



Assessment of Genetic Variability, Character Association and Path Coefficient Analysis in Gomphrena (*Gomphrena globosa* L.) Genotypes for Productivity and Quality Traits

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ABSTRACT

An experiment was conducted during November 2021–March, 2022 at the experimental block of Floriculture and Landscape Architecture, College of Horticulture, Bagalkot, Karnataka, India using thirteen different Gomphrena (*Gomphrena globosa* L.) genotypes under randomized block design to determine the extent of genetic variability. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all growth, flowering, yield and quality traits under study. Higher GCV and PCV was observed for number of leaves plant⁻¹, moderate for plant height, number of secondary branches, stem girth, days to bud initiation, inflorescence length, individual flower weight, number of flowers plant⁻¹, yield plant⁻¹ and shelf life. High heritability combined with high genetic advance over mean was recorded for plant height, secondary branches, number of leaves, stem girth, days to bud initiation, inflorescence length, individual flower weight, number of flowers and yield plant⁻¹. The flower yield plant⁻¹ had significantly positive association with plant height, plant spread in N-S and E-W direction, number of primary and secondary branches, number of leaves, stem girth, duration of flowering, stalk length, inflorescence length, flower diameter, number of flowers plant⁻¹ and individual flower weight. The character association studies revealed that, flower yield plant⁻¹ had direct and positive association with plant spread, stem girth, number of secondary branches, individual flower weight, diameter of flower, inflorescence length, stalk length, days to flowering, bud initiation, number of leaves and plant height.

KEYWORDS: Gomphrena, character association, genetic variability

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1. INTRODUCTION

Bachelor's button is an everlasting flower crop commercially cultivated in India and is used as loose flower both as fresh flower and as dry flower. It signifies special importance due to its bright inflorescence, hardiness and ease in cultivation, salability, short duration and easy transportation (Kumar et al., 2023). The Globe Amaranth (*Gomphrena globosa* L.) is native to North America, South America, Myanmar and India (Jiang et al., 2011). Commonly known as 'Globe Amaranth', 'makhmali' (Nepali), Rakta mallika (Sanskrit), Adike huvvu/rudrakshi huvvu (Kannada) and 'Gul-e-makhamal (Hindi), Gundi (Kashmiri). The genus belongs to the family Amaranthaceae with chromosome number $2n=38$ consists of about 100 species of half-hardy annual, biennial and herbaceous perennial plants, but only one species *Gomphrena globosa* with its cultivars is in general cultivation. About 18 genera and over 50 species have been reported from India. It symbolizes immortality and endless love. The flower has amazing ability to last for years when dried (Kumar et al., 2024). It is one of the hardest garden annual bedding plant which blooms continuously throughout summer and early fall, known for its colorful inflorescence. It grows up to 30–120 cm in height, stems are branched, erect and has bushy appearance. The leaves are opposite, oblong, 4–6 cm in long, and woolly-white when young, becomes sparsely white-hairy as they are aged. The round-shaped or clover like or button like flower inflorescences are visually dominant feature and cultivars exhibit shades of magenta, purple, red, orange, white, pink and lilac but the most common color is magenta. Within the flower heads, the true flowers are insignificant, tiny, white to yellow trumpets that are only visible close up and inconspicuous. It occupies seventh position in the world dry flower market (Kumar et al., 2023). In India, it is majorly grown in Karnataka, Tamil Nadu, Kerala and in Andhra Pradesh. In Karnataka, it is commercially grown in Dharwad, Belagavi, Raichur and Bellary Districts. Gomphrena is commercially grown for loose flowers and as well as cut flowers for making garlands, pomanders, bouquets, flower balls, wreath, greeting cards, potpourris, flower arrangements, stage decorations during marriages, indoor decoration and widely used during Onam, the famous Kerala festival to decorate Pookolam and Bathukamma festival in Telangana (Yaseen et al., 2021).

