

Original Research Article

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Induced Genetic Variability and Scope of Selection for Yield Attributes in Greengram (*Vigna radiata* L. Wilczek)

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ABSTRACT

An experiment was conducted to generate a broad genetic variability through induced mutation using physical and chemical mutagens. Three doses each of gamma rays (20, 40 and 60kR), ethyl methane sulphonate (0.2, 0.4 and 0.6%), nitrosoguanidine (0.005, 0.010, and 0.015%), maleic hydrazide (0.01, 0.02 and 0.03%) and their combinations were administered to the seed of two greengram varieties, Sujata and OBBG-52. In M₂ generation most treatment populations exhibited a reduction in population mean and increased in population variance for pods/plant, seeds/pod, 100 seed weight, yield/plant and the magnitude of such changes varied with mutagens, their doses and genotypes. A greater shift in mean and variance was observed in treatments with higher doses. The negative shift of mean was more pronounced in MH and its combined treatments in both varieties. In general, most of the mutagen treated populations showed a wider range of variation than the parent varieties and the variation was in both directions. The higher values of heritability and genetic advance with a high genotypic coefficient of variation for most of the yield attributing traits confirmed that selection in M₂ populations would be effective in bringing the improvement in yield/plant and its direct components like pods/plant, seeds/pod and 100 seed weight.

Keywords

Genetic variability, Greengram, Induced mutation, Mutagens, Yield

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Introduction

Greengram [*Vigna radiata* (L.) Wilczek] is one of the most important pulse crops, grown from tropical to sub-tropical areas around the world. It generates a triple benefit: income, additional nutrient-rich food, and increased soil fertility via biological nitrogen fixation. Greengram is grown on more than six million ha worldwide (about 8.5% of global pulse area). India is the world's largest producer as

well as consumer of greengram. Though India is the highest producer in the world, productivity is still very low *i.e.* 500 kg/ha (Anonymous. 2018). The bottlenecks in its improvement have been the lack of variability in different traits and improvement of one trait on its own will affect the performance of other traits because of genotypic correlations between traits (Das and Baisakh, 2019). Since genetic variability is essential for crop improvement programme, induction of

mutation by different physical and chemical mutagens provide a powerful means of creating new and useful variability in greengram both in qualitative and quantitative traits (Das *et al.*, 2006). Information on the extent of induced polygenic variability and the genetic parameters for different polygenic traits in M₂ generation indicates the scope of improvement in traits through selection. Thus the present study was undertaken to generate a broad genetic variability through induced mutation using physical and chemical mutagens and study the effect of different mutagens, ascertain the magnitude of induced genetic variability and other genetic parameters of yield and its components in M₂ generation.

Materials and Methods

Healthy seeds of two greengram varieties namely Sujata and OBGG-52 were administered mutagenic treatments with three doses each of gamma rays (20, 40 and 60 kR), ethyl methane sulphonate (EMS) (0.2, 0.4 and 0.6%), nitroso guanidine (NG) (0.005, 0.010 and 0.015%) and maleic hydrazide (MH) (0.01, 0.02 and 0.03%) singly and combine mutagens of 40 kR gamma rays with 0.4% EMS or 0.010% NG or 0.02% MH. The details of mutagenic treatments and the symbols used for treatments are presented in Table 1.

Dry seeds were irradiated with gamma rays treatment at Bhaba Atomic Research Centre (BARC), Trombay (India). For treatment with EMS, NG, and MH, the seeds were presoaked in distilled water for six hours, blotted dry and then treated with a freshly prepared aqueous solution of above chemical mutagens for six hours, with intermittent shaking. For combination treatments, seeds were first irradiated with 40 kR gamma rays and then treated with 0.4% EMS or 0.01 % NG or 0.02% MH solution in the same manner as

described above. After treatment, the seeds were thoroughly washed with running water to bleach out the residual chemicals and then dried on blotting paper after treatment. These treated seeds were sown as M₁ and the seed of M₁ used to grow the M₂ generation at Orissa University of Agriculture and Technology, Bhubaneswar, in two separate trials in randomized block design (RBD) with three replications and spacing of 25x10cm². Twenty normal-looking plants, excluding the macro-mutants, were randomly chosen from each plot and observations were recorded on yield/plant (g) and yield attributing traits. The mean and variance of the traits in each treatment population were estimated and subjected to statistical analysis. The genetic parameters for the traits in different mutagenic treatment populations were calculated as follows:

$$\text{Genotypic variance } (\sigma_g^2) = \sigma_p^2 - \sigma_e^2$$

Phenotypic coefficient of

$$\text{variability (PCV)} = \frac{\sigma_p}{\text{Mean}} \times 100$$

Genotypic coefficient of

$$\text{variability (GCV)} = \frac{\sigma_g}{\text{Mean}} \times 100$$

$$\text{Heritability coefficient (h}^2\text{)} = \frac{\sigma_g^2}{\sigma_p^2}$$

$$\text{Heritability (h}^2\text{ in \%)} = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

$$\text{Genetic Advance (GA)} = k.h.\sigma_g = k.h^2.\sigma_p$$

$$\text{GA (as \% of mean)} = \frac{\text{GA}}{\text{Mean}} \times 100$$

Where,

k = Standardized selection differential for specified selection intensity at 5%.

