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Evaluation of genetic diversity in pansy accessions (*Viola spp*.) using growth and flowering traits

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ABSTRACT

The breeding programmes of floricultural crops lay prime stress on adding colour variability in the existing pool along with retention of other important vegetative and reproductive traits of the crop. The evaluation of accessions produced in breeding programmes of pansy in the Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana during the year 2019-21was conducted with twenty accessions for vegetative and flowering traits. Maximum plant height was recorded in A-12 (37.4 cm), maximum plant spread in A-13 (42.1 cm) and highest number of branches in A-11 (21.6). The accession A-5 took maximum number of days (63.9days) for flowering whereas the minimum number of days for flowering (56.5 days) was taken by accession A-14. Among all the tested accessions, the maximum duration of flowering was recorded in A-5 (96.1 days). Amongst the pansy accessions, A-11 was maximum flower producing (91.1), while A-3 produced the largest flowers (4.8cm) and flower from A-20 had longest stalk (11 cm). Correlation analysis further showed that the number of flowers per plant was affected by plant vegetative traits (plant height,spread and number of branches). Cluster analysis based on morphological data divided the accessions into three groups. These variations might help in classifying pansy for pot cultivation, bedding and exhibition purposes, which could be beneficial for breeders and growers.

Keywords: Pansy, varietal assessment, vegetative characters, flowering characters, accessions

INTRODUCTION

Pansy (*Viola tricolor*), a member of the Violaceae family, is a European native. Viola is an annual plant with alternating, serrated, and congressional leaves, as well as a serrated or simple stipule that can develop and curve into a leaf. Flowers of the viola family are either cleistogamous or chasmogamous.They possess five unequal sepals and petals, with a larger bottom petal that serves as a landing strip for insect pollinators. The flowers are of various colours with attractive patterns, beautiful forms and variable colour combination. The flowers have a wide range of colours, including different shades of blue, purple, yellow, pink and beautiful marked stripes or penciled blotches.The blooms have sporophytic self-incompatibility and require human pollination to set seed (Dalbato *et al.*, 2013). The flowers are mildly sweet scented, particularly early in the morning. It is a cold-hardy winter annual that is suitable for growing in beds, pots, and borders, hanging baskets, window boxes and landscapes.

Genetic diversity is highly important in plant breeding and is required for making any kind of changes in plant genetic structure and to know the level and kind of existing diversity in germplasm to be able to use it according to the intended breeding goals. The primary goal of breeding programmes in floricultural crops is adding colour variability along with retention of other important vegetative and reproductive traits. The evaluation of accessions produced in breeding programmes can assist pansy growers in selecting their preferred trait. It is essential for plant breeders to sort the variation present in cultivars in order to make an informed decision about which cultivars to use for future crop breeding.Cut flower should be characterized by a long straight stem, with less branching, while garden flower is with less and more branched stem. Single-stem plants need to have large flowers, while one that is characterized by a branch of a small central flower with several side, even smaller flowers.This study was done to add new colour to the pansy and evaluate performance of accessions that could be used by breeders as well as growers, landscapers and/or consumers.

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MATERIALS AND METHODS

The present investigation was conducted at Punjab Agricultural University, Ludhiana during two consecutive years(2019-21). The soil of the experimental site was sandy loam in texture with good water holding capacity and medium in fertility with pH of 8.3. After the application of well rotten farmyard manure, N, P and K were applied in the soil. Twenty accessions of pansy hybrids viz. A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, A-9, A-10, A-11, A-12, A-13, A-14, A-15, A-16, A-17, A-18, A-19 and A-20 were planted in first week of November at a spacing of 30 X30 cm and the experimental field was immediately irrigated with a light stream of water. All recommended packages of practices were followed to raise the good crop. Manual weeding was done regularly at 15 days intervals, during growing season. Irrigation was given at regular interval. Six plants were randomly selected from each accession and were tagged for recording the observations. The observations for vegetative parameters such as plant height, plant spread (East-West and North-South) and total number of branches per plant were recorded at interval of one month and their average was recorded. The floral parameters viz., days to flowering, duration of flowering,number of flowersand diameter of the flowerwerealso recorded. The collected data of two years were statistically analyzed at 5% level of significance using randomized block design through OPSTAT by adopting pooled analysis.Hierarchical Cluster analysis and correlation were performed by using SPSS software (version 24.0.0).

