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Assessment of genetic variability in Crossandra genotypes

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Abstract

Use of the conventional urea not only increase the cost of income but also act as harmful effect on crop, soil. The present investigation entitled Assessment of genetic variability in crossandra genotypes was conducted at ICAR-IIHR, Bengaluru. To facilitate effective crop improvement strategies. Phenotypic and genotypic coefficients of variation (PCV and GCV) were highest for number of flowers per plant 66.10%, peduncle length (PCV=49.45%, GCV=48.42%), and yield (PCV=39.01%, GCV=38.95%), suggesting significant genetic variability and scope for selection. Heritability estimates ranged from moderate to high (65.37%-100%), with traits like number of flowers per plant and fresh flower count per 100 g exhibiting near-complete heritability, indicative of strong additive genetic control. Genetic advance and genetic advance as percent of mean were highest for number of flowers per plant (1431.32%), peduncle length (97.68%) and yield (80.13%), reinforcing their amenability to selection. Traits with high heritability and genetic advance suggest predominance of additive gene action, while those with moderate heritability and low genetic advance, such as rachis length and flower length, may require hybridization or alternative breeding approaches. These findings provide a robust foundation for targeted selection and genetic enhancement in crossandra breeding programs.

Keywords: Crossandra, genetic variability, PCV, GCV, heritability, genetic advance

Introduction

Crossandra spp., commonly known as firecracker flower, is a genus of flowering plants belonging to the family Acanthaceae. Native to South and Southeast Asia, particularly India and Sri Lanka, *Crossandra infundibuliformis* is the most widely cultivated species due to its vibrant orange blooms and ornamental value. The genus comprises approximately 50 species, many of which are valued for their aesthetic appeal, adaptability to tropical climates, and extended flowering period.

In horticultural and floricultural contexts, Crossandra holds significant economic and ecological importance. Its tolerance to partial shade, moderate drought, and varied soil conditions makes it a preferred choice for landscape design and container gardening. Moreover, its non-scented yet vividly colored flowers are extensively used in traditional Indian garlands and temple offerings, contributing to its cultural relevance.

In order to develop an efficient breeding program, it is necessary to characterize and understand the genetic diversity and genetic relationships among the available genotypes. Various methods have been employed to evaluate genetic diversity. Morphological characterization is an important tool to characterize the genotypes. Traditionally, the genotypes identification is based mostly on morphological traits such as growth habit or flower traits like flower colour, form and other characteristics of the plant (Mohapatra and Kout, 2005) [4].

Materials and Methods

A total of 16 crossandra genotypes were collected from different locations (Table 1). The experiment was performed in a completely randomized design (CRD) with three replications during 2023-2025 at a polyhouse in the Division of Flower and Medicinal Crops, ICAR-Indian Institute of Horticultural research, Bengaluru. Data were collected on five randomly chosen

plants from each genotype, adhering to the suggested set of procedures. 26 characteristics were observed viz., plant height, internode number, internode diameter, number of leaves, leaf length, leaf width, inflorescence length, peduncle length, flower number per inflorescence, flower length, flower width in front view, dorsal sepal length, dorsal sepal width, petal length, petal width, lip length, lip width, column width across stigma, spur length, flower longevity on plant, and inflorescence number per plant. Mean values were taken for analysis of variance. Using formulas proposed by Burton and Devane, (1953) ^[1], the genotypic coefficient of variation (GCV) and phenotypic coefficient of variability (PCV) were computed. Genetic advancement (GA) and heritability.

