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Studies on genetic variability, heritability and genetic advance in Gomphrena (*Gomphrena globosa* L.) genotypes

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Abstract
An investigation was undertaken to study the genetic variability and heritability in seventeen Gomphrena genotypes. Highest range of variation was reported for the number of leaves/plant (211.60-1575.80). The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was maximum for plant spread, *i.e*, 42.63 and 41.46 while, minimum in case of days to first flower bud initiation, *i.e*, 6.99 and 6.62, respectively. High heritability was observed for all the characters except days to first flower bud initiation, days to first flowering, days to 50 per cent flowering and duration of flowering. Maximum heritability was recorded for seed yield per plant (99.64%) and minimum was observed in individual flower weight (48.11). High heritability (h^2 = 99.90) with high genetic advance (GA= 80.74) as percentage of mean was observed for stalk length, which indicated that additive gene effects were more important for that trait. High genetic advance as per cent of mean was observed for plant spread (83.05) however, lowest for days to first flower bud initiation (12.93) which indicates the preponderance of additive genes and selection will be effective for improvement of these traits.

Keywords: Gomphrena, genetic advance, heritability, PCV and GCV

1. Introduction

Gomphrena (*Gomphrena globosa* L.) is one of the most important traditional flower crop grown for their loose flowers in different parts of the country, particularly in both tropical and subtropical regions of India. It is commonly known as globe amaranth and bachelor's button belongs to the family Amaranthaceae. *Gomphrena globosa* is native to Central America but is now grown globally (Roriz *et al*., 2014) [2]. It can also be grown for dry flowers as well as for landscaping in gardens. It is widely cultivated for their attractive coloured round shaped flowers used for loose flower, garland making, beds, borders, flower arrangements, wreaths, dye extraction and medicinal products. *Gomphrena globosa* is an outcrossing species that is pollinated by butterflies, bees and other insects. Floral volatiles likely play a significant role in the reproductive success of the plant by promoting the attraction of pollinators.

The round-shaped flower inflorescences are visually dominant feature and cultivars have been propagated to exhibit shades of magenta, purple, red, orange, white, pink and lilac. Within the flower heads, the true flowers are small and inconspicuous (Jiang *et al*., 2011) [1]. *Gomphrena* is highly heat tolerant and fairly drought resistant, but grows best in full sun and regular moisture. The plant fixes carbon through the C_4 pathway (Herold *et al*., 1976) [3].

Gomphrena flowers having a maximum retainment capacity of shape and colour even after natural drying. However, very few cultivars were available in commercial cultivation and few scientific reports are documented on different aspects of the crop. So, therefore in order to identify the superior quality flowers. The present investigation was aimed to study the extent of genetic variation, heritability and genetic advance which are further exploited for future crop improvement.

2. Materials and methods

The experiment was conducted in the research field of Department of Floriculture and Landscape Architecture, College of Horticulture, UHS, Bagalkot, Karnataka. Bagalkot comes under Karnataka state which is located in Northern region of state and it is the dry zone that receives an average rainfall of 682 mm per annum. It is situated at an elevation of 542.0 m above the sea level and has a latitude of $16^0.18''$ North and longitude of $75^0.7''$ East.

Conducted during rabi season *i.e*, from November 2020 to March, 2021. The experiment consisted of 17 gomphrena genotypes, all the genotypes were sown during November 2020 in nursery beds. Gomphrena genotypes like AGS-1, AGS-2, AGS-3, AGS-4, AGS-5, AGS-6, AGS-7, AGS-8, AGS-9, AGS-10, AGS-11, AGS-12, AGS-13, AGS-14, AGS-15, AGS-16 and AGS-17 were selected. Seeds of each germplasm were sown evenly in a well-managed nursery for raising seedlings. The experiment was laid out in a Randomized Block Design (RBD) with two replications. Seedlings having uniform growth and vigour were transplanted at a spacing of 30×30 cm with plot size of 1.8 X 1.5 m^2. The observations were recorded on randomly selected five plants from each genotype for various growth, yield and quality parameters. Variability parameters were worked out as per method given by Burton and Devane (1953) [4] and heritability in broad sense was calculated as per the formula given by Hanson *et al*., 1956 [5]. Genetic advance as percent of mean was calculated according to the formula given by Lush (1940) [6] and Johnson *et al*. (1995) [7].

