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Variability studies in M_3 generation in mungbean (*Vigna radiata* L.) Wilczek

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Abstract
Variability Studies were performed for various yield and yield contributing characters in M3 generation in three varieties of mungbean (AKM-8802, PKV Green gold and AKM-4) by exposing to gamma rays. The 220 mutants isolated in M2 generation were assessed for 11 yield contributing characters. Out of 220 mutants only 28 lines showed true to type breeding behaviour in M3 generation. The PCV values were higher than GCV values for all the characters. The characters sprouting percentage, number of pods per plant, number of seeds per pod and 100 grain weight exhibited high GCV and PCV values. High estimates of heritability were recorded for few characters like sprouting percentage, number of pods per plant and plant height. High heritability values along with high estimates of genetic advance for theses characters indicated the presence of additive gene action and direct selection for such traits is rewarding in crop improvement. Apart from variability studies, variety and dose wise mean performance revealed treatment 250 Gy was more efficient and effective in AKM-8802 and AKM-4. And the treatment 350 Gy was found more efficient and effective in PKV Green gold, for various yield and yield contributing traits.

Keywords: Gamma rays, AKM-8802, PKV Green gold and AKM-4

Introduction
India is the largest producer of mungbean in the world. It accounts for almost 65 per cent area and 54 per cent production of the world. The area under green gram in India during year 2010-11 was 3.55 mha with production of 1.80 mt having productivity 507 kg/ha. While the area under green gram in Maharashtra during year 2010-11 was 5.54 lakh ha. with production 3.72 lakh ton, having productivity 672 kg/ha. In vidharbha region, it is 2.13 lakh ha area with production 1.34 lakh ton having productivity 629 kg/ha. The traditional breeding methods for self-pollinated crops largely depend on natural variability already present in the crop. Green gram being self-pollinated, the naturally existing genetic variability may not be sufficient to achieve desired improvement. Each kind of breeding method involves creation and utilization of genetic variability by means of hybridization, recombination and selection [1]. Due to very small size of flower in mungbean, emasculation and pollination is very difficult and costly. Alternatively, mutation breeding is the best method to create the new genetic variability of a species considerably within a short time. Gamma rays are the ionizing physical mutagens capable of inducing mutations in plants and animals. They have shorter wave length and therefore possess more energy per photon than X- rays. These rays penetrate up to many cm which are generally produced in a wide range of energies like X-rays. Number of workers were attracted towards induced mutation studies in different crops. The variation of induced mutations is not merely due to the recombination as in hybridization but they are original and newly created. Induced mutation is used in different ways in plant breeding [2]. The breeding objectives in green gram are to develop varieties with high yield, early maturity, high protein and resistant to diseases and insects-pests. To achieve these objectives and bring about desired improvement in crop the most sophisticated technique of mutation breeding can be exploited by the plant breeders. The present study was undertaken using three genotypes of green gram *viz.* AKM-8802, PKV Green gold and AKM-4 and one physical mutagen i.e. gamma rays with three doses of 150 Gy, 250Gy and 350 Gy. The present investigation was carried out to Confirmation of identified mutants for various yield and yield contributing characters in M3 generation and to assess the variability generated for various yield and yield contributing characters in M3 generation.

Materials and Methods

The present investigation was conducted at the field of Pulses Research Unit, Dr. PDKV, Akola during *kharif* 2011. The details of materials used and statistical procedures followed for the present study are given below.

Plant Materials

For the present study three released varieties of mungbean *viz.*, AKM-8802, PKV Green gold and AKM-4 were used. These varieties were collected from Pulses Research Unit Dr. PDKV Akola.

Irradiation

Eighty grams seeds of each variety were irradiated with 150, 250 and 350 Gy Gamma rays at the BARC (Bhabha Atomic Research Centre) Trombay, Mumbai on 27th Feb, 2010. Details of treatments are given in table 1. The treated seeds along with one control for each genotype were sown to raise M1 generation in replicated trial, at the research field of Department of Botany, Dr. PDKV, Akola. The M1 generation was observed for different parameters besides population screened for chlorophyll mutants. Seeds from each plant of M1 generation was harvested separately. The M2 generation was raised in *kharif* 2010 (sown on 2nd July 2010). Plant to row progenies were raised from all the harvested seeds from each treatment. The treated populations were carefully screened for chlorophyll mutations whereas viable chlorophyll mutations were scored throughout the life period of the plants. In *kharif* 2011, on 10th July, all the harvested seeds from each treatment from M2 generation were sown to raise M3 generation in replicated trial using Randomized Block Design. The sowing was undertaken on the well leveled piece of land at the field of Pulses Research Unit, Dr. PDKV, Akola. Experiment was planned in Randomized Block Design (RBD) using three replications, 9 treatments and 3 controls. Gross and net plot size was kept 3.00m x 1.80m and 3.00m x 0.90m respectively. Spacing for planting was kept at 45cm x 10cm. The recommended cultural practices were followed throughout the crop growth period. The M3 generation was observed for different parameters. Observations were recorded for different characters on randomly selected 5 plants for each treatment.

