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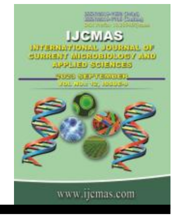

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Genetic Variability Studies in Crossandra (*Crossandra infundibuliformis*)

G. B. Srinivasulu[1*], Mukund Shiragur[1], A. M. Shirol[1], N. Basavaraja[2], P. M. Gangadharappa[3] and Pavankumar[1]

[1]Department of Floriculture and Landscape Architecture, University of Horticultural Sciences, Bagalkot, Karnataka, India
[2]Former Director of Research, Department of Vegetable science, UHS, Bagalkot, Karnataka, India
[3]Director of Extension, Department of Plantation, Spices and Medicinal Aromatic Crops, UHS, Bagalkot, Karnataka, India

**Corresponding author*

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ABSTRACT

Studies were conducted to investigate the variability on growth, flowering, yield and quality parameters of crossandra (*Crossandra undulaefolia* Salisb.). The study carried out at the Department of Floriculture and Landscape Horticulture, College of Horticulture Munirabad, Koppal. The experiment was laid out in Randomised Completely Block Design (RCRD) with ten varieties/genotypes. Genetic parameters such as, Genetic advance, Genotypic variance, Phenotypic variance, Broad sense heritability, Genotypic and Phenotypic coefficient of variation (GCV, PCV), Genetic advance as per cent of mean for different characters of crossandra genotypes. The highest phenotypic and genotypic coefficient of variation, heritability and genetic advance as percent of mean was noticed for plant spread, number of primary and secondary branches, leaf area, chlorophyll content, duration of flowering, number of flowers per spike, spike length, 100 flower weight, flower yield per plant, per plot and per hectare and Flowering parameters such as days taken to flower bud initiation, days taken to 50 % flowering, days taken to first harvest and corolla length have lower estimates of GCV and PCV and moderate estimates of GCV and PCV noticed for plant height, plant spread and flower diameter. The magnitude of heritability in broad sense was high for all the characters under study except for flowering duration. High heritability coupled with high genetic advance as per cent mean was recorded for characters flower yield (kg/plot), flower yield (g / plant), number of spikes per plant, flower yield (t/ha), spike length, number of primary branches per plant, number of flowers per spike, shelf life, number of secondary branches per plant, leaf area, total chlorophyll, weight of 100 flowers (g), flower diameter However, high heritability associated with high GA proves more useful for efficient improvement of a character through simple selection. Thus, these characters can be improved through pure line selection.

Introduction

Crossandra (*Crossandra undulaefolia* Salisb.) is an important commercial traditional flower crop belonging to the family Acanthaceae. It is believed to be native to South India and Sri Lanka, and mainly grown as an important loose flower crop. Crossandra is an important traditional flower crop in south India.

In south India, the flowers are widely used in temples for offering to deity and for making *gajras* and *venis* used for adornment to hair. Area under commercial cultivation of this crop is in increasing trend and presently reached up to an extent of 4,700 ha in Karnataka, Tamil Nadu and Andhra Pradesh (Anon., 2016).

In Karnataka, Crossandra is a major flower crop in Koppal district with an area of 223 ha and placed next to Chikkaballapura (229 ha). Estimation of heritability reveals transmission of characters from one generation to another generation.

Heritability alone is not useful for breeding programmes, heritability along with genetic advance is pre-requisite for selection process. The adequate information on extent of variability parameters may be helpful to improve the yield by selecting the yield component traits because yield is a complex trait, whose manifestation depends on the component traits (Angadi and Archana, 2014).

Based on the requirement, this research work has been undertaken to assess and estimate the magnitude of variation among the different genotypes with respect to various traits which can be further utilized in crop improvement programme.

Materials and Methods

The study was carried out at the Department of Floriculture and Landscape Horticulture, College of Horticulture Munirabad, Koppal. The ten different genotypes were selected based on the superior yield and yield contributing characters. The crop was raised during *Kharif* 2019-20. One month old seedlings were transplanted to main field with spacing of 60 x 30 cm. Observations were recorded on single plant basis for plant height (cm), plant spread (cm), number of branches (primary and secondary) per plant, leaf area (cm^2), days for flower bud initiation, days to 50 per cent flowering, days taken to first harvest, 100 flower weight (g), number of flowers per spike, number of spike per plant, spike length (cm) and total flower yield per plant (g) per plot and per hectare, flower diameter, corolla length.

