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Genetic variability, heritability and genetic advance for yield and quality traits in m_1 generation of chrysanthemum cultivar Poornima pink

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Abstract
The purpose of the study was to investigate genetic variability, heritability and genetic advance for yield and flower characters in the M_1populations of chrysanthemum cultivar Poornima Pink in a Completely Randomized Design during 2019. Cuttings were treated with both gamma ray and EMS and analysed for genetic variation. High phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) estimated for number of primary branches, number of flowers per plant and flower yield per plant in both gamma and EMS induced mutated population indicated that the genotype could be considered by the phenotype and the selection of these characters in the early generation based on the phenotypic performance will be effective. Heritability might be due to effects of additive genes and consideration for the characters with combination of high heritability, high genetic advance will be more effective.

Keywords: heritability, genetic, yield, m_1 generation, chrysanthemum cultivar Poornima pink

Introduction
Mutation is one of the breeding methods to induce variation in flower crops especially in vegetatively propagated plants. Chrysanthemum is commercially cultivated flower crop in worldwide which is propagated vegetatively. Chrysanthemums show a high propensity to spontaneous (Malaure *et al.*, 1991) [6] and induced mutations, which is commonly enforced to chrysanthemum breeding (Zalewska *et al.*, 2010, Zalewska *et al.*, 2011) [11, 12]. Selection of effective and efficient mutagens is very essential need to recover high frequency of mutants which are desirable. Mutation induced by physical or chemical mutagen has been a choice to induce genetic variation. Mutation has been a most useful method for obtaining mutants in a short time in ornamental crops. The commercial traits of ornamental plants are being flower and yield characters and they are governed by many genes. These characters are mostly influenced to a greater extent by environments and they exhibit a wide spectrum of phenotype. Study of such quantitative and qualitative traits in commercial crops like chrysanthemum is important. Mutants of such crops obtained through mutagen were of great significance for improvement and understand the trait genes. So the present investigation was therefore undertaken to study the induced variation and analyse the genetic variation.

Materials and Methods
Plant material: Rooted cuttings of chrysanthemum cultivar Poornima Pink were used as the experimental material. Poornima Pink is a local cultivar and flower colour is Pale purple according to RHS chart. Mother plants were maintained in polyhouse, 10 cm terminal cuttings were taken and basal leaves were removed and slant cut was given just below the nodal portion. Cut portion of the cuttings were dipped in Keradix rooting powder to stimulate rapid and prolific rooting of cuttings. Soon after the treatment, cuttings were placed in protrays which were filled with cocopeat for rooting, further these cuttings were used for mutagenic treatments

Mutagenic treatment
Rooted cuttings were irradiated with four doses of gamma rays (5, 10, 15 and 20Gy) in Gamma Cell-200 (Cobalt-60 source emitting 3600 rads per minutes) at Bhabha Atomic Research Centre (BARC), Trombay, Mumbai. EMS was used as chemical mutagen, rooted cuttings were treated with different concentration of EMS (0.05, 0.1, 0.2, 0.3, 0.4 and 0.5%).

After the irradiation, the rooted cuttings (mutated) were planted along with un treated cutting in the experimental polyhouse in Department of Floriculture and landscape Architecture, Kittur Rani Channamma College of Horticulture, University of Horticultural Sciences, Bagalkote, Karnataka during 2019 for evaluation based on morphological characters to know the effect of mutagens. The experiment was carried out in a completely randomized design (CRD). Rooted cuttings were planted with a spacing 30 cm and row to row space was 30 cm. Cultural practices such as watering, fertilization and control of pest and diseases were practiced according to the standard procedure for chrysanthemum culture of University of Horticultural Sciences, Bagalkote. The crop was kept weed free by hand hoeing as the necessary. Morphological and yield characters were recorded at full growth stage to know the effect of mutagen. Plant height (cm), Stem girth (mm), Number of primary branches, Plant spread E-W (cm), Plant spread N-S (cm), Number of leaves, Leaf area (mm2), Days to flower bud initiation, Days taken for flowering, Duration of flowering (Days), Flower diameter (cm), Flower stalk length (cm), Individual flower weight (g), Number of flowers per plant, Flower yield per plant (g), Vase life (days), Total chlorophyll content (nmol/cm^2) were measured to know the genetic variation in mutated population.

Statistical analyses

All data obtained were subjected to analysis by using JUMP 5.0.1 statistical software. The coefficient of variation (CV) being a standardized form of variance is useful for comparing the extent of variation between different characters with different scales (Singh and Choudhary, 1979) [10]. Genotypic and phenotypic coefficients of variation were estimated based on estimate of genotypic and phenotypic variance (Burton and De-Vane, 1953) [4].