h = Square root of heritability coefficient

σ_g = Square root of genotypic variance

σ_p = Square root of phenotypic variance

Results and Discussion

To assess the nature and magnitude of induced polygenic variability of micro mutations in quantitative traits like pods/plant, seeds/pod, 100-seed weight and yield/plant of the different mutagenic treatments, populations of M_2 generation were analyzed through statistical parameters such as mean, variance, heritability and genetic advance. Analysis of variance for pods/plant, seeds/pod, 100-seed weight and yield/plant of M_2 population showed significant differences among the treatments for the above characters in both the varieties. The effects of different doses of different mutagen on different genetic parameters and in the induction of variability in different quantitative characters are as follows:

Pods per plant (Table 2)

The population means for pods/plant in different treatments of Sujata and OBGG-52 varied from 7.4 to 9.50 and 6.45 to 8.48, respectively, while in their respective controls it was 9.52 and 8.55. All mutagenic treatments exhibited lower pods/plant than respective controls. The negative shift in mean was significant for E3, M1, M2, M3 in Sujata and E3, M1, M2, M3, GM2 in OBGG-52. The reduction in mean generally increased with mutagen dose and the reduction was more pronounced in EMS and MH treatments in Sujata. The ranges of variation for pods per plant in the control populations were 7 to 13 in Sujata and 6 to 11 in OBGG-52. The variations in different treated populations for pods/plant were observed 3 to 16 in the case of Sujata and 4 to 15 in OBGG-52. Though the induced variation in pods/plant was in both directions, the lower mean of most treatment populations indicated the induction of more negative micro mutations. The

variance of pods/plant in treated populations of Sujata and OBGG-52 ranged from 3.85 to 7.46 and 1.94 to 6.21 as against 1.82 and 1.77 in the respective controls. All the mutagenic treatments exhibited greater population variance than controls in Sujata whereas a significant increase of variance over control was observed in all mutagenic treatments except MH treatments and GN2 in OBGG-52. The PCV estimates in the different M_2 populations varied from 20.65% (N1) to 33.11% (E3) in Sujata and 21.59% (M3) to 32.65% (E3) in OBGG-52. The GCV estimates in the different M_2 populations varied from 15.00% (N1) to 28.64% (E3) in Sujata and 6.39% (M3) to 26.65% (E3) in OBGG-52.

Heritability estimates for the trait in the treated populations varied from 52.73% (N1) to 75.60% (G3) and 8.76% (M3) to 71.50% (E1, E2) in Sujata and OBGG-52, respectively. Genetic advance (GA) at 5% selection intensity in the treatments varied from 2.13 (N1) to 4.25 (G3) in Sujata and 0.25 (M3) to 3.67 (E1, E2) in OBGG-52. GA as a percentage of mean ranged from 22.43 to 51.04 in Sujata and 3.90 to 44.92 in OBGG-52. GA as a percentage of mean was higher for all treatments except N1 in Sujata and M2 and M3 in OBGG-52.

Seeds per pod (Table 3)

The mean value for seeds per pod in the treated population of Sujata varied from 7.01 to 8.27 and in OBGG-52 varied from 6.89 to 8.49 while in respective controls it was 8.55 and 8.51, respectively. All mutagenic treatments of both the varieties showed a lower mean than respective controls. The negative shift of mean was significant for G2, N2, N3, M1, M2, M3, GE2, GN2, GM2 in Sujata and M3, GE2, GN2, GM2 in OBGG-52. Though there was no definite trend, the reduction was generally higher in MH and

combined treatments. The range for seeds per pod in the parent population was 6.4 to 9.8 in Sujata and 7.4 to 9.6 in OBG-52 while it was much wider in treated populations with a range of 3.5 to 10.5 in Sujata and 4.3 to 11.6 in OBG-52. Though the induced variation was in both directions, it was more in a negative direction. The variance of seeds/pod in M₂ populations of Sujata and OBG-52 ranged from 0.89 to 2.22 and 0.54 to 1.53, respectively, while population variance in respective controls were 0.76 and 0.28. All treatments in both varieties showed higher population variance than respective controls. In Sujata, a significant increase of variance over control was observed in all mutagenic treatments except G1 and GN2. In case of OBG-52, significant increase of variance over control was observed in G2, G3, E1, E2, E3, N3, M2, M3 and GN2. The PCV estimates in the different M₂ populations varied from 12.02% (GN2) to 20.03% (M3) in Sujata and from 8.92% (M1) to 17.55% (GN2) in OBG-52. The GCV estimates in the different M₂ populations varied from 4.59% (GN2) to 16.24% (M3) in Sujata and from 6.19% (M1) to 15.79 % (GN2) in case of OBG-52.

