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Study of Genetic Variability among Some Petunia Hybrids at Chhattisgarh Plains

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation entitled "Study of genetic variability among some petunia hybrids at Chhattisgarh plains" was carried out during the year 2022-23 at the Horticultural Research cum Instructional farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G.). The experiment was laid out in a Completely Randomized Design in three replications using 10 genotypes, *viz.*, Daddy, Eagle, Dreams, Success 360, Mirage, Supercascade, Tritunia Crimson Star, Double Duo, Double Pirouette Rose and Double Glorious. The analysis of variance revealed significant differences for all the characters. The variability was studied among these different genotypes. The highest range as well as the highest GCV and PCV was found in the number of

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flowers per plant. The heritability ranged between 48.74 (plant spread at 90 days) to 99.97 per cent (number of leaves at 75 days). High heritability (>60%) was found in almost all characters. Genetic advance and genetic advance as per cent of mean were found to be maximum for number of leaves at 90 days (26.66) and leaf area (43.69) respectively. High heritability coupled with a high genetic gain was also observed in some characters indicating that these characters are most suitable for selective breeding.

Keywords: Petunia; variability; GCV; PCV; heritability.

1. INTRODUCTION

Petunia is one of the most economical ornamental plants worldwide used in urban landscaping. Their versatility, diversity and varying flower colours are the reasons why petunias (*Petunia x hybrida*) are among the most popular bedding plants in the world. They can be used for colour masses, borders, containers, hanging baskets or as a seasonal groundcover and also used in the private garden, and building decoration. The crucial role played by the genus Petunia in both horticulture and biological research ventures is undeniable. In some cases, petunia has been used to detect the acidity of the soil. The anthocyanin petunia changes its petal colour to reddish-purple in acidic soil and violet in basic soils. Considering the multipurpose role it plays and the lack of care it requires, it is continuously in demand. So, this obliges the growers for procuring varieties with more novelties that have good acclimatization in varied agro - climatic and ecological conditions, as well as suitability for specific purposes.

Petunia also shows a considerable amount of variation which demands the study of genetic variability for a successful breeding program. Genetic parameters such as mean, range, GCV, PCV, heritability and genetic advance need to be partitioned in order to understand which characters would be more efficient for selection.

2. MATERIALS AND METHODS

Ten genotypes of petunia hybrids, *viz*.,Daddy, Eagle, Dreams, Success 360, Mirage, Supercascade, Tritunia Crimson Star, Double Duo, Double Pirouette Rose and Double Glorious, were evaluated at the Horticultural cum Instructional farm, COA, IGKV, Raipur (C.G.) to estimate the amount of variability for vegetative and flowering characters among them. Seeds of the ten genotypes were sown on 11th November, 2022 and transplanted on 19th December, 2022 into pots. Observations were taken at every 15 days interval for parameters as mentioned in Table 1. The analysis of variance was computed using OPSTAT. The analysis of variance (Table 1) indicated highly significant differences among the genotypes for most of the characters, but the analysis of variance itself is yet not sufficient and determinative in explaining all the inherent genotypic variance in the genotypes. One simple way of assessing the variability of these characters is through a simple study of the genetic parameters.

The parameter of genetic variability *viz.* range, PCV, GCV, heritability (broad sense), genetic advance and genetic advance as per cent of the mean are analysed using formulas as described below. The phenotypic and genotypic coefficients of variation (PCV and GCV) were obtained by the method as suggested by Burton and Devane [1].

$$\text{Genotypic coefficient of variability (GCV)} = \frac{\sigma^2 g}{\bar{x}} \times 100$$

$$\text{Phenotypic coefficient of variability (PCV)} = \frac{\sigma^2 p}{\bar{x}} \times 100$$

Where,

$\bar{x}$ = General mean of character
$\sigma^2 g$ = Genotypic variance
$\sigma^2 p$ = Phenotypic variance

Heritability in broad sense was estimated as per formula given by Falconer [2].

$$\text{Heritability\% } (h^2\ \%) = \frac{\sigma^2 g}{\sigma^2 p} \times 100$$

The genetic advance (GA) and genetic advance as per cent of the mean (GAM) were obtained as per formula described by Johnson et al. [3].

$$\text{Genetic advance (GA)} = K \times h^2 \times \sigma p$$

Where,

K = Selection differential which is 2.063 at 5% selection intensity.
h^2 = Heritability of character under selection
σp = Standard deviation

$$\text{Genetic gain (\%)} = \frac{\text{Genetic advance}}{\text{General mean of population}} \times 100$$

The results obtained for the genetic parameters are summarized in Table 2, and are discussed as follows.