Crop improvement to a large extent is greatly depends on existing genetic variability. Selection of superior variety depends upon the variation that exists in a particular crop (Poulouse et al., 2020). Variability in a population w.r.t phenotypic expression of a character is mainly governed by the genetic make-up of the plant, the environment in which it is grown (Sharma et al., 2025) and the interaction between the genotype and environment (Allard and Bradshaw, 1964;

Bhargav et al., 2019). For any effective selection programme, the information on nature and the magnitude of variability present in genetic stocks, characters, heritability and genetic advance are important (Khangjarakpam et al., 2014). As Gomphrena shows wide range of variability with respect to flower colour, size and vegetative characters, there is a need to screen genotypes for the identification of superior genotypes for improved quality and high yield (Jinks and Pooni, 1982). The yield is largely depends on genetic variability, correlation and association between quantitative and qualitative characters (Rai et al., 2017; Tanya and Kaur, 2023). As Gomphrena is gaining importance now-a-days and the crop improvement is mainly depends on exploring existing genetic diversity of genotypes for crop improvement in this context paper deals on 'Assessment of genetic variability and character association for growth, flowering, yield and quality traits in Gomphrena genotypes'. Thus, the experiment was conducted on thirteen Gomphrena (*Gomphrena globosa* L.) genotypes under randomized block design to determine the extent of genetic variability.

2. MATERIALS AND METHODS

The experiment was conducted during November, 2021–March, 2022 at the experimental block of Floriculture and Landscape Architecture, College of Horticulture, Bagalkot using thirteen different Gomphrena genotypes in a randomized block design with 3 replications. The genotypes belonged to four colours, AGS-1, AGS-5, AGS-9, AGS-17–purple colour; AGS-2, AGS-4, AGS-6, AGS-8–pink colour; AGS-3, AGS-7, AGS-10, AGS-16–white colour and AGS-14–red colour (Plate 1). The spacing followed was 30×30 cm². In each treatment 5 randomly selected plants were chosen to record observations on 19 yield and yield attributing traits viz., plant height (cm), plant spread in N-S and E-W direction (cm), number of primary and secondary branches plant⁻¹, number of leaves, stem girth (mm), days to first flower bud initiation, days taken for bud to flower opening, days to 50% flowering, duration of flowering, stalk length, inflorescence length (cm), flower



Plate 1: Individual flower of different Gomphrena genotypes

diameter (cm), individual flower weight (g), number of flowers plant⁻¹ and yield plant⁻¹ (g). The mean values were taken for analysis of variance (ANOVA) given by Panse and Sukhatme (1978). The genetic variability estimates, character association and correlation of traits were done by using Indostat software, windows 11.

3. RESULTS AND DISCUSSION

The analysis of variance showed there exist highly significant ($p < 0.05$) differences among the genotypes for growth, flowering, yield and quality traits (Table 1) which helps for further breeding programme to develop superior varieties. Among all the traits under study, the value of GCV ranges between 3.17 to 21.55%, PCV of 3.46 to 21.55%, heritability of 49.72 to 99.99% and genetic advance over mean of 5.98 to 44.38% (Table 1). The trait number of leaves plant⁻¹ had showed highest genotypic and phenotypic coefficient of variation, heritability and GAM (21.55%, 21.55%, 99.99% and 44.38%) among all the growth, flowering, yield and quality traits.

Least range of GCV, PCV and GAM (3.17%, 3.46% and 5.98%) was observed in duration of flowering, least heritability (49.72%) in days from bud to full flower opening. In flowering traits highest GCV, PCV and GAM (13.02%,