Table 1: Details of Treatments

Treatment code	Variety	Description of Treatment
T1	AKM-8802	Control (0Gy)
T2	AKM-8802	Irradiation with 150Gy
T3	AKM-8802	Irradiation with 250Gy
T4	AKM-8802	Irradiation with 350Gy
T5	PKV Green gold	Control (0Gy)
T6	PKV Green gold	Irradiation with 150Gy
T7	PKV Green gold	Irradiation with 250Gy
T8	PKV Green gold	Irradiation with 350Gy
T9	AKM-4	Control (0Gy)
T10	AKM-4	Irradiation with 150Gy
T11	AKM-4	Irradiation with 250Gy
T12	AKM-4	Irradiation with 350Gy

Measurement of yield and yield contributing characters

Observations were recorded for different characters on randomly selected 5 plants for each treatment and confirmation was carried out. Total number of mutants were recorded and classified as below. High yielding, Bold seeded, Leaf mutants, Branching, Dwarf mutants, Lodging resistance. Confirmation of these mutants was carried out for all the yield and yield contributing characters. The emergence of cotylledonary leaves above the ground surface was taken as indication of germination. The observations were recorded after 10 days of sowing. The germination percentage was worked out for all treatments including control as per the formula: Germination (%) = Total no of seeds germinated/total no of seeds sown X 100. Days to 50 percent flowering were measured by number of days required for the commencement of flowering to fifty percent plants in each plot was recorded. Height of plant at maturity was recorded in centimeters from the base of plant to point of initiation of terminal inflorescence of randomly selected five plants. Number of branches located on main axis and primary branches were recorded on five randomly selected plants from each plot. Total number of pods on individual plants were counted and recorded. Length of pod in centimeters from base of the pod to its tip was recorded by taking five pods of each plant. Number of seeds per pod of five randomly selected pods from each observational plant was recorded by counting number of seeds in the pod and average was worked out. The pods from each randomly selected plant were threshed separately and weight of grain per plant was recorded in grams. 100 grain weight (g), Number of days to maturity, Final plant count and Sprouting percentage were recorded using standard methodology.

Result and Discussion Components of variation

The phenotypic (Vp), genotypic (Vg) and environmental (Ve) variance components for all the characters have been given in Table 2

Table 2: Genotypic (Vg), phenotypic (Vp) and environmental (Ve) variance components for various characters in M3 generation

S. No	Characters	Vg	Vp	Ve
1	Germination percentage	16.55	30.58	14.02
2	Days to 50% flowering	7.32	13.81	6.49
3	Plant height (cm)	32.02	42.24	10.21
4	Number of branches per plant	0.31	0.65	0.34
5	Pod length (cm)	1.17	1.449	0.26
6	Number of pods per plant	48.22	53.06	4.83
7	Number of seeds per pod	5.52	5.91	0.38
8	Grain yield per plant (g)	0.7	1.52	0.82
9	100 grain weight (g)	0.33	0.42	0.08
10	Number of days to maturity	12.45	24.1	11.65
11	Sprouting percentage	193.04	199.87	6.83

It is revealed from Table 2 that the phenotypic variance components were greater than genotypic variance components for all the characters. The estimates of phenotypic variance was found to be highest for sprouting percentage (199.87).The estimates of genotypic variance was found to be highest for sprouting percentage (193.04).The character 100 grain weight has lowest phenotypic variance(0.42) and the character number of branches per plant has lowest genotypic variance(0.31). The environmental variance was highest for germination percentage (14.02) and lowest for 100 grain weight (0.08).

Components of genetic variability

The parameters of genetic variability were further elaborated with the help of statistics like range, mean, coefficient of variability, heritability and genetic advance.

Coefficients of variation: It is apparent from Table 3 that phenotypic coefficients of variation (PCV) were higher than the genotypic coefficients of variation (GCV) for all the characters. The character sprouting percentage showed the highest PCV of 32.52 followed by number of pods per plant (27.31), number of seeds per pod (22.69), 100 grain weight (20.80) and number of branches per plant (17.37). These characters had considerably high coefficient of phenotypic variability (Table 3). Phenotypic coefficient of variability for pod length, grain yield per plant, plant height, Days to 50% flowering and germination percentage were 16.43, 15.40, 10.71, 10.11 and 8.64 respectively. The lowest PCV was found to be 7.41 for number of days to maturity. The sprouting percentage had the highest GCV of 31.96 followed by number of pods per plant (26.04), Number of seeds per pod (21.93), 100 grain weight (18.51) and pod length (14.42). The moderate GCV of 12.01, 10.46, 9.33, 7.36 and 6.36 were exhibited for number of branches per plant, grain yield per plant, plant height, days to 50% flowering and germination % respectively. The estimates of GCV were found to be lowest for number of days to maturity (5.33).