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance

The mean sum of squares revealed significant differences in all the characters. The highest mean sum of square value was recorded in the number of leaves at 90 days (502.88) followed by the number of leaves at 75 days (418.80). This indicated the presence of sufficient variability for all the characters in the genotypes and genetic improvement in these genotypes is possible based on selection through these traits.

3.2 Genetic Parameters

1. Mean and Range

The range of variation observed for all the traits in the present study (Table 2) depicted the presence of a sufficient amount of variation among the genotypes for all the characters studied. The range in the values reflects the amount of phenotypic variability which is not very reliable since it includes genotypic, environmental, and genotype x environmental interaction components and does not reveal as which component is showing higher degree of variability**.** The highest mean value was recorded in the number of leaves at 90 days and the lowest mean value in the internodal distance at 30 days (2.13). The highest range was found in the number of flowers per plant (48.90 to 11.53) and the lowest range in internodal distance at 60 days (2.60 to 1.12).

2. Coefficients of Variability

The PCV and GCV values were classified, according to Sivasubramanian and Menon [4], as low (0 - 10%), moderate (10 – 20%) and high (>20%). When PCV is higher than GCV, it suggests that the observed variability in a particular trait is influenced to a greater extent by environmental factors rather than genetic factors. In other words, the phenotypic differences are primarily due to variations in growing conditions, cultural practices, or other non-genetic factors. This situation could arise in flower crops when the genetic diversity within the population is relatively limited or when the environmental conditions have a substantial impact on the expression of traits. Factors such as temperature, light intensity, nutrient availability, water availability, and management practices can significantly influence the observed phenotypic variation.

When PCV exceeds GCV, it implies that the selection of plants based solely on phenotypic performance may be less reliable or effective. In such cases, breeding strategies that emphasize improving environmental conditions or developing cultivars better adapted to specific growing conditions may be more suitable.

From the analysis, the estimates for the phenotypic coefficient of variation (PCV) were found to be higher than the genotypic coefficient of variation (GCV) for all the characters studied. Similar results were documented by Kumar [5] in gerbera and Prakash et al*.* [6] in chrysanthemum. The highest magnitude of GCV and PCV was observed for the number of flowers per plant (28.64 and 30.73 respectively). A similar result was obtained by Bennurmath et al*.* [7] in chrysanthemum. The GCV was found to be subsequent for leaf area (25.15) followed by stem length at 90 days (19.94). The PCV values for number of flowers per plant were followed by leaf area (29.81) and longevity of flower on the plant (21.02). The rest of the characters showed

moderate GCV as well as PCV. The lowest magnitude of GCV and PCV were observed for number of leaves at 45 days (1.29 and 1.31 respectively). This result is similar to documentation made by Sahu [8] for chrysanthemum.

Fig. 1. Overview at vegetative stage

Fig. 2. Overview at peak flowering stage

Table 1. Analysis for different characters in 10 genotypes of *Petunia x hybrida*

Sl. No.	Characters	MSS	
		Treatment d.f.(9)	Error d.f.(20)
1	Plant height at 15 days	0.53**	0.06
2	Plant spread at 15 days	4.47**	0.32
3	Number of leaves at 15 days	52.04**	11.15
4	Plant height at 30 days	1.51**	0.09
5	Plant spread at 30 days	5.77**	1.57
6	Number of branches at 30 days	1.89**	0.10
7	Number of leaves at 30 days	28.77**	0.08
8	Stem length at 30 days	1.41**	0.35
9	Internodal distance at 30 days	0.27**	0.04
10	Plant height at 45 days	12.61**	0.13
11	Plant spread at 45 days	9.91**	2.03
12	Number of primary branches at 45 days	1.13**	0.12
13	Number of secondary branches at 45 days	11.89**	0.12
14	Number of leaves at 45 days	9.18**	0.14
15	Plant height at 60 days	21.10**	0.39
16	Plant spread at 60 days	60.01**	5.35
17	Number of primary branches at 60 days	3.36**	0.11
18	Number of secondary branches at 60 days	12.35**	0.12
19	Number of leaves at 60 days	189.41**	0.11
20	Stem length at 60 days	19.51**	0.10
21	Internodal distance at 60 days	0.33**	0.04
22	Plant height at 75 days	19.56**	0.11
23	Plant spread at 75 days	46.32**	7.47
24	Number of primary branches at 75 days	9.07**	0.09
25	Number of secondary branches at 75 days	18.48**	0.13
26	Number of leaves at 75 days	418.80**	0.04
27	Plant height at 90 days	23.45**	0.10
28	Plant spread at 90 days	28.74**	7.06
29	Number of primary branches at 90 days	5.48**	0.06
30	Number of secondary branches at 90 days	13.42**	0.12
31	Number of leaves at 90 days	502.88**	0.09