16.29% and 21.42%) was observed in days to bud initiation, highest heritability in days to 50% flowering (86.17%). Among the yield traits maximum variability per centage (19.35%, 19.35%, 99.99% and 39.19%) was observed in yield plant⁻¹. In flower quality traits, highest GCV and PCV (17.25% and 18.91%) was reported in inflorescence length, heritability and genetic advance as per cent of mean (91.27% and 19.24%) on display life of flower, similarly least variation (6.99%, 8.07% and 12.48%) of GCV, PCV and GAM in stalk length and least heritability of 49.76% was reported in shelf life of Gomphrena flower. The magnitude of phenotypic coefficients of variation (PCV) were higher than genotypic coefficients of variation (GCV), though difference was very less, showing that the traits were less influenced by environmental factors for the expression of traits. Similar findings were reported by Kumar et al. (2024) in Gomphrena, gerbera and balsam by Ghimiray et al. (2015), Khangjarakpam et al. (2014), Bhargav et al. (2019) in China aster and Pal et al. (2018) in Balsam and Sharma et al. (2025) in Marigold.

Correlation between different genotypes regarding several traits provided information about nature and extent of association between the traits, which would help in upgradation of characters by selection. As yield was an

Table 1: Genetic variability estimates for growth, flowering, yield and quality parameters in Gomphrena genotypes

Sl. No.	Characters	Mean	Range		GCV (%)	PCV (%)	h ² (%)	GAM (%)
			Min	Max				
1.	Plant height (cm)	57.06	23.73	65.80	18.37	18.44	99.25	37.71
2.	Plant spread [N-S] (cm)	49.03	42.27	56.13	8.91	9.15	94.95	17.89
3.	Plant spread [E-W] (cm)	44.93	37	53.53	8.76	8.98	95.15	17.60
4.	Primary branches	8.19	6.6	9.27	9.33	11.61	64.64	15.46
5.	Secondary branches	24.97	15.2	28.4	13.02	13.79	89.08	25.31
6.	Number of leaves	416.72	214.67	564.47	21.55	21.55	99.99	44.38
7.	Stem girth (mm)	8.78	4.52	11.31	16.76	17.7	89.68	32.69
8.	Days for bud initiation	10.49	9	15	13.02	16.29	63.84	21.42
9.	Days from bud to flower	9	8	10.33	6.79	9.64	49.72	9.87
10.	Days for 50% flowering	35.13	31.67	41	7.26	7.82	86.17	13.87
11.	Duration of flowering	64.14	61	67	3.17	3.46	83.87	5.98
12.	Stalk length (cm)	19.31	16.41	22.61	6.99	8.07	75.09	12.48
13.	Inflorescence length (cm)	3.53	2.53	4.74	17.25	18.91	83.15	32.40
14.	Flower diameter (mm)	1.86	1.45	2.16	8.9	9.82	83.43	16.88
15.	Individual flower weight (g)	2.64	1.79	3.19	16.51	17.41	89.88	32.23
16.	Number of flowers plant ⁻¹	246.16	167	279.53	11.19	11.19	99.89	23.04
17.	Yield plant ⁻¹ (g)	585.14	357.7	763.57	19.35	19.35	99.99	39.19
18.	Display life (days)	32.28	27	37	9.77	10.23	91.27	19.24
19.	Shelf life (days)	5.88	5	7	11.29	16	49.76	16.4

dependent variable, which depended on association of independent variables along with environmental condition. This would reveal the nature and extent of association between growths, flower and yield traits. Number of flowers, individual flower weight and yield plant⁻¹ were given prime importance as they contributed to economic value. From table 2 and 3, it was observed that at genotypic and phenotypic level of correlation, the yield plant⁻¹ of Gomphrena had

positive significant at 1% correlation with plant height (0.539/0.539), plant spread in N-S direction (0.513/0.500), number of secondary branches (0.541/0.511), stem girth (0.756/0.715), duration of flowering (0.660/0.602), stalk length (0.442/0.383), inflorescence length (0.527/0.482), individual flower (0.820/0.770) and number of flowers (0.603/0.602). Negatively correlated with days to bud initiation (-0.435/0.346), days for bud to flower opening

Table 2: Genotypic correlation of flower yield and its contributing traits in Gomphrena genotypes