The heritability for seeds/pod in treated populations was varied from 14.61% (GN2) to 65.77% (M3) and 48.15% (M1) to 81.70% (G3) in Sujata and OBG-52, respectively. Heritability estimates were high in all the treatments except G1, GN2, and GM2 in Sujata and M1 in OBG-52. GA estimates in treatments varied from 0.28 to 2.02 in Sujata and 0.73 to 2.08 in OBG-52. GA as a percentage of mean showed a variation of 3.62% (GN2) to 27.13% (M3) and 8.85% (M1) to 29.26 % (GN2) in Sujata and OBG-52, respectively. The GA estimates for the trait in the treated populations were generally moderate.

100-seed weight (Table 4)

The populations mean values for the 100-seed weight (gm) in treated populations of Sujata and OBG-52 varied from 1.97 to 2.63gm and 2.73 to 3.09 gm, respectively, whereas in respective controls it was 2.67gm and 3.22gm. The negative shift of mean in mutagenic treatments was significant for M2, M3, and GE2 in Sujata and all except G1 in OBG-52. The reduction in mean generally increased with mutagen dose in both cases. The range of 100-seed weight in control populations of Sujata and OBG-52 showed a range of variation of 2.28 to 2.96gm and 2.85 to 3.57gm, respectively. The ranges of variation of 100-seed weight in the treated populations of these two varieties were 1.52 to 3.54gm in Sujata and 2.1 to 3.8gm in OBG-52. The variance of 100-seed weight in the treated populations varied from 0.053 to 0.1 in Sujata and 0.072 to 0.121 in OBG-52, whereas in respective controls the variances were 0.03 and 0.05. Increases in variance over control were significant in all mutagenic treated populations of both the varieties except for GE2 in Sujata and G1 and GM2 in OBG-52. The PCV estimates for the trait in different treated populations of Sujata and OBG-52 ranged from 8.65 (E1) to 11.72 (G3) and 8.68 (G1) to 12.41 (M3), respectively. The GCV estimates for the trait in different treated populations of Sujata and OBG-52 ranged from 5.05 (GE2) to 9.41(G3) and 4.8 (G1) to 9.45 (GE2), respectively.

The treated populations of Sujata and OBG-52 had heritability estimates of 27.27% (GE2) to 64.44% (G3) and 30.56% (G1) to 58.68 % (M1), respectively. There were a lot of differences in heritability among the treatments and estimates were higher in all treatments of Sujata (except E1, M3, and GE2) and OBG-52 (except G1 and GM2). Genetic advance in the treatments ranged from 0.12 (GE2) to 0.40 (G3) and 0.17(G1) to 0.42 (M1, GE2) in Sujata and OBG-52,

respectively. Genetic advance as a percentage of mean varied from 5.43% (GE2) to 15.56% (G3) in Sujata and 5.47% (G1) to 14.87% (GN2) in OBGG-52.

Table.1 Details of mutagenic treatments

Tr. No.	Treatment symbol	Mutagen	Dose/ concentration	Duration of pre-soaking in distilled water	Duration of treatment with mutagenic solution
1	G1	Gamma-rays	20 kR	-	-
2	G2	Gamma-rays	40 kR	-	-
3	G3	Gamma-rays	60 kR	-	-
4	E1	EMS	0.2 %	6 hours	6 hours
5	E2	EMS	0.4 %	6 hours	6 hours
6	E3	EMS	0.6 %	6 hours	6 hours
7	N1	NG	0.005 %	6 hours	6 hours
8	N2	NG	0.010 %	6 hours	6 hours
9	N3	NG	0.015 %	6 hours	6 hours
10	M1	MH	0.01 %	6 hours	6 hours
11	M2	MH	0.02 %	6 hours	6 hours
12	M3	MH	0.03 %	6 hours	6 hours
13	GE2	Gamma-rays 40 kR + EMS (0.4 %)		6 hours	6 hours
14	GN2	Gamma-rays 40 kR + NG (0.010 %)		6 hours	6 hours
15	GM2	Gamma-rays 40 kR + MH (0.02 %)		6 hours	6 hours
16	C	Control (parent)		6 hours	-

