Effect of Mutagens on Genetic variability, heritability and genetic advance for yield and quality traits in M_1V_1 and M_1V_2 generations of chrysanthemum cultivars.

ABSTRACT

The study's goal was to evaluate genetic diversity, heritability, and genetic progress for yield and floral features in the M1V1 and M1V2 populations of chrysanthemum cultivars Pithika and Daali using a Factorial Randomized Block Design in 2022-23 and 2023-24. Cuttings were treated with gamma rays and EMS before being analyzed for genetic variation. The high phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) estimated for flower yield per plant, leaf length, and single flower weight in both generations of the mutated population indicated that the genotype could be considered by the phenotype, and that selecting these characters in the early generation based on phenotypic performance would be effective. Heritability might be due to effects of additive genes and consideration for the characters with combination of high heritability and high genetic advance will be more effective.

Keywords: heritability, genetic advance, GCV, PCV, chrysanthemum cultivar Pithika and Dalli.

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflora*Tzvelev.) is a multi-purpose flower crop that is becoming increasingly popular as a cut flower for interior decorating and bouquets. Around 1000 kinds have been generated in India as a result of genetic improvement research at various universities. Despite the vast range of variability, little effort has been made to enhance it. There is a need to identify cultivars that are good for growing in varied agroclimatic settings for certain applications. Any breeding strategy for high yield and quality must include information on the type and extent of variability present in current material, as well as the relationship between the various traits. Flower yield is a complicated trait that is controlled by a multitude of genes and the environment in addition to its connected traits. Breeders are able to implement appropriate breeding programmes when genetic variability is

distinguished from total variation, which is a prerequisite for effective selection. To appraise each cultivar's effectiveness, genetic diversity must be determined. Estimating the phenotypic and genotypic coefficient of variability of different polygenic characteristics is possible through the use of analysis of variance. The degree of diversity among the many qualities brought about by the innate ability of a genotype can be determined by the genotypic coefficient of variation. To comprehend how the environment affects different polygenic characteristics, one must know the genotypic and phenotypic coefficients of variation [1].

One breeding technique used to create variety in flower crops, particularly in plants produced vegetatively, is mutation. Worldwide, chrysanthemum is a commercially grown flower crop that is vegetative propagated. [2] Noted that chrysanthemums have a strong tendency for natural and artificial mutations, which are frequently imposed upon chrysanthemum breeding [3&4]. Finding effective and efficient mutagens is crucial to recovering a high frequency of desired mutants. One method of introducing genetic variety has been through mutation brought on by a physical or chemical mutagen. In ornamental crops, the most practical way to quickly create mutants has been via mutagenesis. The flowering and yield characteristics of ornamental plants are their commercial qualities, and these are controlled by several genes. These traits display a wide range of phenotypes and are primarily impacted by their surroundings to a larger extent. It is crucial to research these kinds of quantitative and qualitative characteristics in commercial crops like chrysanthemum. Mutants of these crops that were produced by mutagenesis were extremely important for understanding the trait genes and for improving the crop. Thus, the goal of the current study is to assess genetic variation and examine generated variation.

Materials and Methods

Plant material:

The experimental material consisted of rooted cuttings of the chrysanthemum cultivars Daali and Pithika. In research work used cultivars Pithika and Daali are indigenous cultivars with yellow and white flowers, respectively, as per the RHS chart. The mother plants were kept in a polyhouse. After taking 10 cm terminal cuttings, basal leaves were removed, and a slant cut was made immediately below the nodal section. A part of the cuttings that had been cut were immersed in Keradix rooting powder in order to encourage quick and widespread rooted. Cuttings were utilised for mutagenic treatments shortly after the treatment and were subsequently put in tubes filled with cocopeat for roots.

Mutagenic treatment

At the Indian Agricultural Research Institute (IARI), New Delhi, rooted cuttings were exposed to six different doses of gamma radiation (5, 10, 15, 20, 25, and 30 Gy) using Gamma Cell-200, a Cobalt-60 source that emits 3600 rads per minute. A wide range of EMS concentrations (0.5, 0.10, 0.15, 0.20, 0.25, and 0.3%) were applied to rooted cuttings as a chemical mutagen.