@	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀
X ₁	1	0.603**	0.333*	0.609**	0.896**	0.720**	0.927**	-0.898**	-0.529**	-0.493**
X ₂		1	0.750**	0.2	0.429**	0.334*	0.682**	-0.278	-0.462**	-0.058
X ₃			1	0.206	0.174	0.22	0.411**	0.046	-0.700**	0.244
X ₄				1	0.810**	0.623**	0.517**	-0.657**	-0.957**	-0.701**
X ₅					1	0.616**	0.831**	-0.933**	-0.595**	-0.731**
X ₆						1	0.708**	-0.547**	-0.470**	-0.227
X ₇							1	-0.727**	-0.457**	-0.392*
X ₈								1	0.374*	0.861**
X ₉									1	0.513**
X ₁₀										1
@	X ₁₁	X ₁₂	X ₁₃	X ₁₄	X ₁₅	X ₁₆	X ₁₇			
X ₁	0.292	0.690**	0.729**	-0.013	0.138	0.937**	0.539**			
X ₂	0.730**	0.489**	0.525**	0.361*	0.302	0.680**	0.513**			
X ₃	0.702**	0.085	0.244	0.298	0.187	0.434**	0.343*			
X ₄	-0.068	0.009	0.421**	-0.649**	-0.078	0.416**	0.312*			
X ₅	-0.03	0.509**	0.570**	-0.205	0.197	0.802**	0.541**			
X ₆	0.227	0.268	0.259	0.081	-0.128	0.629**	0.355*			
X ₇	0.478**	0.744**	0.664**	0.242	0.376*	0.948**	0.756**			
X ₈	0.01	-0.645**	-0.635**	0.2	-0.045	-0.796**	-0.435**			
X ₉	-0.480**	0.04	-0.392*	0.316*	-0.174	-0.463**	-0.537**			
X ₁₀	0.089	-0.245	-0.463**	0.379*	-0.276	-0.386*	-0.477**			
X ₁₁	1	0.195	0.398**	0.533**	0.543**	0.419**	0.660**			
X ₁₂		1	0.502**	0.278	0.231	0.805**	0.442**			
X ₁₃			1	-0.293	0.345*	0.619**	0.527**			
X ₁₄				1	0.422**	0.239	0.373*			
X ₁₅					1	0.282	0.820**			
X ₁₆						1	0.603**			
X ₁₇							1			

*Significant at $p=0.05$ level; **Significant at $p=0.01$ level; X₁: Plant height (cm); X₂: Plant spread in N-S direction (cm); X₃: E-W direction (cm); X₄: Number of primary branches plant⁻¹; X₅: Secondary branches; X₆: Number of leaves; X₇: Stem girth (mm); X₈: Day for bud initiation; X₉: Days for bud to flower; X₁₀: 50% flowering (days); X₁₁: Duration of flowering (days); X₁₂: Stalk length (cm); X₁₃: Inflorescence length (cm); X₁₄: Diameter of flower (cm); X₁₅: Individual flower weight (g); X₁₆: Number of flowers; X₁₇: Yield plant⁻¹ (g)

Table 3: Phenotypic correlation of flower yield and its contributing traits in Gomphrena genotypes