Table.2 Genetic parameters for pods per plant in different mutagenic treatment in M₂ population

of greengram

Tr. No.	Tr. Code	Range	Mean	Variance	PCV (%)	GCV (%)	h ² (%)	GA (5 %)	GA (% of Mean)
Sujata									
1	G1	5 – 15	9.47	5.91*	25.67	21.36	69.20	3.47	36.60
2	G2	5 – 15	9.35	7.23*	28.76	24.88	74.83	4.14	44.33
3	G3	4 – 15	8.80	7.46*	31.04	26.99	75.60	4.25	48.34
4	E1	5 – 15	8.72	5.06*	25.80	20.64	64.03	2.97	34.03
5	E2	3 – 16	8.67	7.20*	30.95	26.75	74.72	4.13	47.64
6	E3	3 – 16	8.12*	7.23*	33.11	28.64	74.83	4.14	51.04
7	N1	4 – 14	9.50	3.85*	20.65	15.00	52.73	2.13	22.43
8	N2	4 – 15	9.43	5.49*	24.85	20.32	66.85	3.23	34.22
9	N3	5 – 16	9.38	4.31*	22.13	16.82	57.77	2.47	26.34
10	M1	4 – 13	8.42*	3.99*	23.72	17.50	54.39	2.24	26.58
11	M2	3 – 11	7.40*	4.15*	27.53	20.63	56.14	2.36	31.84
12	M3	3 – 16	7.87*	5.35*	29.39	23.87	65.98	3.14	39.95
13	GE2	4 – 13	9.00	6.81*	29.00	24.82	73.27	3.94	43.77
14	GN2	4 – 15	9.05	7.05*	29.34	25.27	74.18	4.06	44.84
15	GM2	3 – 13	8.65	6.53*	29.54	25.09	72.13	3.80	43.90
16	Control	7 – 13	9.52	1.82					
	CD (5%)	-	1.06	1.91					
OBGG-52									
1	G1	5 – 14	8.48	5.38*	27.35	22.41	67.10	3.21	37.81
2	G2	5 – 15	8.25	5.34*	28.01	22.90	66.85	3.18	38.58
3	G3	5 – 15	7.87	5.28*	29.20	23.81	66.48	3.15	39.98
4	E1	5 – 15	8.17	6.21*	30.50	25.79	71.50	3.67	44.92
5	E2	5 – 14	8.17	6.21*	30.50	25.79	71.50	3.67	44.92
6	E3	4 – 14	7.05*	5.30*	32.65	26.65	66.60	3.16	44.80
7	N1	5 – 14	8.35	5.68*	28.54	23.68	68.84	3.38	40.47
8	N2	4 – 15	8.18	5.57*	28.85	23.83	68.22	3.32	40.55
9	N3	4 – 13	7.53	5.21*	30.31	24.63	66.03	3.10	41.23
10	M1	4 – 14	7.32*	3.83	26.74	19.61	53.79	2.17	29.62
11	M2	4 – 12	6.75*	2.91	25.27	15.82	39.18	1.38	20.39
12	M3	4 – 09	6.45*	1.94	21.59	6.39	8.76	0.25	3.90
13	GE2	5 – 13	7.63	4.61*	28.14	22.09	61.61	2.72	35.71
14	GN2	4 – 13	7.50	4.25	27.49	21.00	58.35	2.48	33.04
15	GM2	4 – 14	7.17*	4.15	28.41	21.52	57.35	2.41	33.57
16	Control	6 – 11	8.55	1.77					
	CD (5%)	-	1.12	2.60					

* Significant decrease (in mean) or increase (in variance) over control at 5 % level.

Table.3 Genetic parameters for seeds per pods in different mutagenic treatment in M₂ population

