J. Soils and Crops 29 (2) 386-390, December 2019

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)
NAAS Rating - 4.46
Scientific Journal Impact Factor - 7.375

GAMMA RAYS INDUCED GENETIC VARIABILITY IN M_2 GENERATION OF SOYBEAN (*Glycine max* (L.) Merrill)

S. R. Kamdi[1], G. A. Kankal[2], M. P. Meshram[3], R. D. Deotale[4], S. K. Gupta[5], S. S. Bhure[6] and J. M. Parbat[7]

ABSTRACT

Soybean cultivar TAMS-38 was treated with three different doses viz., 200, 250 and 300 Gy of gamma rays with the objective to study the variability in M_2 for the qualitative and quantitative characters. The experiment was conducted in the experimental farm of Botany section, College of Agriculture, Nagpur during *kharif* and *rabi* 2018-19. An observations were recorded on yield and yield contributing characters. In M_2 generation, days to flowering and days to maturity increased significantly in all the treatments. Plant height and number of branches plant^{-1} reduced significantly in all the treatments. Number of pods plant^{-1} and seed yield plant^{-1} significantly increased in all the treatments and 100 seed weight significantly decreased in all the treatments as compared to control. Visible macromutants like Albino mutant, early flowering, late flowering, early maturing, late maturing, dwarf, tall, increased 100 seed weight, sterile, high yielding, more pods, more branched mutants were identified and isolated in M_2 generation. The economical and morphological mutants were isolated from the variety of TAMS-38. High yielding mutant with 10.50 g to 12.10 g yield as against 4.15 g in control were identified from this variety. Early maturing mutant matured 7 to 14 days earlier than control were isolated from this variety. These mutants need to be evaluated for their breeding behavior in further generation and their utilization in improvement of soybean.

(Key words: Soybean, Gamma rays, Mutation, Quantitative traits)

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is referred as “Golden bean’’ and “Miracle crop” of 21th century. It is one of the important oilseed as well as legume crop. It contributes more than 50% to the global production of edible oil. Soybean contains 20% oil and 40% protein. Gamma rays a ionizing physical mutagen capable of inducing mutation in plants. The cultivar TAMS-38 is taken for study because, this cultivar is recommended as a high yielder and better adoptable in the area of Vidarbha but this cultivar highly susceptible to YMV and root rot. Induction of mutation in this cultivar and creation of variability would be a better source for selection of desirable mutants for disease resistance and yield and yield contributing characters.

The present research work was therefore, undertaken using seeds of soybean cultivar TAMS-38 subjected to treatment of different doses of gamma rays and hence, to create variable population and select morphologically distinct mutants from the population.

MATERIALS AND METHODS

A dry, healthy and true breeding seeds of soybean cultivar TAMS-38 were used in this study. The seeds of TAMS-38 were irradiated by gamma rays at Bhabha Atomic Research Centre Trombay, Mumbai. Equal quantity of seeds (i.e 500 g of each lot) was irradiated by different doses of gamma rays i.e. 200 Gy, 250 Gy and 300 Gy (Co^{60} at BARC Trombay Mumbai).

M_1 generation was raised in *kharif* 2018-19. The treated seeds along with the control were sown immediately after treatment to raise the M_1 generation at Shankar Nagar farm, Botany section, College of Agriculture, Nagpur. The M_1 population was studied by recording observations at different growth stages. Seeds of each treatment in M_1 generation harvested separately and stored to raise M_2 generation.

Treatment wise seeds of M_2 generation were raised in *rabi* 2018-19. Observations were recorded at different growth stages and statistical analysis was done for mean,

1&3. Asstt. Professors, Agricultural Botany Section, College of Agriculture, Nagpur
2. JRF, DAE-BRNS, BARC Funded Soybean Project, College of Agriculture, Nagpur
4. Professor, Agricultural Botany Section, College of Agriculture, Nagpur
5. Scientific Officer 'F' Nuclear Agriculture and Biotechnology Division, BARC, Trombay, Mumbai-400085
6. Tech. Assistant, AICRP Linseed and Mustard, College of Agriculture, Nagpur
7. Jr. Plant Pathologist, AICRP Linseed and Mustard, College of Agriculture, Nagpur

Standard deviation (S.D.) and Coefficient of Variation (C.V.) by following standard formulas suggested by Singh and Choudhary (1985).

RESULTS AND DISCUSSION

The data for effect of gamma rays on different quantitative traits of soybean are presented in table 1. Maximum mean value for days to flowering was observed in 300 Gy treatment and was statistically significant, while the minimum days to flowering was recorded in 200 Gy treatment as compared to their respective controls. The coefficient of variation increased in all the treatments for days to flowering as compared to control. The range of variation in treated population was 8.07% to 8.76%. It is observed that decrease in days to flowering resulted from gamma rays treatment as compared to control. Mean value for days to maturity was observed to increase in all the treatments as compared to control. The coefficient of variation increased in all the treatments as compared to control. The range of coefficient of variation was 3.97% to 6.76%. Gopinath and Pavadai (2015) also observed that in M_2 and M_3 generations mean for days to maturity increased at mutagenic treatment than control in soybean.