In the experimental field at the Horticulture Research Centre (HRC) College of Horticulture, Sardar Vallabhbhai Patel University of Agriculture Technology Modipuram, Meerut, following the irradiation, the rooted cuttings (mutated) were planted with untreated cuttings(control) in 2022 and 2023 for evaluation based on morphological characters to know the effect of mutagens. Factorial Randomized Block Design (FRBD) was utilised in the experiment's performance. Plants with rooted cuttings were spaced 30 cm apart and 40 cm between rows. The normal approach for chrysanthemum was followed when it came to cultural techniques including fertilization, watering, disease and pest management. When required, hand hoeing was used to keep the crop clear of weeds. Morphological and yield characters were recorded at full growth stage to know the effect of mutagens. Survival percentage (%), Plant height (cm), Stem girth (mm), Leaf length (cm), Leaf width (cm), Number of primary branches, Number of leaves, Leaf area (mm2), Days to flower bud initiation, Days taken for flowering, Duration of flowering (Days), Flower diameter (cm), Single flower weight(g), Number of flowers per plant, Flower yield per plant (g)were measured to know the genetic variation in mutant population.

Result and Discussion

The goal of the current experiment, which analyses genetic variability in a mutant population of chrysanthemum varieties treated with both chemical and physical mutagens (such as EMS and gamma rays), is to determine the amount of genetic variability, which will be helpful for future genetic advancement and selection. The amount of variability as determined by GCV and PCV also gives information regarding the relative amount of variation in different mutant populations.One of the main objective for plant breeders is to increase the number of flowers per plant. Flower yield per plant is dependent trait and it is depends on serval development characters as well as environmental factors. So present study was conducted to analyse variability parameters.

In $M_1V_1$and M_1V_2 generation for both Pithikaand Daalicultivars high GCV was observed in flower yield per plant, leaf length, single flower weight, survival percentage, leaf width, number of primary branches per plant and diameter of flower for both mutagens physical and chemical.The lowest genotypic coefficient of variation was observed for both cultivar in days to first bud initiation, days to first flowering, number offlowers per plant and stem diameter. These findings are in line with the results obtained[5] in China aster, [6] in chrysanthemum and [7] in carnation.

High PCV in both cultivars was observed for different traits such as flower yield per plant, leaf length, leaf width, number of primary branches per plant, single flower weight and number of leaves per plant. Whereas lowest phenotypic coefficient of variation was recorded in days taken to first flowering and days taken to first bud initiation in both $M_1V_1$and M_1V_2 generation. [8] in rice and[9] in gladiolus.

Very high heritability estimates in M_1 V_1 generation was observed forflower yield per plant, survival percentage and single flower weight. While, high estimates of heritability was observed for leaf length and diameter of flower in mutant population and low heritability was recorded for both cultivars such as number of flowers per plant, number of primary branches per plant, flowering duration and leaf width.

. While M_1V_2 generation for both cultivars (Pithika and Daali) very high heritability was observed in flower yield per plant, number of branches per plant and leaf length whereas, high heritability observed in plant height, leaf width, days to first flowering and flowering duration. The low heritability was recorded in days to first bud initiation, diameter of flower, number of leaves per plant and single flower weight.The same heritability pattern was seen in mutated population of bread wheat by [10], [5] in China aster and [11] in Dahlia.

High estimate of genetic advance over mean in both $M_1V_1$and M_1V_2 generationswere observed for flower yield per plant as well as, single flower weight. While, moderate estimates of genetic advance over mean was observed for survival percentage and leaf length whereas, low genetic advance as per cent of mean was noticed in flowering duration, days taken to first bud initiation and days taken to first flowering. Similar variations were seen in gladiolus [9] and [12] in Rose.

Since genotypic coefficients of variability (GCV) only show the heritable fraction, they would be more helpful in assessing intrinsic or genuine variability [1]. For some characters, the calculated GCV was nearly identical to the PCV. It is clear from the study that

these characters' expressions were consistently less influenced by their surroundings. One may infer that selection can be based on the phenotypic diversity as such. The heritable component of the variability found in various characteristics is shown by heritability estimates. The plant breeder can choose the direction of the selection process thanks to their understanding of heredity.