of greengram

Tr. No.	Tr. Code	Range	Mean	Variance	PCV (%)	GCV (%)	h^2 (%)	GA (5 %)	GA (% of Mean)
Sujata									
1	G1	6.3 – 9.9	8.16	1.16	13.20	7.75	34.48	0.77	9.38
2	G2	5.3 – 9.9	7.90*	1.72*	16.60	12.40	55.81	1.51	19.09
3	G3	5.4 – 10.0	8.13	1.79*	16.46	12.48	57.54	1.59	19.51
4	E1	6.0 – 10.4	8.27	1.67*	15.63	11.53	54.49	1.45	17.54
5	E2	5.8 – 9.8	7.92	1.70*	16.46	12.24	55.29	1.49	18.75
6	E3	5.5 – 9.8	7.96	1.68*	16.28	12.05	54.76	1.46	18.37
7	N1	6.0 – 10.5	8.15	1.70*	16.00	11.90	55.29	1.49	18.22
8	N2	5.2 – 10.2	7.60*	1.70*	17.16	12.76	55.29	1.49	19.54
9	N3	5.4 – 9.8	7.61*	1.72*	17.23	12.88	55.81	1.51	19.81
10	M1	3.5 – 9.9	7.73*	1.73*	17.02	12.74	56.07	1.52	19.65
11	M2	5.0 – 9.9	7.46*	1.79*	17.93	13.60	57.54	1.59	21.26
12	M3	5.0 – 10.0	7.44*	2.22*	20.03	16.24	65.77	2.02	27.13
13	GE2	5.3 – 9.8	7.28*	1.77*	18.27	13.80	57.06	1.56	21.48
14	GN2	5.7 – 10.5	7.85*	0.89	12.02	4.59	14.61	0.28	3.62
15	GM2	4.9 – 9.4	7.01*	1.35*	16.57	10.96	43.70	1.05	14.92
16	Control	6.4 – 9.8	8.55	0.76					
	CD (5%)	-	0.64	0.44					
OBGG-52									
1	G1	6.4 – 11.6	8.30	0.87	11.24	9.25	67.82	1.30	15.70
2	G2	6.5 – 11.2	8.19	1.23*	13.54	11.90	77.24	1.76	21.55
3	G3	6.0 – 11.2	8.15	1.53*	15.18	13.72	81.70	2.08	25.54
4	E1	5.5 – 11.4	8.28	1.28*	13.66	12.08	78.13	1.82	21.99
5	E2	5.7 – 11.5	8.31	1.34*	13.93	12.39	79.10	1.89	22.70
6	E3	6.5 – 10.7	8.13	1.05*	12.6	10.79	73.33	1.55	19.04
7	N1	6.3 – 10.5	8.29	0.72	10.24	8.00	61.11	1.07	12.89
8	N2	6.4 – 10.7	8.21	1.00	12.18	10.34	72.00	1.48	18.07
9	N3	4.7 – 11.3	8.49	1.31*	13.48	11.95	78.63	1.85	21.84
10	M1	6.3 – 10.6	8.24	0.54	8.92	6.19	48.15	0.73	8.85
11	M2	6.0 – 11.0	7.88	1.39*	14.96	13.37	79.86	1.94	24.61
12	M3	5.4 – 09.8	7.45*	1.21*	14.77	12.94	76.86	1.74	23.38
13	GE2	4.3 – 09.2	6.90*	0.75	12.55	9.94	62.67	1.12	16.20
14	GN2	4.7 – 10.0	6.91*	1.47*	17.55	15.79	80.95	2.02	29.26
15	GM2	5.5 – 09.2	6.89*	0.61	11.34	8.34	54.10	0.87	12.63
16	Control	7.4 – 09.6	8.51	0.28					
	CD (5%)	-	0.86	0.67					

* Significant decrease (in mean) or increase (in variance) over control at 5 % level.

Table.4 Genetic parameters for 100-seed weight in different mutagenic treatment

in M₂ population of greengram

Tr. No.	Tr. Code	Range	Mean (gm)	Variance	PCV (%)	GCV (%)	h ² (%)	GA (5 %)	GA (% of Mean)
Sujata									
1	G1	2.26 – 3.45	2.63	0.061*	9.39	6.48	47.54	0.24	9.20
2	G2	2.13 – 3.48	2.59	0.081*	11.52	9.22	64.04	0.39	15.20
3	G3	2.10 – 3.16	2.57	0.091*	11.72	9.41	64.44	0.40	15.56
4	E1	2.20 – 3.54	2.63	0.066*	8.65	5.28	37.25	0.17	6.64
5	E2	2.01 – 3.41	2.53	0.081*	10.72	8.04	56.16	0.31	12.40
6	E3	2.03 – 3.27	2.52	0.085*	10.62	7.87	54.93	0.30	12.01
7	N1	2.06 – 3.18	2.56	0.083*	10.67	8.04	56.76	0.32	12.47
8	N2	2.04 – 3.14	2.52	0.087*	10.73	8.00	55.56	0.31	12.28
9	N3	2.14 – 3.51	2.52	0.100*	10.86	8.10	55.56	0.31	12.43
10	M1	2.02 – 3.10	2.60	0.070*	10.18	7.50	54.29	0.30	11.38
11	M2	1.65 – 2.89	2.27*	0.067*	11.32	8.12	51.52	0.27	12.01
12	M3	1.52 – 2.74	1.97*	0.067*	11.41	6.72	34.69	0.16	8.15
13	GE2	1.79 – 2.87	2.18*	0.053	9.67	5.05	27.27	0.12	5.43
14	GN2	2.15 – 2.98	2.59	0.064*	9.77	6.91	50.00	0.26	10.06
15	GM2	2.15 – 3.21	2.54	0.070*	9.88	6.93	49.21	0.25	10.02
16	Control	2.28 – 2.96	2.67	0.030					
	CD (5%)	-	0.15	0.031					
OBGG-52									
1	G1	2.36 – 3.59	3.09	0.072	8.68	4.80	30.56	0.17	5.47
2	G2	2.54 – 3.69	3.03*	0.085*	9.62	6.17	41.18	0.25	8.16
3	G3	2.58 – 3.78	3.03*	0.097*	10.28	7.15	48.45	0.31	10.26
4	E1	2.42 – 3.73	3.03*	0.086*	9.68	6.26	41.86	0.25	8.35
5	E2	2.19 – 3.60	3.02*	0.107*	10.83	7.91	53.27	0.36	11.89
6	E3	2.11 – 3.53	2.73*	0.086*	10.74	6.95	41.86	0.25	9.26
7	N1	2.46 – 3.48	2.91*	0.087*	10.14	6.61	42.53	0.26	8.88
8	N2	2.30 – 3.73	2.84*	0.087*	10.39	6.77	42.53	0.26	9.10
9	N3	2.34 – 3.53	2.86*	0.086*	10.25	6.63	41.86	0.25	8.84
10	M1	2.33 – 3.76	2.89*	0.121*	12.04	9.22	58.68	0.42	14.55
11	M2	2.28 – 3.61	2.88*	0.113*	11.67	8.72	55.75	0.39	13.41
12	M3	2.23 – 3.55	2.78*	0.119*	12.41	9.45	57.98	0.41	14.82
13	GE2	2.18 – 3.76	2.80*	0.120*	12.37	9.45	58.33	0.42	14.87
14	GN2	2.26 – 3.68	2.85*	0.103*	11.26	8.08	51.46	0.34	11.94
15	GM2	2.10 – 3.80	2.75*	0.076	10.02	5.86	34.21	0.19	7.06
16	Control	2.85 – 3.57	3.22	0.050					
	CD (5%)	-	0.14	0.035					