Sl. No.	Characters	MSS	
		Treatment d.f.(9)	Error d.f.(20)
32	Stem length at 90 days	112.39**	0.19
33	Internodal distance at 90 days	0.28**	0.08
34	Flower diameter	1.79**	0.11
35	Number of days taken for first flowering	48.29**	2.19
36	Leaf width	0.61**	0.15
37	Leaf area	19.65**	4.56
38	Longevity of flower on plant	3.61**	0.57
39	Number of flowers per plant	250.38**	19.19
	** - significant at 1%		
	Values in parentheses indicate degrees of freedom		

Table 2. Mean, Range, GCV, PCV, Heritability, Genetic advance and Genetic advance as per cent of mean for all characters of *Petunia x hybrida*

Sl. No.	Characters	Mean	Range		GCV	PCV	Heritability (%)	Genetic advance	Genetic advance as per cent of mean
			Max.	Min.					
1	Plant height at 15 days	7.26	8.53	6.43	5.45	6.44	71.59	0.69	9.50
2	Plant spread at 15 days	14.05	16.10	10.34	8.35	9.32	80.24	2.16	15.40
3	Number of leaves at 15 days	56.37	64.50	46.67	6.51	8.88	53.82	5.55	9.84
4	Plant height at 30 days	9.56	10.97	8.48	7.17	7.90	82.30	1.28	13.40
5	Plant spread at 30 days	23.71	27.40	21.32	5.06	7.17	49.88	1.75	7.36
6	Number of branches at 30 days	13.20	14.83	12.00	5.91	6.24	89.55	1.52	11.51
7	Number of leaves at 30 days	108.49	113.33	104.00	2.85	2.86	99.22	6.35	5.85
8	Stem length at 30 days	15.55	16.82	13.07	3.90	5.30	54.03	0.92	5.90
9	Internodal distance at 30 days	2.13	2.92	1.58	13.14	15.46	72.28	0.49	23.02
10	Plant height at 45 days	11.81	14.78	9.02	17.28	17.51	97.46	4.15	35.15
11	Plant spread at 45 days	29.27	33.72	25.66	5.60	7.28	59.08	2.59	8.86
12	Number of primary branches at 45 days	14.32	15.83	13.00	4.15	4.58	81.94	1.11	7.73
13	Number of secondary branches at 45 days	11.99	15.83	8.17	16.52	16.77	97.14	4.02	33.55
14	Number of leaves at 45 days	133.32	136.83	131.00	1.29	1.31	95.91	3.46	2.59
15	Plant height at 60 days	15.90	19.75	12.50	15.33	15.47	98.13	4.94	31.28
16	Plant spread at 60 days	38.41	49.63	30.62	11.06	12.74	75.29	7.59	19.76
17	Number of primary branches at 60 days	14.76	16.80	13.00	7.05	7.42	90.25	2.04	13.79
18	Number of secondary branches at 60 days	13.51	16.00	9.00	14.96	15.16	97.48	4.11	30.43

Sl. No.	Characters	Mean	Range		GCV	PCV	Heritability (%)	Genetic advance	Genetic advance as per cent of mean
			Max.	Min.					
19	Number of leaves at 60 days	161.08	170.67	132.17	4.65	5.94	61.43	12.12	7.51
20	Stem length at 60 days	21.25	27.97	19.00	11.97	12.07	98.27	5.19	24.44
21	Internodal distance at 60 days	1.76	2.60	1.12	17.68	20.88	71.73	0.54	30.85
22	Plant height at 75 days	18.88	22.75	15.20	13.49	13.59	98.46	5.21	27.57
23	Plant spread at 75 days	38.91	49.02	30.07	9.20	11.62	61.86	5.80	14.90
24	Number of primary branches at 75 days	14.66	17.60	12.17	11.80	11.99	96.92	3.51	23.93
25	Number of secondary branches at 75 days	13.34	16.83	9.00	18.53	18.74	97.76	5.04	37.74
26	Number of leaves at 75 days	179.50	192.33	161.33	6.58	6.58	99.97	24.33	13.56
27	Plant height at 90 days	21.97	25.88	17.63	12.70	12.79	99.00	5.71	25.91
28	Plant spread at 90 days	40.44	48.62	35.27	6.59	9.43	48.74	3.83	9.47
29	Number of primary branches at 90 days	12.69	14.40	10.00	10.58	10.78	96.33	2.72	21.39
30	Number of secondary branches at 90 days	10.96	14.50	8.00	19.24	19.43	98.00	4.30	39.23
31	Number of leaves at 90 days	190.36	203.50	169.67	6.80	6.80	99.94	26.66	14.01
32	Stem length at 90 days	30.68	44.48	24.45	19.94	19.98	99.54	12.57	40.97
33	Internodal distance at 90 days	1.98	3.02	1.51	13.22	18.75	49.71	0.38	19.20
34	Flower diameter	7.27	8.81	5.81	10.33	11.15	85.81	1.43	19.71
35	Number of days taken for first flowering	80.30	88.50	73.17	4.85	5.21	86.49	7.49	9.98
36	Leaf width	2.75	4.25	1.70	14.25	19.89	51.37	0.58	21.05
37	Leaf area	9.55	16.75	4.80	25.15	29.81	71.15	4.17	43.69
38	Longevity of flower on plant	5.93	8.00	4.00	17.10	21.02	66.19	1.70	28.66
39	Number of flowers per plant	31.12	48.90	11.53	28.64	30.73	86.88	1.71	54.99