Genotypic coefficient of variance (GCV)

$$GCV(\%) = \frac{\sqrt{\sigma 2g}}{x}$$

Phenotypic coefficient of variance (PCV) = $\frac{\sqrt{\sigma^2 p}}{\overline{X}} x100$

In broad sense, heritability was calculated as the ratio of genotypic variance to the phenotypic variance and was expressed in percentage. Heritabili ty $h^2 = \frac{h^2 g}{h^2 p} \times 100$

Genetic advance formula given by Robinson *et al.* (1949) [7].
GA = i x h^2 x σp

Genetic advance as per cent over mean was worked out as suggested by Johnson *et al.* (1955) [5]. GAM (%) = $\frac{GA}{\overline{X}}$ X 100

Results and Discussion

The present experiment is on genetic variability studies in mutated population of chrysanthemum varieties which were treated with both physical (*Gamma rays*) and chemical mutagens (EMS) mutagens was conducted mainly to evaluate the extent of genetic variability, which will be useful for further improvement by selection and genetic advancement. The extent of variability as measured by PCV and GCV also gives information regarding the relative amount of variation in different mutated populations.

Improving number of flowers per plant is one of the major objectives for plant breeders. Flower yield is dependent character and it depends on several developmental traits as well as environmental factors. So the present study was conducted to analyse variability parameters (Table 1 and Table 2).

In gamma rays irradiated population, high values of PCV was observed for stem girth, number of primary branches, plant spread in E-W, plant spread in N-S, number of leaves, flower stalk length, number of flowers per plant, flower yield per plant and vase life. Similar variations were seen in rice by Sharifi (2019) [9]. In EMS treated population, high PCV was observed for traits like plant height, number of primary branches, flower stalk length, number of flowers per plant, flower yield per plant and total chlorophyll content. These findings are in line with the results obtained by Bhajantri and Patil (2013) [3] in mutated population of gladiolus.

High values of GCV were observed for stem girth, number of primary branches, plant spread in E-W, plant spread in N-S, number of leaves, number of flowers per plant, flower yield per plant and vase life in gamma irradiated population. In EMS treated population, high GCV was observed for traits like plant height, number of flowers per plant, flower yield per plant and total chlorophyll content. Other traits recorded moderate or low estimates of GCV. Similar analysis was carried out by Roychowdhury and Tah (2011) [8] in carnation.

Very high estimates of heritability was observed for plant height, stem girth, plant spread in E-W, plant spread in N-S, number of leaves, leaf area, days to flower initiation, duration of flowering, flower diameter, flower stalk length, individual flower weight, number of flowers per plant, flower yield per plant, vase life and total chlorophyll content. While, high estimates of heritability was observed for number of primary branches and days to flower bud initiation in gamma irradiated population. The same heritability pattern was seen in mutated population of bread wheat by Balkan (2018) [2].

Very high estimates of heritability was observed for plant height, stem girth, plant spread in E-W, plant spread in N-S, number of leaves, days to flower initiation, flower diameter, flower stalk length, individual flower weight, flower yield per plant and total chlorophyll content. While, high estimates of heritability was observed for number of primary branches, leaf area, days to flower bud initiation, duration of flowering and number of flowers per plant. While, moderate estimates of heritability was observed for vase life in EMS treated population. Similar variations were seen in carnation by Roychowdhury and Tah (2011) [8].

High estimates of genetic advance over mean was observed for plant height, stem girth, number of primary branches, plant spread in E-W, plant spread in N-S, number of leaves, leaf area, duration of flowering, flower stalk length, individual flower weight, number of flowers per plant, flower yield per plant, vase life and total chlorophyll content. While, moderate estimates of genetic advance over mean was observed for days to flower bud initiation, days to flower initiation and flower diameter in gamma irradiated population. Similar reports were seen in rice by Sharifi (2019) [9].

In EMS treated population, high estimates of genetic advance over mean was observed for plant height, stem girth, plant spread in E-W, plant spread in N-S, number of leaves, flower stalk length, individual flower weight, number of flowers per plant, flower yield per plant and total chlorophyll content.

Similar variations were seen in gladiolus Bhajantri and Patil (2013) [3].