* Significant decrease (in mean) or increase (in variance) over control at 5 % level.

Table.5 Genetic parameters for yield per plant in different mutagenic treatment

in M₂ population of greengram

Tr. No.	Tr. Code	Range	Mean (gm)	Variance	PCV (%)	GCV (%)	h ² (%)	GA (5 %)	GA (% of Mean)
Sujata									
1	G1	0.95 – 3.91	2.05	0.51*	34.84	28.44	66.67	0.98	47.84
2	G2	0.71 – 3.64	1.93	0.51*	38.52	32.27	70.18	1.09	55.68
3	G3	0.77 – 3.92	1.85*	0.55*	39.72	32.88	68.52	1.04	56.07
4	E1	0.85 – 3.66	1.89*	0.35*	29.13	19.18	43.33	0.49	26.01
5	E2	0.56 – 3.63	1.73*	0.41*	38.34	30.04	61.36	0.84	48.47
6	E3	0.79 – 3.53	1.63*	0.40*	37.04	26.91	52.78	0.65	40.27
7	N1	0.87 – 3.63	1.96	0.23	23.50	10.26	19.05	0.18	9.22
8	N2	0.56 – 3.12	1.77*	0.21	27.99	15.12	29.17	0.29	16.82
9	N3	0.87 – 3.78	1.83*	0.34*	34.50	25.91	56.41	0.73	40.09
10	M1	0.65 – 3.64	1.70*	0.33*	32.05	20.62	41.38	0.46	27.32
11	M2	0.30 – 2.20	1.26*	0.20	35.49	13.75	15.00	0.14	10.97
12	M3	0.38 – 2.78	1.16*	0.22	37.90	12.30	10.53	0.09	8.22
13	GE2	0.48 – 2.92	1.45*	0.33*	41.38	30.06	52.78	0.65	44.99
14	GN2	0.89 – 3.60	1.84*	0.38*	35.86	28.09	61.36	0.84	45.32
15	GM2	0.52 – 3.04	1.52*	0.25	31.76	16.22	26.09	0.26	17.07
16	Control	1.42 – 2.74	2.16	0.12					
	CD (5%)	-	0.26	0.14					
OBBG-52									
1	G1	1.07 – 3.94	2.16	0.36*	27.78	22.20	63.89	0.79	36.56
2	G2	1.22 – 3.82	2.03	0.37*	29.96	24.13	64.86	0.81	40.04
3	G3	0.95 – 3.78	1.93*	0.40*	32.77	26.92	67.50	0.88	45.57
4	E1	0.87 – 3.96	2.02	0.35*	29.29	23.22	62.86	0.77	37.92
5	E2	0.84 – 3.61	2.03	0.39*	30.76	25.12	66.67	0.86	42.25
6	E3	0.73 – 3.47	1.58*	0.39*	39.53	32.27	66.67	0.86	54.28
7	N1	0.89 – 3.42	2.01	0.37*	30.26	24.37	64.86	0.81	40.44
8	N2	0.87 – 3.76	1.93*	0.51*	37.00	31.94	74.51	1.10	56.79
9	N3	0.79 – 4.09	1.86*	0.56*	40.23	35.26	76.79	1.18	63.64
10	M1	1.02 – 4.16	1.74*	0.35*	34.00	26.96	62.86	0.77	44.03
11	M2	0.62 – 3.16	1.53*	0.23	31.35	20.67	43.48	0.43	28.07
12	M3	0.50 – 2.58	1.35*	0.20	33.13	19.60	35.00	0.32	23.88
13	GE2	0.84 – 2.74	1.46*	0.17	28.24	13.70	23.53	0.20	13.69
14	GN2	0.59 – 3.76	1.48*	0.29	36.39	27.03	55.17	0.61	41.35
15	GM2	0.57 – 3.64	1.37*	0.23	35.01	23.08	43.48	0.43	31.35
16	Control	1.55 – 2.85	2.33	0.13					
	CD (5%)	-	0.33	0.17					

* Significant decrease (in mean) or increase (in variance) over control at 5 % level.