Table 1: List of Crossandra genotypes used in the experiment and their source of collection

Sl. No	Genotype	Source
1	Arka Ambara	ICAR-IIHR, Bengaluru
2	Arka Chenna	ICAR-IIHR, Bengaluru
3	Arka Kanaka	ICAR-IIHR, Bengaluru
4	Arka Shravya	ICAR-IIHR, Bengaluru
5	Arka Shreeya	ICAR-IIHR, Bengaluru
6	IIHR-5	ICAR-IIHR, Bengaluru
7	IIHR-4	ICAR-IIHR, Bengaluru
8	IIHR-3	ICAR-IIHR, Bengaluru
9	IIHR-2	ICAR-IIHR, Bengaluru
10	IIHR-1	ICAR-IIHR, Bengaluru
11	IIHR-AP-1	Chitvel, Andhra Pradesh
12	IIHR-BL-1	Tirumalapura, Bangaluru
13	IIHR-CN-1	Dibbur, Bengaluru, Karnataka
14	IIHR-GC-1	Rajanukunte, Bengaluru, Karnataka
15	IIHR-ML-1	Kankanady, Karnataka
16	IIHR-PY-1	Nidamanuru, Andhra Pradesh

Results and Discussion

A thorough knowledge on the extent of genetic diversity present in the crossandra genotypes for various characters is a prerequisite for any crop improvement program. The variability available in the genotypes can be partitioned into heritable and nonheritable components viz., mean, range, coefficient of phenotypic and genotypic variation (PCV and GCV), heritability in broad sense (H), genetic advance (GA) and genetic advance as per cent of mean. The data for the genetic variability parameters of different crossandra genotypes have been presented in Table 4.4 and is discussed under following head and subheads.

Variability studies

Mean

The mean performance of crossandra genotypes for various morphological traits is presented in Table 2. Considerable variability was observed among the crossandra genotypes for growth, flowering and yield traits.

The number of fresh flowers per 100 g weight (1875.18) recorded the highest mean value, followed by number of flowers per plant (1051.18) and yield per plant per year (264.30 g), clearly indicating the high productivity of the crop. Plant architecture traits showed moderate mean values, with plant height (65.07 cm), number of branches per plant (22.64), stem girth (15.75 mm), plant spread in the East-West direction (50.33 cm) and North-South direction (49.78 cm). The average leaf length and leaf width were 8.99 cm and 2.88 cm, respectively, with a mean leaf area of 14.58 cm², reflecting moderate vegetative growth.

In terms of flowering behaviour, mean for days to spike initiation was 98.88 days, while the days to first flower opening

in a spike averaged 7.27 days, and days to complete opening of flowers in a spike averaged 18.75 days. The number of spikes per plant recorded a mean of 36.77, while the number of flowers in a spike averaged 26.92, and the number of flowers that remained open at a time in a spike was 3.25.

Spike characters showed moderate mean values, with spike length (12.99 cm), rachis length (5.85 cm), peduncle length (7.15 cm), and spike girth (7.65 mm). Floral traits recorded an average flower length of 4.12 cm and a flower diameter of 2.98 cm. The 100-flower fresh weight averaged 5.91 g, while the longevity of a flower in the spike was 2.93 days. Mean of shelf life of flowers recorded 2.47 days. Overall, the mean values indicated substantial variation among crossandra genotypes for key growth, floral and yield traits, providing ample scope for effective selection and genetic improvement.

Range

Wide variation was observed among crossandra genotypes for various morphological traits (Table 2.). Vegetative traits showed substantial variation viz. Plant height ranged from 44.29 to 102.39 cm, number of branches per plant ranged from 8.97 to 41.87, and stem girth ranged from 9.46 to 19.71 mm. Plant spread varied considerably in both directions, from 31.07 to 84.40 cm (North-South) and 31.33 to 84.13 cm (East-West). Leaf traits also displayed clear differences, with leaf length ranging from 5.71 to 12.01 cm, leaf width from 2.05 to 4.12 cm, and leaf area from 6.46 to 27.35 cm².