Plant height (cm) reduced significantly in all the treatments as compared to control. The coefficient of variation for the plant height increased in all the treatments as compared to the control. The maximum variation was noticed in 250 Gy treatment (19.90%) and minimum in 300 Gy treatment (12.74%) as compared to control treatment (2.72%) respectively. The range for the coefficient of variation was 12.74% to 19.90%. Lande *et al*. (2018) reported that the plant height reduced in all the treatment as compared to control. EI-Demerdash (2007) studied the effect of gamma irradiation doses of 100, 150 and 200 Gy on soybean plants and found decrease in plant height by gamma irradiation.

Number of branches decreased in all the treatments as compared to their control treatment. The variability studies showed that the coefficient of variation increased against their control in all the treatments. The variation for the characters ranged from 38.90% to 52.18% as compared to control treatment (26.35%). It is revealed that gamma rays treatment resulted in decrease in number of branches plant^{-1} as compared to control. EI-Demerdash (2007) reported that the number of branches plant^{-1} were decreased by gamma irradiation.

Data on number of pods plant^{-1} revealed that the mean value ranged from 200 Gy treatment (21.76) to 250 Gy treatment (24.22). The coefficient of variation for the characters increased in all the treatments as compared to the control. The variation for the character ranged from 43.08% to 59.22%. It is revealed that the mean number of pods plant^{-1} increased in gamma rays treatment as compared to control. Soliman and Hamid (2003) reported that the number of pods plant^{-1} was significantly increased by over the corresponding control by irradiation. Lande *et al*. (2018) also reported that the mean number of pods plant^{-1} increased in gamma rays treatment as compared to control.

Data regarding 100 seed weight revealed that the 100 seed weight decreased in all treatments as compared to control. The variations for the characters were found to be increased in all the treatments. It was found in this study that mean of 100 seed weight reduced in gamma rays treatment. Waghmare and Mehara (2000) also observed the significant reduction of 100 grain weight in grass pea irradiated with gamma rays.

Data regarding seed yield plant^{-1} revealed that the coefficient of variation increased in all the treatments. The variation for this parameter ranged between 34.50% to 44.50%. It is revealed that mean value of seed yield plant^{-1} increased in gamma rays treatment as compared to control. Gopinath and Pavadai (2015) also reported that the yield parameters like number of seeds plant^{-1}, grain yield plant^{-1}, recorded the moderate and high mean value in the 50 kR of gamma rays, 0.5% of EMS and 0.4% of DES treated population when compared to control plants in soybean.

From different treatments of gamma rays on soybean the economical and morphological mutants were isolated from the variety of TAMS-38 (Table 2). Visible macromutants like early flowering, late flowering, early maturing, late maturing, dwarf, tall, increased 100 seed weight, sterile, high yielding, more pods, more branched mutants and YMV tolerance were identified and isolated in M_2 generation. Maximum 38 mutants were identified in 200 Gy treatment out of which only 14 were economical mutant. It was followed by 250 Gy treatment in which 24 number of mutants were observed of which 10 were economical. High yielding mutants yielded 10.50 to 12.10 g as against 4.15 g in control. Similarly early maturing mutant matured in 7 to 14 days earlier than control.

It is inferred form the study that the gamma rays had the potential to induce variability in yield contributing characters of soybean. It was observed that gamma rays had significant effect on days to flowering, days to maturity, plant height (cm), number of branches plant^{-1}, number of pods plant^{-1}, 100 seed weight (g) and seed yield plant^{-1} (cm). The economical mutants identified needs to be observed for their breeding behavior in further generations and their utilization in improvement of soybean.

Table 1. Effect of gamma rays on different quantitative traits in M_2 generation of soybean (*Glycine max* (L.) Merrill)

Characters	Parameters	Irradiation dose (Gray)			
		200 Gy	**250 Gy**	**300 Gy**	**Control**
Days to flowering	Mean	38.70	39.10	39.45	43.58
	SD	3.12	3.39	3.23	1.50
	CV (%)	8.07	8.76	8.19	3.45
Days to maturity	Mean	99.95	99.90	98.68	98.57
	SD	3.91	6.75	6.30	1.66
	CV (%)	3.97	6.76	6.38	1.66
Plant height (cm)	Mean	36.62	37.50	36.43	55.90
	SD	5.64	7.25	4.77	1.52
	CV (%)	16.22	19.90	12.74	2.72
No. of branches $plant^{-1}$	Mean	2.35	3.22	2.36	4.80
	SD	1.22	1.16	1.04	1.31
	CV (%)	52.29	36.24	44.36	27.42
No. of pods $plant^{-1}$	Mean	21.76	24.22	23.82	21.10
	SD	12.86	14.41	10.26	2.60
	CV (%)	59.11	59.22	43.08	12.32
100 seed weight (g)	Mean	11.56	11.02	10.36	11.76
	SD	0.56	0.82	0.85	0.84
	CV (%)	5.43	7.15	7.71	4.90