RESULTS AND DISCUSSION

Vegetative parameters

There was a significant difference among accessions for plant height (Table 1) which ranged from 37.4cm to 20.1cm. Plant height was maximum in accessionsA-12 (37.4 cm) followed by A-13 (35.1) while the accession A-18 being the short stature recorded minimum plant height (20.1 cm). The marked variations in the plant height of different accessions could be due to inherited characters. Similar variations in plant height, were observed in marigold (Raghuvanshi and Sharma 2011) and in gerbera (Singh *et al.*, 2017).Some accessions of pansy were vigorous in growth and some were less vigorous, owing to genotypic variance in accessions.The plant spread ranged from 42.1 cm to 20.1 cm among different pansy hybrid accessions (Table 1). The data revealed significant difference in plant spread, the accession A-13 registered maximum plant spread (42.1 cm). However, accession A-19 recorded minimum plant spread (20.14 cm). The significant variations in plant spread were reported among rose (Adhikary and Sarkar, 2019) and dahlia cultivars (Kumar *et al.*, 2021). The difference in the plant spread might be due to the plant accessions demonstrating variability for this trait.Pansy accessions showed wide variation in number of branches varying from 21.6 to 8.2 (Table 1).A-11 recorded highest number of branches(21.6) per plant followed by 21.4 in accession A-10 whereas A-19 registered least number of branches (8.2) per plant. The variation in branches might be due to either variation in genetic constitution or environmental factor (Nadeem *et al.*, 2011). Similar variation for number of branches was also observed in China aster by Munikrishnappa *et al.*, (2013).

Floral parameters

Days taken to flowering showed significant differences among pansy accessions (Table 1). The resulst showed that accession A-14 and A-11 early to flower which took56.5 and 56.7 days respectively. However, the longer time was taken by accession A-5(63.9 days) and A-8 (63.8 days) to come to flowering.The variation in accessions for the number of days taken for flowering could be due to better growth and development in terms of maximum number of branches, plant spread which led to higher production and accumulation of sugar leading to switching of vegetative phase into reproductive phase. The flowering times in chrysanthemum varied with variety, habitat and species type (Kim *et al.*, 2014).There was significant variation ranging from 15.8 to 18.5 days taken from bud initiation to flowering (Table 1).The accession A-17 was earliest to flower as it took 15.8 days to flower from bud initiation. However, it differed significantly from the other accessions except A-4 that took 16.1 days between bud initiation and flowering. The accession A-8 and A-15 respectively took 18.5 and 18.4 days to flower from bud initiation.There was significant variation

Table 1: Evaluation of pansy accessions for different vegetative and floral characters (pooled data of 2 years)

Accession number	Vegetative Characters			Flower characters					
	Plant height (cm)	Plant spread (cm)	Branches/ plant	Days taken to flowering	Days from bud initiation to flowering	Duration of flowering	Flowers per plant	Flower size (cm)	Stalk length (cm)
A-1	30.2	28.3	11.1	57.9	16.6	89.1	54.8	4.50	10.4
A-2	28.9	27.3	8.6	59.4	16.8	89.5	37.8	4.24	10.1
A-3	30.3	29.9	15.8	58.4	17.3	93.1	61.0	4.83	8.8
A-4	32.1	28.8	10.6	57.0	16.1	92.9	47.8	3.87	6.7
A-5	25.8	27.3	16.3	63.9	16.8	96.1	62.8	4.37	9.3
A-6	31.4	29.1	18.1	58.9	16.8	95.1	74.8	4.04	8.4
A-7	31.6	30.4	16.4	60.7	17.6	93.6	60.4	3.87	7.5
A-8	24.8	27.4	16.1	63.8	18.5	86.7	58.4	3.95	7.1
A-9	29.2	30.4	17.7	62.6	18.1	86.6	73.7	3.81	5.1
A-10	32.1	32.4	21.4	60.4	17.6	90.4	88.3	4.10	8.8
A-11	28.4	32.9	21.6	56.7	17.0	88.5	91.1	3.92	7.6
A-12	37.4	36.9	20.9	58.2	16.3	95.8	89.1	3.20	6.6
A-13	35.1	42.1	15.6	60.7	16.9	91.3	66.4	4.16	7.4
A-14	25.3	22.7	9.8	56.5	17.6	94.1	40.5	3.12	10.5
A-15	34.3	33.4	13.5	60.2	18.4	95.5	61.6	4.08	10.2
A-16	28.2	26.6	10.8	63.0	17.1	95.2	46.9	3.83	9.8
A-17	30.1	29.2	9.3	59.6	15.8	89.9	44.8	4.25	8.2
A-18	20.1	21.7	10.5	63.1	17.6	95.8	46.5	3.62	6.1
A-19	20.3	20.1	8.2	60.6	16.4	88.4	39.6	3.87	7.5
A-20	28.6	26.7	13.8	61.0	16.9	93.4	65.1	4.29	11.0
CD (P=0.05)	4.10	3.67	2.90	1.12	0.82	2.78	10.53	0.45	1.14

among different accessions of pansy in flowering duration (Table 1). Duration of flowering was found to be ranging from 96.1 days to 86.6 days and accession A-5 had maximum flowering duration to 96.1 days whereas duration was lowest for 86.6 days for A-9 hybrid. Theflowering duration of accession A-6(95.1 days) and accessions A-12 and A-18 (95.8 days) were also statistically at par with accession A-5. Pal *et al.* (2003) in gerbera reported that the variation for the duration of flowering among the cultivars could be attributed to differences in genetic makeup of the pant.