The genotypic and phenotypic coefficient of variation was estimated according to the methods of Burton (1952). Heritability in broad sense was calculated as per method given by Webber and Moorthy (1952). The expected genetic advance as per cent of mean was worked out as suggested by Johnson *et al.,* (1955).

Results and Discussion

In breeding programme, the mean performance and variability are the important factors for selection. Based on mean performance undesirable plant may be eliminated and also variability may be used for selection procedure.

Plant height (cm)

Plant height at 120 days after transplanting (DAT), the mean values for plant height in Crossandra genotypes ranged from 32.31cm to 55.31 cm with a grand mean of 40.91 cm.

Moderate estimate of GCV (16.34 %) and PCV (18.91 %) were observed. High heritability (74.66 %) was observed along with high genetic advance as per cent of mean (29.09) and genetic advance (11.90) for this trait (Table 1).

Plant spread (cm)

At 120 DAT, plant spread in North to South direction ranged from 36.60 cm to 47.82 cm with a mean value of 41.87 cm. Estimate of low GCV and moderate PCV were 7.62 % and 11.13 %. Moderate heritability (46.80 %) was observed along with moderate genetic advance as per cent of mean (10.73) and genetic advance (4.49) for the trait plant spread in North to South direction. Similarly, plant spread in East to West direction ranged from 42.31 cm to 59.58 cm with a mean value of 49.33 cm. Estimates of GCV and PCV were high (10.13 % and 14.87 %). Heritability (46.40 %) was observed along with high genetic advance as per cent of mean (14.21) and genetic advance (7.01) for this trait (Table 1).

Number of Primary branches

For the character number of primary branches per plant, it was ranged from 4.6 to 9.2 with a mean of 6.69. Estimate of GCV and PCV were high (24.20 % and 25.21 %). High heritability (92.13 %) was observed along with high genetic advance as per cent of mean (47.86) and genetic advance (3.20) for this trait (Table 1).

Number of Secondary branches

The number of secondary branches per plant ranged from 16.13 to 29.63 with a mean of 22.43. The estimate of GCV and PCV were high (20.07 % and 24.68 %). High heritability (82.11 %) was observed along with high genetic advance as per cent of mean (37.46) and genetic advance (8.40) for this trait. GCV and PCV were high (20.07 % and 22.15 %). High heritability (82.11 %) was observed along with high genetic advance as per cent of mean (37.46) and genetic advance (160.3) for this trait (Table 1).

Leaf area (cm^2)

Leaf area of different crossandra genotypes at 120 DAT ranged from 1485.61 cm^2 to 2605.17 cm^2 with a mean of 1986.26 cm^2. High estimates of GCV and PCV (19.99 % and 22.11 %) were observed. High heritability (81.73 %), high genetic advance as per cent of mean (37.23) and genetic advance (739.44) for this trait (Table 1).

Days taken for flower initiation

Days taken for flower bud initiation ranged from 84.25 days to 105.15 days with a mean value of 93.07 days. Lower estimates of GCV and PCV (7.35 % and 9.07 %) were observed. High heritability (65.52 %) was observed with moderate genetic advance as per cent of mean (12.25) and genetic advance (11.40) for this trait (Table 1).

Days to 50 per cent flowering

Days taken to 50 per cent flowering was ranged from 96.34 days to 115.64 days with a mean value of 105.04 days. Lower estimates of GCV and PCV (5.88% and 8.09%) were observed. Moderate heritability (52.81 %) was observed with lower genetic advance as per cent of mean (8.80) and genetic advance (9.25) for this trait (Table 1).

Days taken for first harvest

Days taken for first harvest was ranged from 87.25 days to 109.28 days with a mean value of 102.11 days. Lower estimates of GCV and PCV (7.05 % and 10.35 %) were observed. Moderate heritability (46.43 %) was observed with lower genetic advance as per cent of mean (9.57) and genetic advance (9.90) for this trait (Table 1).