@	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀
X ₁	1	0.586**	0.329*	0.491**	0.842**	0.717**	0.883**	-0.725**	-0.370*	-0.449**
X ₂		1	0.727**	0.111	0.407**	0.325*	0.630**	-0.232	-0.361*	-0.064
X ₃			1	0.158	0.184	0.215	0.383*	0.027	-0.526**	0.247
X ₄				1	0.595**	0.501**	0.400**	-0.342*	-0.461**	-0.489**
X ₅					1	0.582**	0.730**	-0.675**	-0.364*	-0.613**
X ₆						1	0.671**	-0.436**	-0.332*	-0.21
X ₇							1	-0.556**	-0.335*	-0.332*
X ₈								1	0.254	0.616**
X ₉									1	0.309*
X ₁₀										1
@	X ₁₁	X ₁₂	X ₁₃	X ₁₄	X ₁₅	X ₁₆	X ₁₇			
X ₁	0.264	0.589**	0.664**	-0.007	0.13	0.933**	0.537**			
X ₂	0.649**	0.433**	0.498**	0.306	0.294	0.665**	0.500**			
X ₃	0.648**	0.077	0.245	0.284	0.191	0.423**	0.335*			
X ₄	0.004	-0.051	0.218	-0.409**	-0.114	0.342*	0.251			
X ₅	0.013	0.492**	0.523**	-0.129	0.194	0.761**	0.511**			
X ₆	0.208	0.232	0.237	0.074	-0.121	0.628**	0.355*			
X ₇	0.428**	0.624**	0.570**	0.226	0.345*	0.899**	0.715**			
X ₈	0.056	-0.336*	-0.531**	0.154	-0.084	-0.633**	-0.346*			
X ₉	-0.338*	-0.025	-0.428**	0.271	-0.122	-0.329*	-0.381*			
X ₁₀	0.106	-0.223	-0.335*	0.380*	-0.236	-0.358*	-0.444**			
X ₁₁	1	0.209	0.342*	0.463**	0.433**	0.385*	0.602**			
X ₁₂		1	0.411**	0.223	0.146	0.700**	0.383*			
X ₁₃			1	-0.223	0.321*	0.564**	0.482**			
X ₁₄				1	0.406**	0.221	0.340*			
X ₁₅					1	0.268	0.777**			
X ₁₆						1	0.602**			
X ₁₇							1			

*Significant at $p=0.05$ level; **Significant at $p=0.01$ level; X₁: Plant height (cm); X₂: Plant spread in N-S direction (cm); X₃: E-W direction (cm); X₄: Number of primary branches plant⁻¹; X₅: Secondary branches; X₆: Number of leaves; X₇: Stem girth (mm); X₈: Day for bud initiation; X₉: Days for bud to flower; X₁₀: 50% flowering (days); X₁₁: Duration of flowering (days); X₁₂: Stalk length (cm); X₁₃: Inflorescence length (cm); X₁₄: Diameter of flower (cm); X₁₅: Individual flower weight (g); X₁₆: Number of flowers; X₁₇: Yield plant⁻¹ (g)

(0.537/0.381) and days to 50% flowering (-0.477/-0.444). At 5% level of significance, yield at genotypic and phenotypic level correlated with E-W direction (0.343/0.335), number of leaves (0.355/0.335) and diameter of flower (0.373/0.340). Positive and non-significant effect of number of primary branches plant⁻¹ with yield at phenotypic level. From this it was confirmatory that, for increase of flower yield in Gomphrena selection might be based on plant height, plant spread in E-W and N-S direction, primary and

secondary branches, number of leaves, stem girth, duration of flowering, stalk length, flower height, diameter, individual flower weight and number of flowers plant⁻¹. With increase in vegetative traits, yield was positively correlated with increase in photosynthetic efficiency and reproductive development of the crop. The results were confirmatory with Kumar et al. (2024) in Gomphrena, Tirakannanavar et al. (2015) in China aster and Choudhary et al. (2015) in marigold.

Selection of genotypes based on correlation might be misleading because it showed only association between the traits, while, path coefficient explained contribution of

individual traits either direct or indirect on yield character (Table 4 and 5). From the genotypic path analysis, Flower yield plant⁻¹ had direct positive impact on individual flower

Table 4: Genotypic path analysis of flower yield and its contributing traits in different Gomphrena genotypes