Yield per plant (Table 5)

Mean yield per plant in treated populations of Sujata varied from 1.16 gm (M3) to 2.05gm (G1) whereas 2.16 gm in control and in the case of OBGG-52, it ranged from 1.35gm (M3) to 2.16gm (G1) whereas 2.33gm in control. All mutagenic treatments showed lower seed yield than respective controls. Mutagenic treatments except for G1, G2 and N1 in Sujata and G1, G2, E1, E2 and N1 in OBGG-52 showed a significant negative shift of mean as compared to respective controls. Though there was no definite trend, the reduction was generally higher in higher doses (except N3 of Sujata) and in combined treatments. Yield per plant was with a variation of 1.42 to 2.74gm and 1.55 to 2.85gm in control population of Sujata and OBGG-52, respectively. But the variation in yield/plant in the mutagenic treated populations was much wider with a range of 0.30 to 3.92 gm in Sujata and 0.50 to 4.16 gm in OBGG-52. This trait for different treated populations of Sujata and OBGG-52 exhibited a variance range of 0.20 (M2) to 0.55 (G3) and 0.17 (GE2) to 0.56 (N3), respectively, while in the respective controls the variances were 0.12 and 0.13. All mutagenic treatments of both the varieties exhibited higher population variance than respective controls. All the mutagenic treatments, except N1, N2, M2, M3, GM2 in Sujata and M2, M3 GE2, GN2, GM2 in OBGG-52, showed a significant increase in population variance as compared to their parent respective controls.

The PCV estimates for this trait in different treated populations of Sujata and OBGG-52 ranged from 23.50 (N1) to 41.38 (GE2) and 27.78 (G1) to 40.23 (N3), respectively. The GCV estimates for yield in the treatments ranged from 10.26% (N1) to 32.88 % (G3) in Sujata and 13.70% (GE2) to 35.26% (N3) in OBGG-52 and it was relatively higher ($\geq 25\%$) in G1, G2, G3, E2, E3 N3, GE2 and GN2 treatments of Sujata and G3, E2, E3, N2, N3, M1 and GN2 treatments of OBGG-52.

Heritability estimates for yield in treated populations varied from 10.53% (M3) to 70.18% (G2) in Sujata and 23.53% (GE2) to 76.79% (N3) in OBGG-52. Heritability estimates were higher in G1, G2, G3, E2, E3, N3, GE2 and GN2 treatment populations of Sujata and G1, G2, G3, E1, E2, E3, N1, N2, N3, M1 and GN2 of OBGG-52. Genetic advance in the treatments varied from 0.09 (M3) to 1.09 (G2) in Sujata and 0.20 (GE2) to 1.18 (N3) in OBGG-52. GA as a percentage of mean in treatment population varied from 8.22% (M3) to 56.07% (G3) and 13.69% (GE2) to 63.64% (N3) in the case of Sujata and OBGG-52, respectively and it was generally moderate to high in both varieties.

Induction of mutation is an important tool for the creation of genetic variability for specific characters in a crop when the variability of the crop is completely exhausted and can lead to no further possibility for genetic improvement through the conventional approach. In mutation breeding, the possibility exists to change a single gene or only a few genes without altering the total genetic makeup of a specific/outstanding genotype (Broertjes and Van Harten, 1978). In this study, there was a negative shift in mean for all these quantitative characters in mutagen treated M_2 populations in both the varieties and the shift was significant in most of the cases. A large portion of this induced variability in different treatments might have been due to the induction of more micro-mutations with a negative effect on the trait. Thus mean seed yield in the treatments was lower than the control. A wide range of variation and lower population mean of the treatments showed that induction of change was more in a negative direction and less in a positive direction. A similar differential negative shift of mean in different M_2 populations of greengram was presented by Das and Misra (2005), Das *et al.* (2006), Khan *et al.* (2006), and Kozgar *et al.* (2011).