Duration of flowering (Days)

Duration of flowering in spike ranged from 21.83 to 45 days with a mean value of 28.71 days. Higher estimates of GCV and PCV (25.84 % and 27.30 %) were observed. High heritability (89.56 %) was observed with higher genetic advance as per cent of mean (50.37) and genetic advance (14.46) for this trait (Table 1).

Number of flowers per spike

Number of flowers per spike varied from 15.21 to 48.67 with a mean value of 26.00. High estimates of GCV and PCV (35.90 % and 37.50 %) were observed. High heritability (91.6 7%) was observed with high genetic advance as per cent of mean (70.81) and genetic advance (18.41) for this trait (Table 1).

Number of spikes per plant

Number of spikes per plant varied from 63.26 to 139.53 with a mean value of 101.15. Higher estimates of GCV and PCV (24.57 and 25.23 %) were observed. High heritability (94.81 %) was observed with moderate genetic advance as per cent of mean (49.27) and genetic advance (49.84) for this trait (Table 1).

Spike length (cm)

Spike length varied from 3.75 cm to 11.36 cm with a mean value of 6.00. Higher estimates of GCV and PCV (35.89 % and 37.34 %) were observed. High heritability (92.34 %) was observed with high genetic advance as per cent of mean (71.04) and genetic advance (4.26) for this trait (Table 1).

Weight of hundred flowers (g)

Weight of hundred flowers varied from 4.73 g to 7.96 g with a mean value of 6.32 g. Estimates of lower GCV (18.01 %) and higher PCV (20.12 %) were observed. High heritability (80.14 %) was observed with higher genetic advance as per cent of mean (33.22) and genetic advance (2.10) for this trait (Table 1).

Flower yield per plant (g)

Flower yield per plant ranged from 45.36 g to 180.73 g with a mean value of 98.03 g. Higher estimates of GCV and PCV (43.20 % and 44.22 %) were observed. High heritability (95.41 %) was observed with high genetic advance as per cent of mean (86.92) and genetic advance (85.20) for this trait (Table 1).

Flower yield per plot (kg)

Flower yield per plot ranged from 0.95 kg to 3.65 kg with a mean value of 2.06 kg. Higher estimates of GCV and PCV (41.37 % and 42.15 %) were observed. High heritability (96.33 %) was observed with higher genetic advance as per cent of mean (83.65) and genetic advance (1.72) for this trait (Table 1).

Flower yield per hectare (t)

Flower yield per hectare ranged from 1.32 t to 5.07 t with a mean value of 2.86 t. Higher estimates of GCV and PCV (41.19 % and 42.51 %) were observed. High heritability (93.86 %) was observed with high genetic advance as per cent of mean (82.19) and genetic advance (2.35) for this trait (Table 1).

Flower diameter (cm)

Flower diameter ranged from 2.36 cm to 3.73 cm with a mean value of 3.28 cm. Moderate estimates of GCV and PCV (13.27 % and 15.18 %) were observed. High heritability (76.42 %) was observed with high genetic advance as per cent of mean (23.89) and genetic advance (0.79) for this trait (Table 1).

Corolla length (cm)

Length of corolla of different genotypes ranged from 2.36 cm to 2.69 cm with a mean value of 2.58 cm. Lower estimates of GCV and PCV (4.14 % and 6.08 %) were observed. Moderate heritability (46.41 %) was observed with lower genetic advance as per cent of mean (5.81) and genetic advance (0.15) for this trait (Table 1).

Shelf life

Shelf life of different genotypes ranged from 1.80 to 3.67 with a mean value of 2.79. Higher estimates of GCV and PCV (26.18 % and 28.11 %) were observed. Higher heritability (86.70 %) was observed with high genetic advance as per cent of mean (50.21) and genetic advance (1.40) for this trait (Table 1).

Data pertaining to mean, range, variances, genotypic and phenotypic co-efficient of variation, heritability and genetic advance as per cent mean has been discussed here.

The range in the values reflect the amount of variability, which is not very reliable since it includes genotypic, environmental and genotype × environmental interaction components and does not reveal as to which character is showing higher degree of variability.