Table 3: Estimates of genetic parameters for various yield and yield contributing characters in M3 generation

Sr. No	Characters	Mean	Range	GCV	PCV	Heritability (%)	Genetic advance
1	Germination percentage	63.95	57.63-72.10	6.36	8.64	54.14	6.16
2	Days to 50% flowering	36.76	29.66-40.33	7.36	10.11	53.01	4.05
3	Plant height (cm)	60.64	48.73-70.26	9.33	10.71	75.82	10.15
4	Number of branches per plant	4.655	3.73-6.26	12.01	17.37	47.84	0.79
5	Pod length (cm)	7.326	5.74-10.06	14.82	16.43	81.41	2.01
6	Number of pods per plant	26.668	19.20-40.85	26.04	27.31	90.88	13.63
7	Number of seeds per pod	10.71	6.07-14.38	21.93	22.69	93.44	4.68
8	Grain yield per plant (g)	8.012	6.60-9.71	10.46	15.4	46.11	1.17
9	100 grain weight (g)	3.122	2.43-4.14	18.51	20.8	79.14	1.05
10	Number of days to maturity	66.21	60.60-74.40	5.33	7.41	51.66	5.22
11	Sprouting percentage	43.47	21.66-60.66	31.96	32.52	96.58	28.12

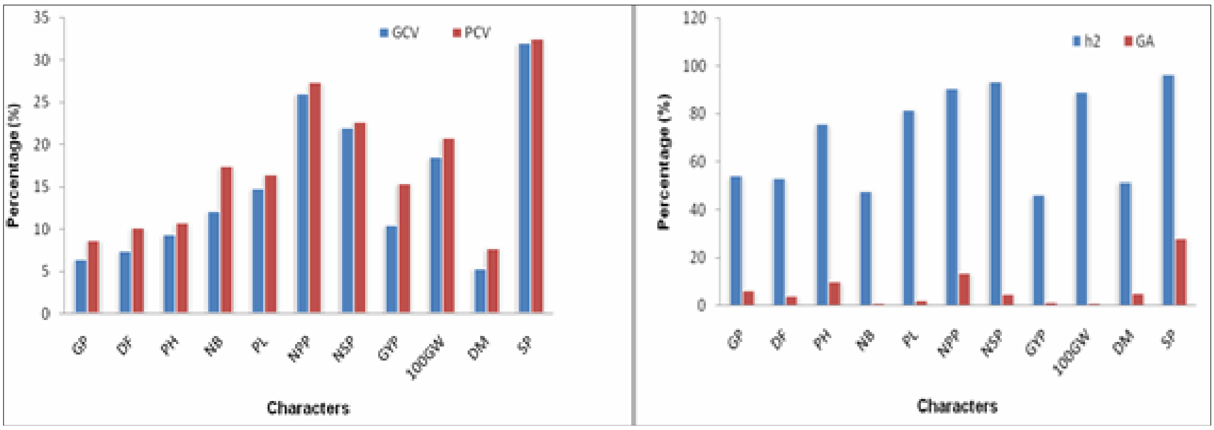

Fig 1: a. GCV and PCV estimates for various characters in M3 generation and 1b. Heritability and genetic advance estimates for various characters in M3 generation. (Where, GPL: Germination percentage, DF: Days to 50% flowering, PH: Plant height (cm), NB: Number of branches per plant, PL: Pod length (cm), NPP: Number of pods per plant, NSP: Number of seeds per pod, GYP: Grain yield per plant (g), 100 GW: 100 grain weight (g), DM: Days to maturity and SP: Sprouting percentage).

Heritability

The heritability estimates presented in Table 3 indicated that different traits showed very wide range of heritability from 46.11 percent for grain yield per plant to 96.58 percent for sprouting percentage. The high estimates of heritability were obtained for sprouting percentage (96.58), number of seeds per pod (93.44%), number of pods per plant (90.88%), pod length (81.41%), 100 grain weight (79.14%) and plant height (75.82%). The low to moderate heritability was observed for germination percentage (54.14%), days to 50% flowering (53.01%) and number of days to maturity (51.66%). The grain yield per plant and number of branches per plant showed low heritability estimates of 46.11% and 47.84% respectively.

Genetic advance

The highest magnitude of genetic advance was observed for sprouting percentage (28.12) followed by number of pods per plant (13.63) and plant height (10.15). Number of days to maturity (5.22), germination percentage (6.16), days to 50% flowering (4.05), number of seeds per pod (4.68) and pod length (2.01) showed moderate genetic advance. The lowest magnitude of genetic advance was reported for number of branches per plant (0.79), 100 grain weight (1.05) and grain yield per plant (1.17). The characters sprouting percentage, number of pods per plant and plant height showed high heritability accompanied with high genetic advance (Table 3).