@	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉
X ₁	0.7882	0.4752	0.2626	0.6647	0.7423	0.5674	0.731	-0.708	-0.4169
X ₂	-0.1695	-0.2811	-0.2108	-0.1632	-0.1284	-0.0938	-0.1917	0.0781	0.1298
X ₃	-0.005	-0.0112	-0.015	-0.0078	-0.0024	-0.0033	-0.0061	-0.0007	0.0105
X ₄	0.2909	0.2002	0.1808	0.3449	0.2939	0.1783	0.2924	-0.2339	-0.2406
X ₅	-0.1048	-0.0508	-0.0175	-0.0948	-0.1112	-0.0729	-0.0964	0.1086	0.0632
X ₆	-0.132	-0.0612	-0.0403	-0.0948	-0.1202	-0.1834	-0.1299	0.1003	0.0863
X ₇	0.9422	0.6927	0.4179	0.8613	0.8806	0.7195	1.0159	-0.7385	-0.4646
X ₈	0.0785	0.0243	-0.004	0.0592	0.0853	0.0478	0.0635	-0.0874	-0.0327
X ₉	0.0732	0.0639	0.0969	0.0966	0.0787	0.0651	0.0633	-0.0518	-0.1385
X ₁₀	0.1422	0.0167	-0.0703	0.114	0.2109	0.0655	0.1128	-0.2482	-0.1478
X ₁₁	0.208	0.5222	0.5006	0.1993	0.0569	0.1683	0.3406	0.0089	-0.3422
X ₁₂	0.3717	0.263	0.0457	0.2453	0.315	0.1443	0.4005	-0.3473	0.0215
X ₁₃	-0.4407	-0.317	-0.1473	-0.4518	-0.397	-0.1562	-0.4009	0.3834	0.2366
X ₁₄	0.0002	-0.0059	-0.0049	0.0018	0.0025	-0.0013	-0.004	-0.0033	-0.0052
X ₁₅	0.0506	0.1108	0.0685	0.129	0.0793	-0.0469	0.138	-0.0164	-0.0638
X ₁₆	-1.5549	-1.1292	-0.7194	-1.2788	-1.4058	-1.0435	-1.5736	1.3215	0.7677
@	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄	X ₁₅	X ₁₆	pR ²	
X ₁	-0.3888	0.2302	0.5441	0.5749	-0.0104	0.1086	0.7386	0.4248	
X ₂	0.0163	-0.2061	-0.1373	-0.1475	-0.1015	-0.0848	-0.1913	-0.1441	
X ₃	-0.0036	-0.0105	-0.0013	-0.0036	-0.0044	-0.0028	-0.0065	-0.0051	
X ₄	-0.1364	0.0965	0.1571	0.258	-0.0378	0.1212	0.2658	0.2156	
X ₅	0.0814	-0.0089	-0.0651	-0.0731	0.0169	-0.024	-0.0942	-0.0645	
X ₆	0.0417	-0.0433	-0.0491	-0.0474	-0.0149	0.0234	-0.1153	-0.0651	
X ₇	-0.3977	0.4859	0.7555	0.6742	0.2461	0.3817	0.9634	0.7676	
X ₈	-0.0752	-0.0011	0.0563	0.0554	-0.0175	0.0039	0.0696	0.0380	
X ₉	-0.071	0.0665	-0.0055	0.0542	-0.0437	0.0241	0.0641	0.0743	
X ₁₀	-0.2882	-0.0255	0.0706	0.1334	-0.1093	0.0794	0.1113	0.1376	
X ₁₁	0.0631	0.7123	0.1348	0.2776	0.382	0.3808	0.2977	0.4677	
X ₁₂	-0.132	0.1019	0.5385	0.2702	0.1494	0.1241	0.4332	0.2375	
X ₁₃	0.2796	-0.2354	-0.3031	-0.6041	0.1771	-0.2082	-0.3737	-0.3183	
X ₁₄	-0.0062	-0.0088	-0.0046	0.0048	-0.0164	-0.0069	-0.0039	-0.0061	
X ₁₅	-0.1012	0.1964	0.0846	0.1266	0.1549	0.3673	0.1035	0.3011	
X ₁₆	0.6409	-0.6934	-1.3346	-1.0265	-0.3973	-0.4677	-1.6594	-1.0002	