In most of the above reports, the shift of mean varied with mutagens and their doses. In this study, there was a greater reduction in higher doses for most traits. A decrease in the mean value of various quantitative traits at higher concentrations may be due to mutagenic treatment means was shifted to a direction opposite to selection (Bhatia and Swaminathan, 1962). A comparative study of the effect of mutagens indicated that the negative shift of mean was more pronounced in MH and its combined treatments in both the varieties. This might be due to chromosomal abnormalities like stickiness, fragments, laggards, bridges, etc (Ghose and Chatterjee, 1989). The comparatively lower magnitude of a negative shift in gamma rays treatments might be due to less drastic effect and either induction of less number of micro mutants or induction of micro mutations in either direction (Das and Misra, 2005). The negative shift could be attributed to either physiological damage caused chiefly by chemical mutagens or chromosomal aberrations caused mainly by irradiations (Swaminathan *et al.*, 1968; Brock, 1971). Induction of more chromosomal aberrations was also reported by Virk *et al.*, (1978) in NG than EMS treatments.

Most of the mutagen treated M₂ populations showed a significant increase in population variance than the control population for all the characters studied in both of the varieties. Among different treatments each mutagen group sufficient genetic variability observed in the induced population of G3, E3, N2, M3 and GN2 for pods/plant; G3, E2, N3, M3 and GE2 for seeds/pod; G3, E3, N3, M1 and GM2 for 100- seed weight and G3, E2, N3, M1 and GN2 for yield/plant in Sujata whereas, G1, E1, E2, N1 and GE2 for pods/plant; G3, E2, N3, M2 and GN2 for seeds/pod; G3, E2, N2, M1 and GE2 for 100-seed weight and G3, E3, N3 and M1 for yield/plant in OBG-52. The increase in the variance of the M₂ population

in a trait is a general indicator of the induction of micro mutation with a negative and/or positive effect on the trait. However, the magnitude of an increase in population variance varied with the mutagen and their concentration, parental genotype and the character concerned. A similar increase in variability in M₂ population and differential increase in treatments with different mutagens, their combinations and doses in various growth and yield attributing traits in greengram had earlier been reported by Das and Misra (2005), Das *et al.* (2006), Khan *et al.* (2006), Wani and Khan (2006) and Kozgar *et al.* (2011). The study showed that though the dose-variance relationship was not completely linear, in most of the cases higher doses of mutagens induced greater variance. These results are in agreement with earlier reports of Singh *et al.* (2001) and Sharma *et al.* (2008).

In General, most mutagens treated M₂ populations showed an increase in phenotypic variability which can be attributed partly to genetic effects and partly to environmental effects. Depending upon the magnitude of induced genetic variability in different treatment populations, different genetic parameters like the phenotypic coefficient of variability (PCV), genetic coefficient of variability (GCV), heritability and genetic advance under selection (GA) would vary with different mutagens and its doses. These parameters represent an indication of the effectiveness of mutagenic treatments for the induction of micro-mutations and the scope of improvement for the trait through selection in M₂ populations.

The GCV estimates varied with mutagenic treatments and were high (> 20%) for pods/plant and yield per plant while moderate (10-20%) for seeds/pod and low (<10%) for 100-seed weight in both varieties. Similar results for different traits in greengram were

also reported earlier by Das *et al.* (2006), Singh *et al.* (2001), Sharma *et al.* (2008) and Kozgar *et al.* (2010, 2011). The GCV value alone is not enough to determine the amount of heritable variability thus estimation of heritability and genetic advance along with the GCV are required to assess the heritable portion of the total variation. Heritability along with high GA has indicated the existence of additive and epistatic gene effects, which are fixable and can provide the desirable genetic gain. Thus, it is necessary to consider all these three genetic parameters (GCV, heritability and genetic advance) for an effective selection of a particular trait.

The heritability estimates for different traits in M₂ populations varied with mutagens and their dose and in many cases it was relatively high in both varieties for all traits, indicating the greater scope of improvement through selection in those treated population. Genetic advance as a percentage of mean also increased in treatments and comparatively higher for pods/plant and yield per plant of both the varieties. Similar results for different traits in mutagenic populations of greengram were also reported by Das and Misra (2005), Mishra *et al.* (2008) and Sharma *et al.* (2008).

In conclusion, the present investigation most of the mutagenic treatments induced a wide range of variation in populations than their parental population in both varieties. The range indicated that almost all mutagenic treatments induced a wider range of variation in M₂ populations in both directions for all the traits. Most treatment populations exhibited a reduction in population mean and increased in population variance for all the four traits studied and the magnitude of such changes varied with mutagens, their dose and the variety indicating that these treatments appeared to be effective for induction of micro mutation in yield component traits

however higher dose of gamma-rays and NG, moderate to a higher dose of EMS, the low dose of MH and moderate dose combination of gamma rays and NG found as the most useful dose for creation of sufficient induced genetic variability for yield as well as the yield attributing characters. The selection of these doses of different mutagens would be effective in the creation of sufficient genetic variability and the development of desirable high yielding genotypes. The higher value of GCV, heritability and genetic advance for yield and yield attributing traits *i.e.* pods per plant, seeds per pod and 100 seed weight indicated that selection in M₂ populations would be effective for yield improvement.

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