The difference between GCV and PCV was found to be very minute and the values for both were almost the same for all the characters studied. This explains the little influence of the environment on the expression of various characters. It is important to note that GCV and PCV are statistical measures and should be used in conjunction with other breeding techniques and considerations, such as heritability estimates, selection indices, and specific breeding goals, to make informed decisions in flower crop improvement programs. The narrow difference between GCV and PCV also indicates their suitability for selection programs. It also suggests the presence of sufficient genetic variability, which can be exploited by practicing pure line selection. The results are in conformity with the findings of Baskaran et al. [9] in chrysanthemum.

3. Heritability

Selection is said to be efficacious not only depending on the amount of variability but rather on the degree to which the variability is inherited in the next generation. So estimation of heritability becomes an important aspect. It is categorized as low (<30%), moderate (30–60%) and high (>60%) [10]. The concept of heritability in the broad sense provides a broader perspective on the genetic contributions to phenotypic variation, encompassing both additive and non-additive genetic effects [2].

Heritability estimates were high for most of the studied traits. The heritability ranged between 48.74 to 99.97 per cent. Heritability was found to be the lowest for plant spread at 90 days (48.74%) followed by plant spread at 30 days (49.88%). These two parameters had a medium level of heritability (30-60 per cent). The highest heritability was found in the number of leaves at 75 days (99.97%), followed by the number of leaves at 90 days (99.94%) and the number of leaves at 30 days (99.22%). High heritability was also observed in other characters such as the number of branches, number of flowers per plant, flower diameter and number of days taken for first flowering. Similar findings were reported by Hussein and Misiha [11] in petunia. The presence of high heritability in most of the characters studied depicts lower level of environmental influence.

Ali et al. [12], Najeeb et al. [13] found that high heritability may not always associate with large genetic advance. Since high heritability does not always indicate a high genetic gain, heritability is recommended to be considered in association with genetic advance to predict the effect of selecting superior crop varieties [14].

4. Genetic advance and Genetic advance as per cent of mean

The highest magnitude of genetic advance was recorded for the number of leaves at 90 days (26.66) followed by number of leaves at 45 days (24.33), stem length at 90 days (12.57) and number of leaves at 60 days (12.12). The lowest magnitude was recorded in internodal distance at 90 days (0.38) followed by internodal distance at 30 days (0.49) and internodal distance at 60 days (0.54).

The Genetic advance as per cent of mean values was grouped into low (10%), moderate (10-20%), and high (>20%) categories, as suggested by Johnson et al. [3]. The higher values of genetic advance as per cent of the mean were recorded in leaf area (43.69) followed by stem length at 90 days (40.97) and the number of secondary branches at 90 days (39.23). The lowest value recorded was for the number of leaves at 30 days (5.85).

5. High heritability coupled with high genetic gain

Mishra et al. [15] noticed that high heritability associated with high genetic advance would be used as a clue in most selection programs. It offers the most effective condition for selection, since the characters under study are less influenced by environment in their expression.

High heritability coupled with a high genetic gain was observed in characters such as internodal distance at 30 days, number of secondary branches at 45 days, plant height at 60 days, number of secondary branches at 60 days, stem length at 60 days, internodal distance at 60 days, plant height at 75 days, number of primary branches at 75 days, plant height at 90 days, number of secondary branches at 90 days, stem length at 90 days, leaf area and number of flowers per plant [16]. This indicates the presence of additive genes and the direct selection of such characters can be gratifying.

4. CONCLUSION

The research findings provide compelling evidence for the characters, *viz.*, plant height, plant spread, number of branches per plant, number of leaves per plant, stem length and flower longevity, that have to be taken into consideration for maximizing flower production in Chhattisgarh conditions. The results of this paper

contribute to a deeper understanding of the morphological study of different petunia hybrids and have wide-ranging implications for plant breeding, horticulture, taxonomy, ecology, education, and research, contributing to advancements in understanding, utilizing, and conserving these popular ornamental plants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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