Residual effect: R Square=1.0606 Residual Effect=SQRT(1-1.0606); *Significant at $p=0.05$ level; **Significant at $p=0.01$ level; X₁: Plant height (cm); X₂: Plant spread in N-S direction (cm); X₃: E-W direction (cm); X₄: Number of primary branches plant⁻¹; X₅: Secondary branches; X₆: Number of leaves; X₇: Stem girth (mm); X₈: Day for bud initiation; X₉: Days for bud to flower; X₁₀: 50% flowering (days); X₁₁: Duration of flowering (days); X₁₂: Stalk length (cm); X₁₃: Inflorescence length (cm); X₁₄: Diameter of flower (cm); X₁₅: Individual flower weight (g); X₁₆: Number of flowers; X₁₇: Yield plant⁻¹ (g)

Table 5: Phenotypic path analysis of flower yield and its contributing traits in different Gomphrena genotypes

@	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉
X ₁	0.1716	0.1024	0.0569	0.1432	0.1604	0.1233	0.1564	-0.1418	-0.0782
X ₂	-0.4836	-0.81	-0.6011	-0.4624	-0.3644	-0.268	-0.5375	0.2096	0.3353
X ₃	0.5843	1.3075	1.762	0.9052	0.2785	0.384	0.7072	0.0676	-1.0904
X ₄	-1.4724	-1.0067	-0.906	-1.7635	-1.4799	-0.9051	-1.454	1.0608	1.078
X ₅	1.155	0.5558	0.1953	1.0367	1.2354	0.8053	1.0409	-1.095	-0.5887
X ₆	0.2061	0.0949	0.0625	0.1472	0.1869	0.2867	0.1994	-0.1438	-0.1167
X ₇	1.2592	0.9165	0.5543	1.1387	1.1637	0.9602	1.3811	-0.9066	-0.5534
X ₈	-0.5262	-0.1647	0.0244	-0.3829	-0.5642	-0.3191	-0.4178	0.6365	0.2016
X ₉	-0.0147	-0.0133	-0.0199	-0.0197	-0.0153	-0.0131	-0.0129	0.0102	0.0322
X ₁₀	0.3296	0.0414	-0.169	0.2658	0.4842	0.1526	0.2554	-0.5248	-0.2902
X ₁₁	-0.1896	-0.4735	-0.4593	-0.1746	-0.0557	-0.1542	-0.3085	-0.0189	0.281
X ₁₂	0.2655	0.1903	0.0333	0.179	0.2295	0.1035	0.2843	-0.21	0.0045
X ₁₃	0.7041	0.5138	0.2436	0.7173	0.6393	0.2502	0.6279	-0.5898	-0.4034
X ₁₄	-0.0058	0.1816	0.1558	-0.0588	-0.0732	0.0418	0.1259	0.0965	0.1565
X ₁₅	0.0768	0.1699	0.1069	0.1931	0.1212	-0.0712	0.2073	-0.034	-0.0853
X ₁₆	-1.5217	-1.0978	-0.6992	-1.2439	-1.3696	-1.0223	-1.5137	1.1854	0.6522
@	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄	X ₁₅	X ₁₆	pR ²	
X ₁	-0.0819	0.0484	0.1118	0.1211	-0.0019	0.0232	0.1606	0.0923	
X ₂	0.0485	-0.571	-0.3782	-0.4171	-0.2761	-0.2421	-0.5469	-0.4116	
X ₃	0.4315	1.2049	0.1438	0.4301	0.5152	0.3313	0.7576	0.5999	
X ₄	0.6791	-0.4583	-0.7747	-1.2678	0.1945	-0.599	-1.3491	-1.0942	
X ₅	-0.8667	0.1024	0.6958	0.7916	-0.1698	0.2634	1.0406	0.7126	
X ₆	-0.0634	0.0658	0.0729	0.0719	0.0225	-0.0359	0.1803	0.1018	
X ₇	-0.511	0.6343	0.9635	0.8692	0.3264	0.5038	1.2858	1.0239	
X ₈	0.4839	0.0179	-0.3279	-0.3762	0.1153	-0.0381	-0.4641	-0.2533	
X ₉	0.0135	-0.0135	0.0004	-0.013	0.0094	-0.0048	-0.0129	-0.0150	
X ₁₀	-0.6902	-0.0651	0.1632	0.2868	-0.262	0.1804	0.2596	0.3213	
X ₁₁	-0.0634	-0.6717	-0.1316	-0.2493	-0.3418	-0.3331	-0.2729	-0.4276	
X ₁₂	-0.0964	0.0798	0.4075	0.1902	0.1044	0.0807	0.3114	0.1706	
X ₁₃	-0.4146	0.3703	0.4656	0.9978	-0.2664	0.3353	0.5974	0.5093	
X ₁₄	0.2023	0.2712	0.1365	-0.1423	0.5328	0.2217	0.1239	0.1924	
X ₁₅	-0.1485	0.2818	0.1126	0.191	0.2365	0.5684	0.1574	0.4575	
X ₁₆	0.6116	-0.6607	-1.2425	-0.9734	-0.3781	-0.4502	-1.626	-0.9799	