The estimates of genotypic co-efficient of variation and phenotypic co-efficient of variation were higher for the characters like flower yield (g / plant) (43.20 % and 44.20 %) followed by flower yield (kg/plot) (41.37.20 % and 42.15 %), flower yield (t/ha) (41.19 % and 42.51 %), number of flowers per spike (35.90 % and 37.50 %), spike length (cm) (35.89 % and 37.34 %), shelf life (26.18 % and 28.11 %), duration of flowering (25.84 % and 27.30 %), chlorophyll-b (25.50 % and 27.67 %), number of primary branches per plant (24.20 % and 25.21%), number of secondary branches per plant (20.07 % and 22.15 %), respectively. The results are in agreement with the findings of Seemanthini *et al.,* (2022) in hibiscus and Anitha *et al.,* (2021) in chrysanthemum.

Moderate genotypic co-efficient of variation and phenotypic co-efficient of variation was observed for the characters leaf area (19.99 % and 22.11%, respectively), weight of 100 flowers (18.01 % and 20.12 %, respectively), plant height (16.34 % and 18.91%, respectively), flower diameter (13.27 % and 15.18 %, respectively), total chlorophyll (11.84 % and 13.14 %, respectively), plant spread (EW) (10.13% and 14.87%, respectively). Bharathi *et al.,* (2018) in lilium, Seemanthini *et al.,* (2022) in hibiscus, Panwar *et al.,* (2013) observed moderate genotypic and phenotypic co-efficient of variation for days to 50 per cent flowering, vase life and shelf life; Pavani (2014); Sankari *et al.,* (2019) for days to 50 per cent flowering in China aster and Manjula and Nataraj (2016) observed same results for days to 50 per cent flowering and vase life in dahlia. The low genotypic co-efficient of variation and phenotypic co-efficient of variation was observed for plant spread at North-South (7.62 % and 11.13 %, respectively), days for flower initiation (7.35 % and 9.07 %, respectively), days taken to first harvest (7.05 % and 10.35 %, respectively), corolla tube length (cm) (4.14 % and 6.08 %, respectively). Similar results were observed for these characters earlier by Gaikwad *et al.,* (2020) in chrysanthemum and Ramya *et al.,* (2019) in China aster.

The characters *viz.,* flower yield (g/plant), flower yield (kg/plot), flower yield (t/ha), number of flowers per spike, spike length (cm), shelf life, duration of flowering, number of primary branches per plant and number of secondary branches per plant had shown high genotypic co-efficient of variation coupled with narrow difference between the genotypic and phenotypic co-efficient of variation, hence, could be utilized in further breeding programme.

In the present study, high heritability coupled with high genetic advance as per cent mean was recorded for characters flower yield (kg/plot) (96.33 % and 83.65 %), flower yield (g / plant) (95.41 % and 86.92 %), number of spikes per plant (94.81 % and 49.27 %), flower yield (t/ha) (93.86 % and 82.19 %), spike length (92.34 % and 71.04 %), number of primary branches per plant (92.13 % and 47.86 %), number of flowers per spike (91.67% and 70.81 %), shelf life (86.70.% and 50.21 %), number of secondary branches per plant (82.11 % and 37.46 %), leaf area (81.73 % and 37.23 %), total chlorophyll (81.18 % and 21.98 %), weight of 100 flowers (g) (80.14 % and 33.22 %), flower diameter (76.42 % and 23.89 %), respectively indicates the effectiveness of selection through phenotypic performance, but it does not mean that a high genetic gain.

However, high heritability associated with high GA proves more useful for efficient improvement of a character through simple selection. Thus, these characters can be improved through pure line selection.

Table.1 Estimates of variability and genetic parameters for growth and flowering traits in crossandra genotypes