3. Results and discussion

The evidence from table 1, depicts the significant difference among the gomphrena genotypes for the different characters at 0.1% and 5% significance. The mean sum of squares due to genotype for different characters are presented in Table 1. The highest significant differences observed for plant spread (242566.71). The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for growth, flowering, yield and quality parameters of gomphrena different genotypes are presented in table 2 and Fig. 1. The magnitude of (GCV and PCV) were found highest for plant spread (42.63 and 41.46) and followed by number of leaves per plant (39.29 and 39.55), stalk length (39.22 and 39.24), number of secondary branches (38.44 and 38.91), flower yield per hectare (38.29 and 38.91) flower yield per plot (38.02 and 39.13), number of flowers per plant (37.83 and 38.83), flower yield per plant (36.64 and 37.50), plant height (34.63 and 34.76), seed yield per plant (32.93 and 32.99), seed yield per hectare (30.05 and 31.16), seed yield per plot (28.50 and 29.74), individual flower weight (21.43 and 30.89), number of primary branches per plant (21.70 and 22.20), days to bud initiation to flowering (21.28 and 21.57) and stem girth (20.90 and 22.17). The moderate values of GCV and PCV was recorded for characters *viz.* shelf life (17.08 and 17.38), display life (15.44 and 16.04), inflorescence length (12.50 and 13.25), duration of flowering (10.87 and 11.10) and flower diameter (9.71 and 10.67). The lowest values of GCV and PCV are recorded for characters *viz*. Days to first flowering (7.83 and 7.96), days to 50 per cent flowering (7.68 and 8.40) and days to first flower bud initiation (6.62 and 6.99). Similar results were reported by Kumar *et al*. (2019) [8] in French marigold and Pal *et al*. (2018) [9] in balsam.

Table 1: Analysis of variance for growth, flowering, yield and quality traits in gomphrena genotypes

Sl. No.	Character	Genotypes	Replication	Error	S.Em±	CD @ 5%
	Degrees of Freedom	16	1	16		
A.	**Growth parameters**					
1	Plant height (cm)	486.06	0.89	1.90	0.97	2.92
2	Number of leaves	47954.35	938.18	321.68	12.68	38.02
3	Stem girth (cm)	7.18	0.03	0.42	0.46	1.38
4	Number of primary branches per plant	5.05	0.49	0.22	0.33	0.99
5	Number of secondary branches per plant	232.76	28.45	1.27	0.80	2.39
6	Plant spread (cm^2)	242566.71	48429.48	6786.57	58.25	174.61
B	**Flowering parameters**					
8	Days to first flower bud Initiation	4.80	3.56	0.26	0.36	1.07
9	Bud initiation to first flower opening	6.90	0.57	0.09	0.21	0.64
10	Days for first flowering	12.34	1.52	0.20	0.32	0.95
11	Days to 50% flowering	16.16	1.88	1.44	0.85	2.55
12	Duration of flowering (Days)	43.63	0.03	0.90	0.67	2.02
C	**Yield parameters**					
11	Number of flowers per plant	26489.57	670.62	692.87	18.61	55.80
12	Individual flower weight (g)	0.02	0.01	0.01	0.06	0.18
13	Flower yield per plant (g)	925.56	21.41	21.47	3.28	4.63
14	Flower yield per plot (kg)	0.95	0.02	0.03	0.12	0.35
15	Flower yield per hectare (t)	13.05	0.15	0.30	0.39	1.17
16	Seed yield per plant (g)	290.22	0.34	0.53	0.51	1.54
17	Seed yield per plot (kg)	0.21	0.03	0.01	0.07	0.20
18	Seed yield per hectare (t)	3.18	0.17	0.11	0.24	0.72
D	**Quality parameters**					
19	Flower diameter (cm)	0.07	0.01	0.01	0.06	0.17
20	Stalk length (cm)	41.94	0.02	0.02	0.10	0.31
21	Inflorescence length (cm)	0.24	0.07	0.04	0.14	0.41
22.	Shelf life (days)	1.72	0.03	0.03	0.12	0.36
23.	Display life (days)	50.45	0.74	1.92	0.98	2.94

Table 2: Variability components, heritability with genetic advance as percent mean for various traits of gomphrena genotypes

Traits	Range	Mean	PCV	GCV	h^2	GA	GAM
Plant height (cm)	20.20-64.45	44.93	34.63	34.76	99.22	31.93	71.06
Stem girth (cm)	4.39-11.50	8.80	20.90	22.17	88.86	3.57	40.58
Number of primary branches per plant	4.60-9.90	7.53	20.65	21.56	91.76	3.07	40.75
Number of secondary branches per plant	8.90-41.40	29.55	36.41	36.61	98.91	22.04	74.59
Plant spread(cm^2)	211.60-1575.8	828.18	41.46	42.63	94.56	687.78	83.05
Number of leaves per plant	152.40-625.00	392.82	39.29	39.55	98.67	315.78	80.78
Days to first flower bud initiation	18.70-25.40	22.7	6.62	6.99	89.86	2.94	12.93
Days for first flowering	27.30-34.80	31.48	7.83	7.96	96.78	4.99	15.86
Days to bud initiation to flowering	5.30-11.10	8.67	21.28	21.57	97.37	3.75	43.26
Days to 50% flowering	31.0-40.50	35.91	7.68	8.40	83.48	5.19	14.45
Duration of flowering (days)	32.0-49.0	42.50	10.87	11.10	95.94	9.33	21.94
Flower diameter (cm)	1.52-2.10	1.83	9.71	10.67	82.90	0.33	18.22
Stalk length (cm)	2.73-15.59	11.67	39.22	39.24	99.90	9.43	80.74
Inflorescence length cm)	2.07-3.15	2.75	12.50	13.25	89.01	0.67	24.30
Shelf life (days)	4-7	5.38	17.08	17.38	96.64	1.86	34.60
Display life of flowers (days)	24-38	31.91	15.44	16.04	92.66	9.77	30.61
Number of flowers per plant	114.50-415	300.21	37.83	38.83	94.90	227.91	75.92
Individual flower weight (g)	0.23-0.53	0.38	21.43	30.89	48.11	0.12	30.62
Flower yield per plant (g)	22.90-96.80	58.03	36.64	37.50	95.47	42.79	73.75
Flower yield per plot (kg)	0.69-2.91	1.79	38.02	39.13	94.41	1.36	76.11
Flower yield per hectare (t)	2.55-10.76	6.59	38.29	39.19	95.44	5.08	77.05
Seed yield per plant (g)	18.20-56.10	36.55	32.93	32.99	99.64	24.75	67.70
Seed yield per plot (kg)	0.63-1.69	1.12	28.50	29.74	91.82	0.63	56.26
Seed yield per hectare (t)	2.10-6.23	4.12	30.05	31.16	93.02	2.46	59.71