Table 2. Selection of mutants in M_2 generation from different treatments of gamma rays in soybean

Treatments	Plant No. M2	Characters	Days to flowering	Days to maturity	Plant height (cm)	No. of branches plant^{-1}	No. of pods plant^{-1}	100 seed weight (g)	Grain yield weight (g)
T_1 (200Gy)	1	Tall, More number of pods	35	93	72	5	66	12.00	9.80
	2	100 SW	35	93	45	4	24	13.00	5.60
	4	More branches, late flowering, high yielding	46	93	40	5	46	11.61	8.20
	5	Early maturity	38	85	37	3	28	11.87	5.30
	6	Dwarf plant	35	98	32	2	32	10.35	5.50
	8	More number of pods, high yielding	40	97	43	4	54	11.65	7.40
	9	Early flowering	35	111	32	3	33	12.50	5.50
	11	More number of pods	41	97	37	4	44	12.80	6.10
	12	More branches	46	97	37	5	39	10.25	4.10
	14	Dwarf plant	43	98	22	1	17	12.65	3.50
	16	Dwarf plant	35	111	21	1	14	12.09	3.60
	21	Dwarf plant	43	93	19	1	13	12.65	3.70
	24	Early maturity	35	93	40	2	16	12.09	3.60
	36	Late flowering, 100 SW	44	111	35	1	16	13.00	5.30
	38	Sterile plant	-	-	42	2	-	-	-
T_2 (250 Gy)	1	Dwarf plant, high yielding	35	93	10	3	23	12.00	7.00
	2	More number of pods and branches, high yielding	38	93	38	6	81	10.65	12.10
	3	100 SW	41	95	37	4	24	13.00	6.40
	4	Dwarf plant	39	95	21	4	19	11.38	5.80
	5	High yielding, More number of pods & branches	38	99	32	5	51	11.96	10.50
	6	100 SW	35	97	37	3	28	13	6.70
	7	Late flowering	44	97	36	4	31	9.50	5.00
	9	More number of branches, late maturity	43	111	37	5	20	12.38	4.60
	20	YMV tolerance	38	102	41	2	21	11.38	4.50
	24	Sterile plant	-	-	46	1	-	-	-
T_3 (300Gy)	1	Early maturity	35	93	32	3	31	10.38	7.40
	2	High yielding plant, Early maturity	38	93	39	4	45	10.65	7.90
	3	High yielding plant, More number of pods	44	93	39	4	58	11.05	8.50
	6	Late flowering	44	111	43	2	34	9.52	5.40
	13	YMV tolerance	38	95	37	3	20	11.20	4.80
	14	Dwarf plant	38	97	21	2	16	10.02	3.10
	17	Early maturity	42	93	39	1	12	10.00	2.70
	19	YMV tolerance	37	97	39	3	23	11.00	4.80
	20	Early flowering	35	97	41	2	37	9.52	6.20
	21	Early maturity	35	93	38	1	19	10.98	4.80

REFERENCES

El-Demerdash, H. M. 2007. Genetic studies on two soybean cultivars irradiated with gamma rays. Isotope and Rad. Res. **39**(3):719-730.

Gopinath, P. and P. Pavadai, 2015. Morphology and yield parameters and biochemical analysis of soybean (*Glycine max* (L.) mrr.) using gamma rays, EMS and DES treatment. Int. Lett. Nat. Sci. **8**: 50-58.

Lande, N. H., S. K. Dhapke, S. R. Patil, R. A. Sayyad, K. N. Uikey, V. S. Jayade and G. A. Kankal, 2018. Genetic variability induced by gamma rays in M_2 generation of soybean (*Glycine max* (L.) Merrill.). J. Soils and Crops, **28** (1): 177-184.

Singh, R. K. and B. D. Choudhary, 1985. Biometrical methods in quantitative genetic analysis. Kalyani publisher, New Delhi, India. pp. 318.

Soliman, M. S. A. and M. A. El-Hamid, 2003. Certain physiological, biological and molecular aspects of kidney bean plants originating from gamma-irradiated seeds during seed germination and plant development. Egypt. J. Rad. Sci. Applic. **16**(1):189-211.

Waghmare, V. and R. B. Mehra, 2000. Induced genetic variability for quantitative characters in grass pea (*Lathyrus sativus* L.). Indian J. Genet. **60**(3):232-236.

Rec. on 01.08.2019 & Acc. on 10.08.2019