Sl. No.	Characters	Range	Mean	GV	GCV	PV	PCV	h^2	GA (5%)	GAM (5%)
1	Plant height (120 DAT)	32.31-55.31	40.91	44.68	16.34	59.85	18.91	74.66	11.90	29.09
2	Primary branches per plant	4.60-9.20	6.69	2.62	24.20	2.85	25.21	92.13	3.20	47.86
3	Secondary branches per plant	16.13-29.63	22.43	20.27	20.07	24.68	22.15	82.11	8.40	37.46
4	Plant spread (N-S) (cm)	36.60-47.82	41.87	10.17	7.62	21.73	11.13	46.80	4.49	10.73
5	Plant spread (E-W) (cm)	42.31-59.58	49.33	24.96	10.13	53.78	14.87	46.40	7.01	14.21
6	Lear Area (cm^2)	1485.61-2605.17	1986.26	157640.40	19.99	192872.09	22.11	81.73	739.44	37.23
7	Days for flower initiation	84.25-105.15	93.07	46.73	7.35	71.33	9.07	65.52	11.40	12.25
8	Days to 50 per cent flowering	96.34-115.64	105.04	38.15	5.88	72.24	8.09	52.81	9.25	8.80
9	Days taken to first harvest	87.25-109.28	96.68	46.52	7.05	100.20	10.35	46.43	9.57	9.90
10	Duration of flowering (days)	21.33-45.00	28.71	55.00	25.84	61.41	27.30	89.56	14.46	50.37
11	Number of flowers per spike	15.21-48.67	26.00	87.14	35.90	95.06	37.50	91.67	18.41	70.81
12	Number of spikes per plant	63.26-139.53	101.15	617.43	24.57	651.25	25.23	94.81	49.84	49.27
13	Spike length (cm)	3.56-11.36	6.00	4.64	35.89	5.02	37.34	92.34	4.26	71.04
14	100 flower weight (g)	4.73-7.96	6.32	1.30	18.01	1.62	20.12	80.14	2.10	33.22
15	Flower yield (g/plant)	45.36-180.73	98.03	1792.94	43.20	1879.19	44.22	95.41	85.20	86.92
16	Flower yield (kg/plot)	0.95-3.65	2.06	0.73	41.37	0.75	42.15	96.33	1.72	83.65
17	Flower yield (kg/ha)	1.32-5.07	2.86	1.39	41.19	1.48	42.51	93.86	2.35	82.19
18	Flower diameter (cm)	2.36-3.86	3.28	0.19	13.27	0.25	15.18	76.42	0.79	23.89
19	Corolla tube length (cm)	2.36-2.77	2.58	0.01	4.14	0.03	6.08	46.41	0.15	5.81
20	Shelf life (days)	1.80-3.67	2.79	0.53	26.18	0.62	28.11	86.70	1.40	50.21

h^2 – Broad sense heritability, GAM – Genetic advance as Per cent of mean, GA –Genetic advance, GV – Genotypic variance, GCV – Genotypic co-efficient of variation, PV – Phenotypic variance, GAM 0-10 %= Low, 10-20 % = Moderate, 20-30 % = High, Heritability 0-30 %= Low, 30-60 % =Moderate, >60% = High, PCV – Phenotypic co-efficient of variation

High heritability coupled with high genetic advance as per cent mean has also been reported for number of florets per flower head, weight of flower per plant, plant height, flower head diameter reported by for disc diameter by Pavani (2014); Latha and Dharmatti (2018) in marigold High heritability associated with high genetic advance proves more useful for efficient improvement of a character through selection Naresh *et al.,* (2015).

High heritability and moderate genetic advance has also been reported for was recorded for chlorophyll –A (60.34 % and 10.50 %), respectively. The high heritability is being exhibited due to favourable influence of environment rather than genotype, selection for such traits may not be rewarding inferring that these characters could be improved through hybridization this is in accordance with the findings of Pavani (2014) and Patel *et al.,* (2018) in marigold.

The character days taken to first harvest, days to 50% flowering and corolla tube length recorded moderate heritability, low genetic advance and moderate genetic advance as per cent mean indicating action of non additive gene action and these traits can be improved through heterosis. These findings are in line with the findings of Naikwad *et al.,* (2018) and Sankari *et al.,* (2019) in China aster.

High heritability value of a particular character had less influence of environment which is highly useful in selecting genetically good individual.

Heritability along with genetic advance is more useful in predicting the resultant effect of selecting the best individuals.

High heritability coupled with high genetic advance over mean was recorded for characters *viz.* number of primary and secondary branches, leaf area, duration of flowering, number of flowers per spike, number of spikes per plant, spike length, 100 flower weight, flower yield and shelf life. High heritability with high genetic advance is an important character for selection and these are traits controlled by additive gene action and consideration of these characters will be potential in breeding programme.

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