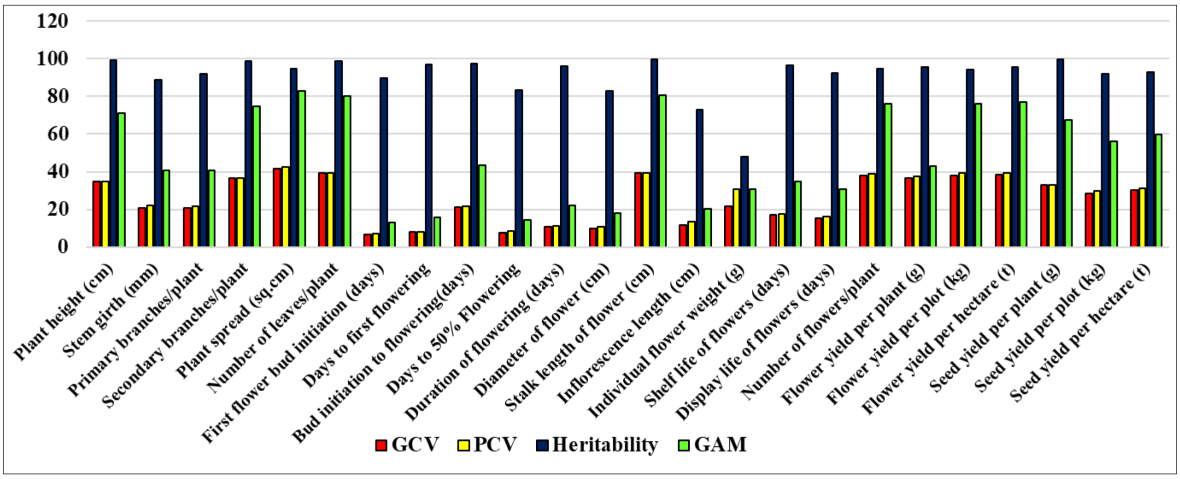

Fig 1: GCV, PCV, h^2 e and GAM exhibited for various growth, yield and flower quality traits by various gomphrena genotypes

High heritability combined with high genetic advance over mean are presented in Table 2 and Fig. 1 and was noticed for the parameters stalk length (99.90 and 80.74), seed yield per plant (99.64 and 67.70), plant height (99.22 and 71.06), number of leaves per plant (98.67 and 80.78), number of secondary branches per plant (97.61 and 78.24), days to bud initiation to flowering (97.37 and 43.26), number of primary branches per plant (95.60 and 43.71), flower yield per hectare (95.44 and 77.05), flower yield per plant (95.41 and 76.11), number of flowers per plant (94.90 and 75.92), plant spread (94.56 and 83.05), flower yield per plot (94.41 and 76.11), seed yield per hectare (93.02 and 59.71), seed yield per plot (91.82 and 56.26) and stem girth (88.86 and 40.58). Hosalli *et al.* (2019) [10] in China aster and Hebbal *et al.* (2018) [11] in chrysanthemum also proved that stalk length, number of secondary branches per plant, number of flowers per plant and other yield parameters shown high heritability coupled with high genetic advance over mean which are highly suitable traits for effective selection.

4. Conclusion

Plant spread followed by number of leaves per plant, stalk length, secondary branches and flower yield per plant etc had high enough GCV (42.63, 39.29, 39.22, 38.44 and 37.83) and PCV (42.63, 39.55, 39.24, 38.91 and 38.83), respectively. Stalk length had highest heritability with high genetic advance 99.90 and 80.74 respectively. High estimates of GCV and heritability could be good predictors for improving the number of flowers/plant. Furthermore, moderate to high amount of heritability, GCV and GA% in a mean could be explained by additive gene action and their improvement could be achieved through mass selection.

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