Discussion

Mungbean is one of the most important pulse crops grown in India. Significant genetic improvement in this crop could not be made in the recent past, which could be attributed to relatively low genetic variability for yield potential in available genotypes. Since induced mutations may result in creating useful variability for yield attributes in the mungbean. The mutation research occupies a prominent place in modern and applied genetics. The induced mutagenesis is the complementary breeding method to the conventional breeding methods. In M3 generation, plant to row progenies were grown from 220 selected M2 plants for their confirmation. Out of these 220 lines, only 28 lines showed true to type breeding behaviour in M3 generation and remaining lines showed segregation for the selected characters. Significant treatment sum of squares for all characters studied revealed the presence of considerable amount of variability in the genotypes. The phenotypic coefficients of variation (PCV) were higher than the genotypic coefficients of variation (GCV) for all the characters. The parameters of genetic variability revealed high PCV values for sprouting percentage, number of pods per plant, number of seeds per pod, 100 grain weight and number of branches per plant. The highest GCV values was observed for sprouting percentage, number of pods per plant, number of seeds per pod, 100 grain weight and pod length. The lowest GCV and PCV values were recorded for number of days to maturity and days to 50% flowering suggesting the narrow range of variation for these traits. The magnitudinal differences between GCV and PCV estimates were minimum for sprouting percentage, number of seeds per pod, number of pods per plant and plant height suggesting relatively less influence of environment on the expression of these characters. Previously similar kind of studies shows that, treated dry seeds of mungbean variety BM-4 with 10, 15 and 25 kR doses of gamma rays. In M2 and M3 the range, variability and variances increased compared to control [3]. Similarly estimates of heritability and genetic advance were greater in treated population. Almost all characters showed positive shift in mean except plant height which had shown negative shift in one or other treated population. Gajraj Singh *et al*. (2001) observed that PS 16 variety of green gram after gamma irradiation and EMS and epichlorhydrin treatment produced increased number of pods per plant, seeds per pod, 100-seed weight and yield. Estimates of genetic parameters showed higher values of phenotypic and genotypic coefficient of variation for number of pods per plant, number of seeds per pod and yield with highest variation recorded for yield [4]. Mittal *et al*. (2001) irradiated the Seeds of green gram (cultivars ML-9 and K-851) with gamma rays (20 kR) for the induction of genetic variability in M2 and M3 generations [5]. Irradiated ML-9 showed an increase in the genotypic coefficient of variation, heritability and genetic advance for pod length, number of seeds per pod and 100-seed weight; while irradiated K-851 showed an increase in all parameters, except 100-seed weight. The genotypic and phenotypic coefficients of variation, heritability and genetic advance for plant height and number of pods per plant decreased in ML-9. High magnitudes of heritability were recorded for sprouting percentage, number of seeds per pod, number of pods per plant, pod length, 100 grain weight and plant height. The lowest heritability was found for grain yield per plant and number of branches per plant. High heritability coupled with high genetic advance was observed for sprouting percentage, number of pods per plant and plant height suggesting the role of additive gene effect and possibilities of achieving high genetic progress through selection. Pod length, number of seeds per pod and 100 grain weight recorded high heritability accompanied by low genetic advance suggesting the presence of non- additive gene action for these characters. Apart from variability studies variety and dose wise mean performance of the 3 genotypes was analyzed for various yield and yield contributing characters. From the study it was revealed that in AKM-8802, 250 Gy dose of gamma irradiation was found to be most effective as it produced maximum increase in number of pods per plant, number of seeds per pod, pod length, number of branches per plant and grain yield per plant. While in PKV Green gold, 350 Gy dose and in AKM-4 250 Gy dose of gamma irradiation was found to be most effective, as it produced maximum number of pods per plant, number of seeds per pod, pod length and grain yield per plant. In AKM-8802, 150 Gy dose produced early flowering and early maturity. The doses 150 Gy and 350 Gy showed less sprouting percentage in PKV Green gold as compared to control.

Conclusion

Out of these 220 mutant lines, 28 mutant lines were confirmed for the characters early maturity, tallness, dwarfness, high branching, bold seeds, high yielding etc. These mutants can be used to improve these characters in the further breeding programme. The sprouting percentage showed the highest GCV followed by number of pods per plant, number of seeds per pod, 100 grain weight and pod length. The genetic variability exhibited by these characters can be exploited in the selection programme. The characters sprouting percentage and number of pods per plant are predominantly governed by additive gene effects and therefore selection based on phenotypic performance will be useful to improve these characters in future.

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