For spike and floral characters, number of spikes per plant also varied considerably, ranging from 21.33 to 60.53, while the number of flowers per spike ranged between 20.67 and 53.33, and the number of flowers that remained open at a time in a spike varied from 2.00 to 4.00. Days to spike initiation ranging narrowly from 97.33 to 101.67 days, while the days to first flower opening in a spike and days to complete opening of flowers in a spike ranged from 3.33 to 10.33 and 7.33 to 26.67 days, respectively. Spike length varied from 6.46 to 21.06 cm, rachis length ranged from 4.34 to 7.89 cm, peduncle length ranged from 0.37 to 13.17 cm, and spike girth ranged from 6.31 to 10.71 mm. Floral traits recorded ranges of 3.03 to 4.59 cm for flower length and 1.23 to 3.76 cm for flower diameter, while the fresh weight of 100 flowers varied between 3.01 and 8.34 g. Number of flowers per plant exhibited the widest range, varying from 440.89 to 3228.17, followed by number of fresh flowers per 100 g weight (1200.00 to 3326.00) and yield per plant per year (33.00 to 404.37 g), clearly reflecting large differences in productive potential. Longevity of a flower in the spike ranging from 1.00 to 4.00 days, and the shelf life ranged from 0.50 to 3.67 days, reflecting differential keeping quality among the genotypes.

Coefficient of variation

Phenotypic coefficient of variation

The maximum phenotypic coefficient of variation was recorded for number of flowers per plant with 66.10%. This was followed by peduncle length (PCV=49.45%), shelf life (PCV=40.27%), and yield per plant per year (PCV=39.01%) respectively. While the least was observed for days to spike initiation with 1.47% PCV.

Genotypic coefficient of variation

The maximum genotypic coefficient of variation was recorded for number of flowers per plant with 66.10%. This was followed by peduncle length (GCV=48.42%), yield per plant per year (GCV=38.95%) and shelf life (GCV=36.76%), respectively. While the least was observed for days to spike initiation with

1.35% PCV.

High GCV and PCV were recorded for number of flowers per plant, peduncle length, yield per plant, and number of branches per plant. This indicates the presence of a wide range of genetic variability and substantial scope for selection. Moderate levels of variability were observed for spike length, number of flowers per spike, and flower diameter, while low variability was evident for days to spike initiation, suggesting restricted scope for improvement through direct selection. These findings are in agreement with the results reported by Vinodh and Kannan (2020)^[8] in crossandra, and by Sharma and Raghuvansi (2011)^[6] in French marigold.

Heritability (%)

The estimated broad sense heritability for all the morphological traits ranged from 65.37% to 100%. Maximum heritability (broad sense) was recorded in number of flowers remain open at a time in spike (100%) followed by number of flowers per plant (99.99%) and number of fresh flowers per 100g weight (99.98%).

However, minimum heritability was observed in rachis length (65.37%) followed by days to first flower opening in the spike (78.31%) and longevity of flower in the spike (78.89%). Traits with high heritability are expected to respond effectively to selection.

Heritability estimates were generally high for most traits such as plant height, plant spread, number of flowers per plant, yield per plant, and fresh flowers per 100 g weight. These results imply that the traits are governed by additive gene action, and hence selection based on phenotype will be highly reliable. Moderate heritability was observed for rachis length and longevity of flowers in spike, indicating the influence of both genetic and environmental factors. The findings of the present study are supported by Mishra *et al.* (2001)^[3], who reported high heritability for total crop duration in carnation. Similarly, Singh and Kumar (2008)^[7] observed high heritability for the number

of secondary branches and single flower weight, high heritability for the number of flowers per plant and days to flower bud appearance and Vinodh and Kannan (2020)^[8] reported high heritability for number of flowers per spike in crossandra.

Genetic advance

The genetic advance for all the traits showed the highest degree in number of flowers per plant (1431.32%) followed by number of fresh flowers per 100g weight (1363.10%), yield per plant per year (211.78%) and plant height (44.10%). While, the least percent of genetic advance was recorded for flower length (0.83%) followed by leaf width (1%), flower diameter (1.32%) and rachis length (1.35%).

Genetic advance as per cent of mean

The trait number of flowers per plant was observed to have the highest value (136.16%) for genetic advance as per cent of mean which was followed by peduncle length (97.68%), yield per plant per year (80.13%) and number of branches per plant (77.83%). However, the least genetic advance as per cent of mean (2.54%) was exhibited by days to spike initiation followed by flower length (20.03%), rachis length (23.02%) and spike girth (33.54%).