Significantly maximum number of flowers/plant yield was produced by accession A-11 (91.1) closely followed by accession A-12 (89.1). The accession A-2 yielded the least number of flowers (37.8) per plant. Such variations in number of flower were reported in gerbera by Singh *et al.*(2016). The increase in number of flower may be accounted to greater number of branches per plant as well as plant spread which might resulted in production and accumulation of maximum photosynthates, ultimately resulting in the production of a greater number of flowers with bigger size (Ramzan *et al.*, 2014).Longest stalk was produced in accession A-20 (11 cm)followed by accession A-14 (10.5 cm) while the shortest was found in A-18 (6.0 cm) (Table 1).The findings are in accordance with the result reported by Sil *et al.*(2017).The flower diameter ranged from 4.8 cm to 3.1 cm (Table 1). The maximum size (4.8 cm) of flower was recorded in A-3followed by A-1 (4.5 cm). The accession A-14 recorded minimum size of flowers (3.1cm). Similar variations in flower diameter have been reported in gerbera by Kumar *et al.* (2013) and in ornamental pot plants like rose, orchids by Shahrin *et al.* (2015).

Table 2: Correlation coefficients between the morphological characteristics on pansy accessions

Characters	Plant height	Plant spread	Branches /per plant	Days taken to flowering	Days from bud initiation to flowering	Duration of flowering	Flowers per plant	Flower size	Stalk length
Plant height	1	.864**	.462*	-0.375	-0.138	0.177	.523*	0.093	0.041
Plant spread	.864**	1	.615**	-0.172	-0.007	-0.001	.652**	0.116	-0.173
Branches/per plant	.462*	.615**	1	-0.003	0.244	-0.009	.965**	-0.029	-0.305
Days taken to flowering	-0.38	-0.172	-0.003	1	0.41	0.007	-0.094	0.11	-0.195
Days taken from bud initiation to flowering	-0.14	-0.007	0.244	0.41	1	-0.079	0.133	-0.119	-0.049
Duration of flowering	0.177	-0.001	-0.009	0.007	-0.079	1	-0.015	-0.196	0.245
Flowers per plant	.523*	.652**	.965**	-0.094	0.133	-0.015	1	-0.026	-0.251
Flower size	0.093	0.116	-0.029	0.11	-0.119	-0.196	-0.026	1	0.339
Stalk length	0.041	-0.173	-0.305	-0.195	-0.049	0.245	-0.251	0.339	1

*** 0.01 level (2-tailed), * 0.05 level (2-tailed)*

Correlation analysis of the morphological traits

The highest positive and significant correlation was observed between the number of branches and number of flowers per plant (r = 0.965), followed by plant spread and plant height (r = 0.864), plant spread and number of flowers per plant (r = 0.652) (Table 2). Correlation analysis deduced that the accessions with higher plant height, in addition to more plant spread, had more number of branches and in turn has more number of flowers per plant. Diverse photosynthetic efficiency of genotypes may have increased food synthesis resulting in enhanced plant growth and consequently increased number of flowers per plant (Sunitha *et al.*, 2007).

Hierarchical cluster analysis of morphological traits

Cluster analysis was carried out using morphological features, and the dendrogram (Fig. 1) demonstrated the relevance of this classification. At 5 rescaled distance, the dendrogram grouped the 20 accessions into three distinct clusters I, II and III. The cluster I (CI) comprised three accessions (A-10, A-11 and A-12), cluster II (CII) had seven accessions (A-2, A-4, A-14, A-16, A-17, A-18 and A-19) and cluster III (CIII) had remaining ten accessions. The cluster III was further subdivided into III A, III B and III C, the subcluster III A contained seven accessions(A-1, A-3, A-5, A-7, A-8, A-15 and A-20), subcluster III B contained two accessions

Table 3: Final cluster centres (mean values) for three clusters based on vegetative and flowering traits of different accessions of pansy

Characters	Cluster		
	1	2	3
Plant height	32.72	26.47	30.17
Plant spread	34.13	25.25	30.56
Branches/per plant	21.33	9.73	15.48
Days taken to flowering	58.48	59.93	60.86
Days taken from bud initiation to flowering	17.00	16.83	17.44
Duration of flowering	91.61	92.33	92.11
Flowers per plant	89.57	43.45	63.96
Flower size	3.74	3.83	4.19
Stalk length	7.73	8.46	8.56