However, heritability estimates paired with genetic progress would be more dependable [13] and valuable in designing selection process. Heritability in broad sense, evaluating the level of variation attributable to non-genetic variables. Broadsense heritability may not always indicate a greater responsiveness to selection since it includes non-additive genetic variables. Thus, estimating genetic progress will provide insight into the nature of genes' effects, allowing for easy prediction of their response to selection. Thus, the research of heredity in conjunction with genetic advancement was prioritized in evaluating the resultant influence for picking the finest individuals.

Table 1: Genetic variability in mutant population M_1V_1 of Pithika cultivar treated with mutagens

Traits	Mean	Min.	Max.	Heritability (%)	GCV (%)	PCV (%)	Genetic Advance	Genetic Advance as % of mean
SURVIVAL PERCENTAGE	67.38	48.67	91.86	90.17	18.91	19.91	24.92	36.99
PLANT HEIGHT	40.20	34.95	50.66	41.14	10.38	16.13	5.5	13.75
STEM DIAMETER	4.54	3.89	5.44	37.61	8.97	14.62	1.01	11.33
LEAF LENGTH	6.30	4.10	8.96	57.18	25.12	33.22	2.46	39.13
LEAF WIDTH	4.09	2.97	6.05	30.11	17.81	32.46	1.82	20.13
NUMBER OF PRIMARY BRANCHES	15.50	10.65	21.57	27.99	16.81	31.77	2.84	18.32
NUMBER OF LEAVES PER PLANT	80.90	58.48	104.68	42.44	14.62	22.44	15.87	19.62
DAYS TO FIRST FLOWER BUD INITIATION	33.63	27.31	38.02	41.53	7.03	10.91	3.14	9.34
DAYS TO FIRST FLOWERING	48.47	41.27	54.00	47.68	6.87	9.95	4.74	9.77
NUMBER OF FLOWER PER PLANT	182.73	152.37	214.67	22.38	4.67	18.67	1.78	11.56
DIAMETER OF FLOWER	2.59	1.96	3.5	51.77	16.44	22.85	5.45	24.36
SINGLE FLOWER WEIGHT	2.31	1.38	3.28	74.54	23.64	27.39	1.21	42.06
FLOWERING DURATION	33.92	29.46	41.97	29.93	7.73	14.14	2.95	8.72
FLOWER YIELD PER PLANT	432.11	210.27	684.47	96.01	34.94	35.66	304.77	70.53

Table 2: Genetic variability in mutant population M_1V_1 of Daali cultivar treated with mutagens

Traits	Mean	Min.	Max.	Heritability (%)	GCV (%)	PCV (%)	Genetic Advance	Genetic Advance as % of mean
SURVIVAL PERCENTAGE	60.13	42.45	84.94	89.89	20.61	21.74	24.21	40.27
PLANT HEIGHT	31.92	25.15	42.14	64.44	14.96	18.64	7.90	24.74
STEM DIAMETER	3.45	2.89	4.13	35.21	8.75	14.75	2.36	10.69
LEAF LENGTH	8.14	5.92	12.23	46.48	24.26	35.59	2.77	34.07
LEAF WIDTH	5.10	3.87	7.10	17.25	13.11	31.58	2.01	11.34
NUMBER OF PRIMARY BRANCHES	10.11	7.18	14.56	38.49	18.07	29.12	2.33	23.09
NUMBER OF LEAVES PER PLANT	53.05	41.20	64.56	68.37	12.22	14.78	11.04	20.81
DAYS TO FIRST FLOWER BUD INITIATION	42.61	33.79	52.27	54.89	10.67	14.40	6.94	16.29
DAYS TO FIRST FLOWERING	58.62	52.45	64.10	13.68	3.48	9.41	1.55	2.65
NUMBER OF FLOWER PER PLANT	37.17	29.15	45.82	28.66	8.67	16.21	3.56	9.57
DIAMETER OF FLOWER	3.59	2.93	4.61	81.88	14.15	15.64	1.21	26.39
SINGLE FLOWER WEIGHT	2.96	1.54	4.76	79.24	28.02	31.55	1.53	51.49
FLOWERING DURATION	26.63	21.88	42.91	66.66	18.79	23.01	8.41	31.59
FLOWER YIELD PER PLANT	113.02	44.89	10.54	96.82	38.33	38.96	87.83	77.70