Genotypic coefficients of variability (GCV) would be more useful for the assessment of inherent or real variability as it exhibits the heritable portion only (Allard, 1960) [1]. The estimated GCV for different characters were almost the same as that of PCV. It is evident that the influence of environment on the expression of these characters was invariably low in the study. It may be assumed that the phenotypic variability as such can be utilized in making selection. Heritability estimates reveals the heritable portion of variability present in different characters. The knowledge of heritability enables the plant breeder to decide the course of selection procedure. However, heritability values coupled with genetic advance would be more reliable (Johnson *et al.*, 1955) [5] and useful in formulating selection procedure. Heritability in broad sense, estimating the extent of variation due to non-genetic factors. High heritability in broadsense does not always mean better response to selection, since it is also inclusive of non-additive genetic factors. Thus, estimation of genetic advance will give clue to the nature of genes effects and thus, its response to selection can be easily predicted. Thus, the study of heritability in combined with genetic advance was emphasized in estimating the resultant effect for selecting the best individuals.

Table 1: Genetic variability in mutant population of Poornima Pink treated with gamma rays

Trait	Mean	Range	PCV	GCV	h^2%	GAM
Plant height (cm)	67.93	39.00-89.30	19.00	18.59	97.70	38.25
Stem girth (mm)	10.01	4.03-18.27	33.67	33.23	99.42	68.95
Number of primary branches	2.64	1.00-4.00	33.15	27.06	68.02	46.44
Plant spread E-W (cm)	49.45	30.00-67.20	22.61	22.00	96.64	45.01
Plant spread N-S (cm)	46.46	29.00-62.30	23.20	22.68	97.48	46.59
Number of leaves	325.70	132.00-463.00	23.64	23.02	96.80	47.14
Leaf area (mm^2)	688.10	593.50-852.30	12.49	12.15	96.63	24.86
Days to flower bud initiation	68.88	58.00-78.00	8.41	7.38	78.58	13.61
Days to flower initiation	82.82	70.00-95.00	9.13	8.98	98.86	18.59
Duration of flowering (Days)	66.52	41.00-82.00	18.39	17.78	95.37	36.14
Flower diameter (cm)	5.13	4.30-5.40	5.85	5.71	97.27	11.71
Flower stalk length (cm)	14.00	10.40-29.40	20.30	19.36	92.82	38.82
Individual flower weight (g)	1.61	1.23-2.12	16.20	15.85	97.73	32.61
Number of flowers per plant	200.64	37.00-412.00	48.05	46.28	94.64	93.68
Flower yield per plant (g)	265.72	52.00-486.00	43.94	43.09	98.15	88.84
Vase life (days)	5.36	4.00-14.00	27.89	26.58	92.70	53.26
Total chlorophyll content (nmol/cm^2)	43.97	17.50-56.40	18.13	17.54	95.48	35.66

Table 2: Genetic variability in mutant population of Poornima Pink treated with EMS

Trait	Mean	Range	PCV	GCV	h^2%	GAM
Plant height (cm)	58.39	35.60-93.60	21.45	21.08	97.58	43.12
Stem girth (mm)	7.62	4.50-12.50	17.82	17.41	96.43	35.41
Number of primary branches	2.81	2.00-4.00	22.45	13.92	38.88	17.98
Plant spread E-W (cm)	45.14	30.50-61.20	15.73	14.98	91.75	29.73
Plant spread N-S (cm)	35.84	24.60-48.60	13.38	12.44	87.36	24.08
Number of leaves	325.72	212.00-405.00	12.73	11.95	89.07	23.36
Leaf area (mm^2)	649.34	598.20-696.40	4.12	3.32	65.64	5.58
Days to flower bud initiation	86.39	75.00-98.00	6.16	5.30	74.88	9.50
Days to flower initiation	101.67	87.00-115.00	5.25	5.16	97.73	10.57
Duration of flowering (Days)	72.62	64.00-79.00	4.29	2.30	29.09	2.57
Flower diameter (cm)	5.30	4.60-6.10	3.46	3.32	92.8	6.62
Flower stalk length (cm)	14.72	9.40-23.50	20.16	19.38	93.48	38.82
Individual flower weight (g)	1.51	1.10-2.10	12.64	12.31	95.81	24.95
Number of flowers per plant	106.38	28.00-255.00	36.72	30.03	67.62	51.15
Flower yield per plant (g)	148.11	45.00-354.00	32.30	30.33	89.10	59.29
Vase life (days)	5.18	5.00-7.00	8.51	3.47	16.84	2.95
Total chlorophyll content (nmol/cm^2)	52.69	34.20-96.50	21.76	21.40	97.84	43.85

Conclusion

In this experiment High heritability coupled with high genetic advance as per cent over mean was recorded for the triats *viz*, plant height, stem girth, number of primary branches, plant spread in E-W, plant spread in N-S, number of leaves, number of flowers per plant, flower yield per plant and total chlorophyll content. High heritability and high genetic advance as per cent over mean indicating predominance of additive gene component. Thus, there is ample scope for improving these characters through direct selection.

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