Residual effect: R Square=1.0000 Residual effect=SQRT(1-1.0000); pR²: Partial regression; *Significant at $p=0.05$ level; **Significant at $p=0.01$ level; X₁: Plant height (cm); X₂: Plant spread in N-S direction (cm); X₃: E-W direction (cm); X₄: Number of primary branches plant⁻¹; X₅: Secondary branches; X₆: Number of leaves; X₇: Stem girth (mm); X₈: Day for bud initiation; X₉: Days for bud to flower; X₁₀: 50% flowering (days); X₁₁: Duration of flowering (days); X₁₂: Stalk length (cm); X₁₃: Inflorescence length (cm); X₁₄: Diameter of flower (cm); X₁₅: Individual flower weight (g); X₁₆: Number of flowers; X₁₇: Yield plant⁻¹ (g)

weight (0.3673), stalk length (0.5385), duration of flowering (0.7123), stem girth (1.0159), number of primary branches (0.3449) and plant height (0.7882).

Whereas, direct negative effect on plant spread in North-South and East-West direction (-0.2811 and -0.015), number of secondary branches (-0.1112), number of leaves (-0.1834), days to bud initiation (-0.0874), days from bud to flower opening (-0.1385), 50% flowering (-0.2882), inflorescence length (-0.6041), diameter of flower (-0.0164) and number of flowers per plant (-1.6594). From phenotypic path analysis, Dependent variable yield had shown significantly direct negative effect on number of flowers plant⁻¹ (-1.626), positive indirect association with 50% flowering (0.6116), bud to flower (0.6522) and bud initiation (1.1854). Indirect and negatively associated with plant height (-1.5217), plant spread in N-S and E-W direction (-1.0978 and -0.6992), primary and secondary branches (-1.2439 and -1.3696), leaves count (-1.0223), stem girth (-1.5137), duration of flowering (-0.6607), stalk length of flower (-1.2425), inflorescence length (-0.9734), flower diameter (-0.3781) and individual flower weight (-0.4502). From the path analysis at both genotype and phenotypic level, it was reported that yield could be increased by direct selection of characters like individual flower weight, number of flowers, stalk length of flower, duration of flowering, stem girth, number of primary branches and plant height. Similar observations on effect of yield were found by Rai et al. (2017) in China aster, Kumar et al. (2024) in Gomphrena, Poulouse et al. (2020), Tanya and Kaur (2023) in Marigold and Kumar et al. (2012) in Chrysanthemum.

4. CONCLUSION

High broad sense heritability coupled with high genetic advance as per cent of mean was observed for plant height, secondary branches, leaves, stem girth, days to bud initiation, flower length, individual flower weight, number of flowers and yield plant⁻¹. Parameters like plant spread, number of branches and leaves, flower diameter, inflorescence length, stalk length, duration of flowering and individual flower weight had significantly direct association and positively correlated with yield plant⁻¹ of Gomphrena genotypes, thus selection of these characters accounted for improvement in total crop yield.

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