Table 3: Genetic variability in mutant population M_1V_2 of Pithika cultivar treated with mutagens

Traits	Mean	Min.	Max.	Heritability (%)	GCV (%)	PCV (%)	Genetic Advance	Genetic Advance as % of mean
SURVIVAL PERCENTAGE	68.60	52.89	85.89	49.98	13.22	18.69	13.20	19.25
PLANT HEIGHT	44.21	38.56	54.78	74.30	10.83	12.57	8.50	19.24
STEM DIAMETER	5.26	4.26	6.78	52.52	13.97	19.28	1.09	20.85
LEAF LENGTH	6.78	4.73	9.54	78.96	25.44	28.63	3.15	46.57
LEAF WIDTH	4.55	3.45	6.78	73.78	21.14	24.61	1.70	37.42
NUMBER OF PRIMARY BRANCHES	17.01	11.64	24.03	85.34	21.50	23.88	6.96	40.93
NUMBER OF LEAVES PER PLANT	86.40	64.80	109.40	38.73	12.94	20.80	14.34	16.60
DAYS TO FIRST FLOWER BUD INITIATION	29.67	22.97	34.55	18.90	5.04	18.78	8.78	12.78
DAYS TO FIRST FLOWERING	43.76	36.54	51.23	65.07	9.48	11.75	6.90	15.76
NUMBER OF FLOWER PER PLANT	197.03	160.55	279.86	49.11	13.61	19.43	38.73	19.66
DIAMETER OF FLOWER	3.38	2.75	4.44	39.45	11.48	18.28	5.03	14.85
SINGLE FLOWER WEIGHT	3.11	2.34	3.98	39.91	12.28	19.44	4.98	15.99
FLOWERING DURATION	38.26	33.20	45.50	64.00	8.89	11.11	5.60	14.65
FLOWER YIELD PER PLANT	605.91	375.68	866.05	93.34	24.70	25.57	297.95	49.17

Table 4: Genetic variability in mutant population M_1V_2 of Daali cultivar treated with mutagens

Traits	Mean	Min.	Max.	Heritability (%)	GCV (%)	PCV (%)	Genetic Advance	Genetic Advance as % of mean
SURVIVAL PERCENTAGE	64.81	48.04	88.69	43.23	16.03	24.38	14.07	21.71
PLANT HEIGHT	36.69	29.23	46.33	65.57	12.30	15.20	7.53	20.52
STEM DIAMETER	3.83	3.23	4.98	49.31	9.01	16.34	3.89	12.31
LEAF LENGTH	8.78	6.28	12.93	92.78	26.70	27.72	4.65	52.98
LEAF WIDTH	5.51	4.02	7.56	69.02	18.74	22.56	1.76	32.07
NUMBER OF PRIMARY BRANCHES	12.51	9.04	17.56	89.66	20.35	21.50	4.50	39.70
NUMBER OF LEAVES PER PLANT	58.06	46.80	68.90	53.58	9.95	13.59	8.71	15.00
DAYS TO FIRST FLOWER BUD INITIATION	39.56	28.89	52.98	76.44	14.20	16.24	10.12	25.57
DAYS TO FIRST FLOWERING	53.16	45.78	60.44	33.05	6.21	10.81	3.92	7.36
NUMBER OF FLOWER PER PLANT	46.30	38.90	54.30	62.43	8.40	10.63	6.33	13.67
DIAMETER OF FLOWER	4.42	3.45	5.50	62.56	13.06	16.51	1.11	21.27
SINGLE FLOWER WEIGHT	3.56	2.34	5.25	84.96	23.86	25.89	1.62	45.30
FLOWERING DURATION	30.09	25.60	38.83	24.53	8.60	17.38	2.64	8.78
FLOWER YIELD PER PLANT	167.92	91.03	259.88	95.89	32.03	33.71	108.49	64.61

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