High heritability coupled with high genetic advance was observed in number of flowers per plant, peduncle length, yield per plant, and number of branches per plant, suggesting predominance of additive gene action and greater scope for effective selection. Traits such as rachis length and flower length showed low genetic advance despite moderate heritability, implying the role of both additive and non-additive gene effects and suggesting that improvement may require hybridization or other breeding strategies rather than simple selection. Similar results have been reported by Vinodh and Kannan (2020)^[8] in crossandra, Sankari *et al.* (2019)^[5] in china aster and Kadam *et al.* (2014)^[2] in gladiolus.

Table 2: Genetic parameters of crossandra for morphological traits

Sl. No.	Traits	Mean	Range		Variability		Heritability (%)	Genetic Advance	Genetic Advance as percent of mean
			Min	Max	GCV (%)	PCV (%)			
1	Plant height (cm)	65.07	44.29	102.39	32.99	33.08	99.44	44.10	67.77
2	Number of branches per plant	22.64	8.97	41.87	38.14	38.50	98.13	17.62	77.83
3	Stem girth (mm)	15.75	9.46	19.71	18.08	18.62	94.25	5.70	36.16
4	Leaf length (cm)	8.99	5.71	12.01	17.47	17.73	97.10	3.19	35.46
5	Leaf width (cm)	2.88	2.05	4.12	17.20	17.56	95.93	1.00	34.70
6	Leaf area (cm ²)	14.58	6.46	27.35	32.01	32.37	97.75	9.51	65.19
7	Plant spread NS (cm)	49.78	31.07	84.40	32.59	32.67	99.56	33.35	67.00
8	Plant spread EW (cm)	50.33	31.33	84.13	33.23	33.31	99.50	34.37	68.28
9	Days to spike initiation	98.88	97.33	101.67	1.35	1.47	83.73	2.51	2.54
10	Days to first flower opening in the spike	7.27	3.33	10.33	24.09	27.22	78.31	3.19	43.91
11	Days to complete opening of flowers in a spike	18.75	7.33	26.67	30.96	31.27	98.03	11.84	63.14
12	Spike length (cm)	12.99	6.46	21.06	29.52	30.75	92.14	7.58	58.37
13	Number of flowers in a spike	26.92	20.67	53.33	28.85	29.37	96.52	15.72	58.39
14	Number of flowers remain open at a time in spike	3.25	2.00	4.00	30.77	30.77	100.00	2.06	63.38
15	Rachis length (cm)	5.85	4.34	7.89	13.82	17.10	65.37	1.35	23.02
16	Peduncle length (cm)	7.15	0.37	13.17	48.42	49.45	95.90	6.98	97.68
17	Spike girth (mm)	7.65	6.31	10.71	16.52	16.76	97.13	2.57	33.54
18	Flower length (cm)	4.12	3.03	4.59	9.96	10.20	95.34	0.83	20.03
19	Flower diameter (cm)	2.98	1.23	3.76	21.82	22.02	98.14	1.32	44.53
20	Number of flowers per plant	1051.18	440.89	3228.17	66.10	66.10	99.99	1431.32	136.16
21	Number of fresh flowers per 100g weight	1875.18	1200.00	3326.00	35.29	35.29	99.98	1363.10	72.69
22	Number of spikes per plant	36.77	21.33	60.53	32.78	33.41	96.25	24.36	66.24
23	Longevity of flower in the spike	2.93	1.00	4.00	29.74	33.48	78.89	1.59	54.41
24	100 flowers fresh weight	5.91	3.01	8.34	30.13	30.27	99.08	3.65	61.79
25	Yield per plant per year (g)	264.30	33.00	404.37	38.95	39.01	99.71	211.78	80.13
26	Shelf life (days)	2.47	0.50	3.67	36.76	40.27	83.32	1.71	69.12

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