(A-6, A-9) and only one accession in subcluster III C (A-13). Cluster I was found to have maximum plant height, maximum plant spread and also have more number of branches per plant (Table 3). The accessions in this cluster took minimum days to flower and had maximum number of flowers per plant. The accessions with more number of flowers per plant and plant spread are well suited for potpurpose.The probability of reaching this goal can be fulfilled through those accessions which were found in this cluster. Thus, accessions A-10, 11, 12 could be used by breeders in breeding programmes for producing varieties for pot purposes. Cluster II had accessions with smaller plant spread, less branches per plant but bigger flower size and longer stalk length. Thus, accessions in this cluster are suitable for exhibition purpose.Cluster III had accessions with good plant height, plant spread and branches per plant. The flowers are large sized with longer stalk length. Thus, these accessions are suitable for bedding purposes.

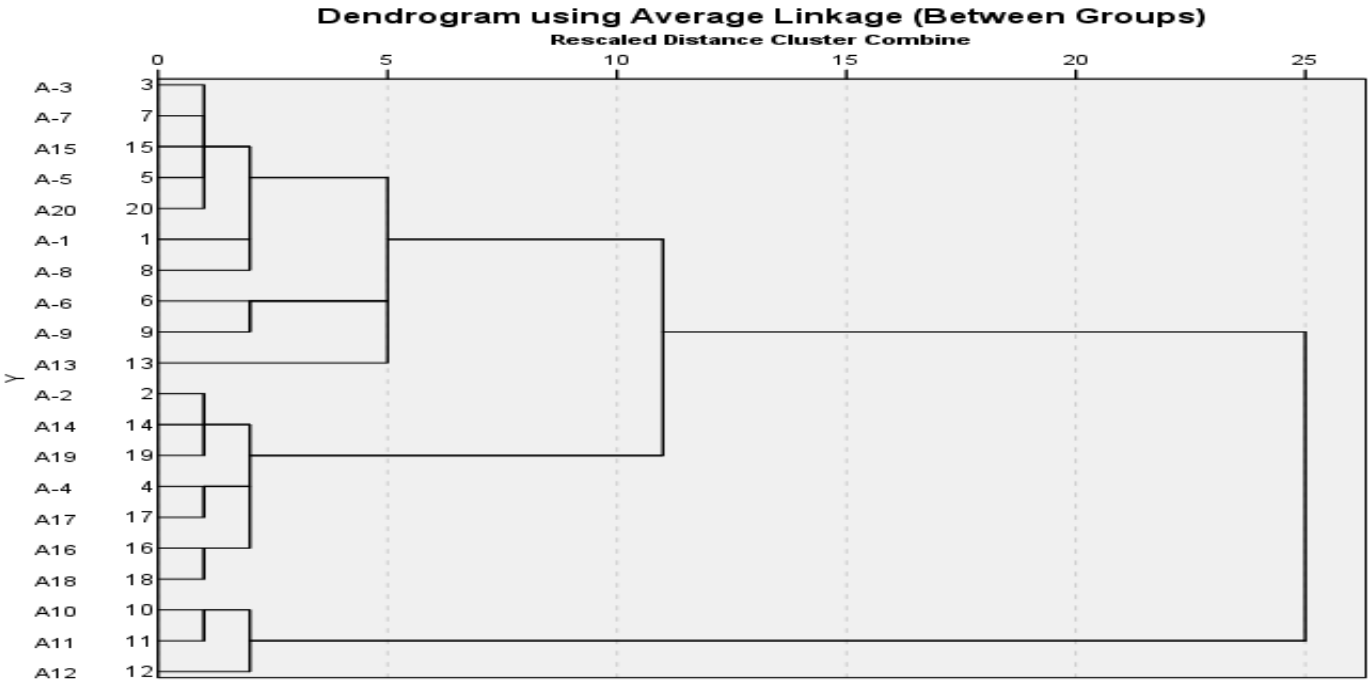

Figure 1: Dendrogram representing clustering of different accessions of pansy using squared Euclidean distance based on vegetative and flowering traits

There were certain anomalies and differences in respect to vegetative growth, flower yield and quality among accessions, which could be attributed to the fluctuations in temperature and to the distinct genetic constitution of each accession.This richness allows for a wide range of options and convenience in applications from every sector (floriculture, pot, landscape). As per the performance, all accessions are adapted to

Punjab conditions.The accessions A-10, A-11 and A-12 suitable for pot culture, accessions A-2, A-4, A-14, A-16, A-17, A-18,A-19 for exhibition purpose and accessions A-1, A-3, A-5, A-7, A-8, A-9, A-13, A-15, A-20 for bedding purposes. The purpose of evaluation of pansy accessions was to screen accessions on the basis of their commercially valuable characteristics. Thus, in the present scenario of diversification, pansy can emerge as asuitable optionfor pot culture, bedding and exhibition purposes.

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