



Estimation of genetic parameters for quantitative traits in pansy (*Viola* × *wittrockiana*)

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Pansy (*Viola* × *wittrockiana* Gams.), a member of family Violaceae and is a native of Europe. It consists of a large genus of 500 species. The modern pansy probably represents crosses among the *Viola tricolor*, *Viola lutea* and *Viola altacia*. The flowers are of various colours with attractive patterns and beautiful forms. The plants are dwarf, having 15-50 cm in height. It is a cold tolerant winter annual and appropriate for growing in beds, pots, borders, hanging baskets or in landscapes. The flowers possess sporophytic self-incompatibility and set seed through hand cross pollination (Dalbato *et al.* 2013). Planning and execution of a breeding programme for the evolution of new varieties based on magnitude upon the genetic variability. Knowledge on nature and extent of variability existing in the plant material and association among the various traits being indispensable for enhancement in the yield and other characters. The genotypic and phenotypic coefficient of variation are beneficial in examining the nature of variability in the breeding population whereas, the estimates of heritability provides index of transmissibility of characters from one generation to the other, thus facilitate the plant breeder in isolating the elite selection in the crop. Estimates of genetic advance linked with heritability would be valuable in determining the nature of gene action. Keeping this in view, the present study was undertaken to estimate the magnitude and nature of variation among 8 parents of pansy and its 28 F₁'s with respect to various traits which can be further exploit in crop improvement programme.

The present investigation was conducted at Floriculture and Landscaping department, Punjab Agricultural University, Ludhiana during 2015. The experimental material was comprised of 8 inbred lines of pansy which have been developed by the department after 4-5 generation of selfing. All possible single crosses were made in diallel mating design excluding reciprocals among eight parents and

consisted of 28 crosses. The field experiment was laid out in a randomized block design and replicated thrice. Seeds of all 28 crosses (F₁) along with eight parents were sown in open field conditions during the month of October, 2016. Seedlings were transplanted in the month of November, 2016 at a spacing of 30 cm × 30 cm in a plot having size 2.4 m × 2.4 m. Twelve parameters covering vegetative and floral attributes were recorded from 10 randomly selected plants of each plot. The phenotypic and genotypic coefficient of variation was estimated according to the methods of Panse and Sukhatme (1969). Heritability in broad sense was calculated as per method given by Burton and De Vane (1953). The expected genetic advance resulting from the selection of 5% superior individuals were worked out as suggested by Lush, (1940) and Johnson *et al.* (1955).

The data (Table 1) reveals that there were significant differences among genotypes for various characters. The maximum range was depicted for number of flowers per plant (70.24-599.23), duration of flowering (77.33-146.00) and pod setting % (43.33-95.00 %). The results were also in consonance with Singh and Saha (2009) that reported high range for yield of flower and number of flowers per plant in French marigold. The perusal of data revealed most of the traits under study exhibited moderate to low coefficient of variation (Table 1). The highest coefficient of variation was observed in pod setting (8.82%) recommended the high degree of variation in the studied genotypes for this trait and it is the indispensable aspect while selecting a genotype. It was followed by flower size (7.39%), plant height at first flowering (7.27%), days from bud initiation to flowering (6.81%), stalk length (6.33%), days to flowering (5.89%), number of branches per plant (5.89 %), plant spread (5.74%), final plant height (4.86%), number of flowers per plant (4.85%), final plant spread (4.57%) and was lowest for duration of flowering (2.08%).

The estimates of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the 12 characters under examination that designated greater genotype × environment interactions. The PCV and GCV showed a range of variation from 14.25-67.50% and 14.10-67.29% respectively. Phenotypic and

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Table 1 Range, mean, coefficient of variation, PCV and GCV for various characters in pansy

Character	Range	Mean	Coefficient of variation (%)	PCV (%)	GCV (%)
Plant height at first flowering (cm)	5.89 - 17.44	11.41	7.27	23.88	22.75
Final plant height	17.54 - 55.76	32.21	4.86	31.23	30.85
Plant spread	8.60 - 29.86	18.71	5.74	30.61	30.07
Final plant spread	25.31 - 60.83	39.77	4.57	20.15	19.60
Number of branches per plant	5.28 - 35.85	15.34	5.89	51.66	51.32
Stalk length	7.33 - 16.51	11.23	6.33	22.34	21.42
Flower size	2.44 - 6.48	4.71	7.39	25.36	24.26
Days from bud initiation to flowering	2.86 - 12.35	8.29	6.81	37.88	37.26
Days to flowering	12.33 - 40.33	28.44	5.89	32.78	32.25
Duration of flowering	77.33 - 146.00	119.07	2.08	14.25	14.10
Number of flowers per plant	70.24 - 599.23	243.83	4.85	67.50	67.29
Pod setting (%)	43.33 - 95.00	70.62	8.82	21.74	19.88

genotypic coefficient of variance was maximum for number of flowers per plant (PCV=67.50, GCV=67.29) followed by number of branches per plant (PCV=51.66, GCV=51.32), days from bud initiation to flowering (PCV=37.88, GCV=37.26) and days to flowering (PCV=32.78, GCV=32.25). Higher PCV and GCV values suggested the presence of considerable variability for these traits hence, scope for selection and improvement as previously delineated by Singh and Singh (2010) and Singh *et al.* (2004) in marigold. The minimum PCV and GCV (14.25, 14.10) were assessed for duration of flowering respectively. Our results are in close accordance with the findings of Singh and Sen (2000) that worked on chrysanthemum and reported high PCV and GCV for flower number. Narrow differences between PCV and GCV exhibited that variability existing among different genotypes of pansy was mainly due to genetic makeup and there is less environmental impact on the expression of these traits. These results are also in agreement with those of Verma *et al.* (2008) in rose.

