	0.6003	-0.5042	0.2109	-0.634**
Length of stalk (cm)	1.4366	1.3366	-0.9962	1.4660	1.4705	1.1893	1.4215	1.2617	-0.8965	0.4734	-0.624**
Girth of stalk (cm)	0.6820	0.6806	-0.4042	0.6464	0.6364	0.7869	0.7111	0.4705	-0.2157	0.4797	-0.2755
Diameter of flower (cm)	-1.1020	-1.0533	0.6803	-1.1168	-1.1374	-1.0632	-1.1766	-0.9149	0.6069	-0.6295	-0.521*
Diameter of disc (cm)	-0.0200	-0.0188	0.0091	-0.0179	-0.0204	-0.0142	-0.0185	-0.0238	0.0062	-0.0100	-0.2753
Flowers per plant	-0.6545	-0.4570	1.0959	-0.8332	-0.8012	-0.3602	-0.6778	-0.3441	1.3142	0.4242	0.824**
Vase life (Days)	-0.0373	-0.0359	0.0187	-0.0320	-0.0389	-0.0736	-0.0646	-0.0507	-0.0390	-0.1207	0.3499
Flowers per meter square	-0.505*	-0.3724	0.825**	-0.634**	-0.624**	-0.2755	-0.521*	-0.2753	0.824**	0.3499	1.0000
Partial R^2	0.2122	0.3891	0.2017	-0.5040	-0.9177	-0.2168	0.6127	0.0065	1.3779	-0.0422	

, * significant at 5% and 1% respectively

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Table 6- Phenotypic path matrix of Flowers per meter square

PATH matrix of Flowers per plant											
	Plant height (cm)	Plant Spread (cm)	Number of leaves	Days to 1st flower bud initiation	Length of stalk (cm)	Girth of stalk (cm)	Diameter of flower (cm)	Diameter of disc (cm)	Flowers per plant	Vase life (Days)	Flowers per meter square
Plant height (cm)	-0.9061	-0.8609	0.5191	-0.8552	-0.8654	-0.7689	-0.7741	-0.7281	0.3986	-0.2556	-0.467*
Plant Spread (cm)	0.2402	0.2528	-0.1085	0.2278	0.2257	0.2128	0.2055	0.1880	-0.0835	0.0685	-0.3390
Number of leaves	-0.0924	-0.0692	0.1613	-0.1080	-0.1055	-0.0810	-0.0872	-0.0617	0.1209	-0.0179	0.757**
Days to first flower bud initiation	-0.2743	-0.2619	0.1945	-0.2906	-0.2765	-0.2364	-0.2528	-0.2107	0.1624	-0.0713	-0.586*
Length of stalk (cm)	0.3644	0.3407	-0.2496	0.3629	0.3815	0.2985	0.3390	0.3090	-0.2202	0.1061	-0.568*
Girth of stalk (cm)	0.4296	0.4262	-0.2542	0.4117	0.3961	0.5062	0.4180	0.2838	-0.1208	0.2805	-0.2687
Diameter of flower (cm)	-0.1988	-0.1891	0.1258	-0.2024	-0.2068	-0.1921	-0.2327	-0.1713	0.1076	-0.0853	-0.460*
Diameter of disc (cm)	0.2865	0.2652	-0.1363	0.2585	0.2888	0.1999	0.2625	0.3565	-0.0929	0.1341	-0.2405
Flowers per plant	-0.2902	-0.2180	0.4945	-0.3686	-0.3807	-0.1575	-0.3052	-0.1720	0.6597	0.1502	0.911**
Vase life (Days)	-0.0256	-0.0246	0.0101	-0.0223	-0.0253	-0.0503	-0.0333	-0.0341	-0.0207	-0.0908	0.2184
Flowers per meter square	-0.467*	-0.3390	0.757**	-0.586*	-0.568*	-0.2687	-0.460*	-0.2405	0.911**	0.2184	1.0000
Partial R^2	0.4230	-0.0857	0.1221	0.1704	-0.2167	-0.1360	0.1071	-0.0858	0.6011	-0.0198	

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CONCLUSION

In the present investigation, it is concluded that genotype Cut T/C Pink was identified best for flower yield per plant and flower yield per square meter. Highly significant differences were observed for all characters which illustrated significant variation. High heritability coupled with high genetic advance as percent of mean revealed for days to first flower initiation, length of stalk, plant height and plant spread which shows the evidence that these characters are under control of additive gene action. Correlation analysis revealed that characters such as number of leaves and flower per plant are the most important characters as these exhibited positive and strong association with flower yield. Path coefficient analysis revealed that characters like flower per plant, plant height, days to flower bud initiation, number of leaves and vase life exhibited direct positive effect at both phenotypic and genotypic level.

Comment [s8]: conclusion is too long, made shorter and clearer

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Comment [s9]: References are too few, add new references that are appropriate to this research

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UNDER PEER REVIEW

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