As it can be noted from data (Table 2) that the heritability in narrow sense ranged from 0.09 in plant height at first flowering to 0.70 in flower size accompanied by low to high heritability in narrow sense. High estimates of heritability in broad sense were estimated for all the characters studied i.e more than 83.55% and indicate that though the character was least influenced by the environmental effects, the selection for enhancement of such characters may not be convenient because broad sense heritability is based on total genetic variance which includes both fixable (additive) and non-fixable (dominance and epistatic) variances. These results were in agreement with those of Verma *et al.* (2004) in dahlia. The broad sense heritability ranges between 83.55-99.37% for different analysed characters. The very high value of heritability were obtained for number of flowers per plant (99.37%) followed by number of branches per plant (98.62), final plant height (97.58%), duration of flowering (97.36%), days from bud initiation to flowering (96.79%), days to flowering (96.69%). High heritability estimates were also

reported by Hedge and Gopinath (2003) in gaillardia for plant height, number of branches per plant, flower diameter, days taken to flowering and number of flowers per plant.

The estimates of genetic advance were varied from 2.25-336.80% and from 28.73-138.17% for genetic advance as % of mean. In the present study, the very high estimates of genetic advance as % mean were obtained maximum in number of flowers per plant (138.17%) and number of branches per plant (105.03%). It indicates that substantial improvement in these traits can be achieved through simple selection. Similar results observed by Verma *et al.* (2008) in rose where high genetic advance was determined for the

Table 2 Heritability (%) and Genetic advance and Genetic advance as % of mean for different characters in pansy

Character	Heritability (%)		Genetic advance	Genetic advance as % of mean
	Narrow sense (h ²)	Broad sense (H)		
Plant height at first flowering (cm)	0.09	88.77	5.09	44.63
Final plant height	0.42	97.58	19.97	62.77
Plant spread	0.40	95.35	11.39	60.84
Final plant spread	0.35	94.63	15.57	39.28
Number of branches per plant	0.46	98.62	15.94	105.03
Stalk length	0.21	91.98	4.74	42.32
Flower size	0.70	90.39	2.25	47.81
Days from bud initiation to flowering	0.50	96.79	6.27	75.52
Days to flowering	0.23	96.69	18.58	65.35
Duration of flowering	0.30	97.36	34.20	28.73
Number of flowers per plant	0.50	99.37	336.80	138.17
Pod setting (%)	0.20	83.55	26.36	30.04

traits like number of flowers per plant, number of petals per flower.

Johnson *et al.* (1955) reported that heritability together with genetic advance is more applicable criterion in predicting the resultant effects for selecting the best individual. High heritability along with high genetic advance was observed for number of flowers per plant ($H=99.37\%$, $GA=138.17\%$), number of branches per plant ($H=98.62\%$, $GA=105.03\%$) and days from bud initiation to flowering ($H=96.76$, $GA=75.52\%$). Similar findings observed in marigold by Yuvraj and Dhatt (2014) and tell that the character is prevalence by the additive gene action and for this simple selection is recommended. The characters like days to flowering, final plant height, plant spread, flower size, plant height at first flowering, stalk length and final plant spread were revealed with high heritability with medium genetic advance suggests that the character is governed by the dominant and epistatic gene action. High heritability with low genetic advance gain were observed for duration of flowering and pod setting ($H=97.36\%$, $GA=28.73\%$ and $H=83.55\%$, $GA=30.04\%$) respectively. This indicates the prevalence of non-additive gene action and for this selection on the basis of these characters will be less effective hence, exploited through hybridization.

Above findings shows that sufficient variability in the germplasm was present for most of the characters. High estimates of heritability concluded that the character was least influenced by the environmental effects. High heritability coupled with high genetic advance for the characters, viz. number of flowers per plant, number of branches per plant and days from bud initiation to flowering were recorded and suggested the role of additive gene action in the inheritance of these traits. Hence, simple selection based on phenotypic performance of these traits would be more effective.

SUMMARY

Genetic parameters of variability, heritability and genetic advance were evaluated to ascertain for various vegetative and floral characters in 36 genotypes (eight parents and its 28 F_1 's) of pansy. The highest coefficient of variation was observed in pod setting (8.82%) and lowest for flowering duration (2.08%). PCV was higher in magnitude with narrow differences than the GCV for all the characters studied. High PCV and GCV were observed for flower number followed by branch count, days from bud

initiation to flowering, days to flowering and final plant height. High estimates of heritability were acquired for all traits. The traits flower number, branch count and days from bud initiation to flowering manifested high heritability ($>80\%$) along with high genetic advance as % mean ($>60\%$) indicating additive gene action in expression of these traits. So, further improvement in these traits could be brought by rehearse phenotypic selection.

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