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EFFECT OF GAMMA IRRADIATION ON F_1M_1 SEEDS IN BLACK GRAM [*VIGNA MUNGO* (L.) HEPPER]

S. Anandhi Lavanya[1]*, C. Vanniarajan[1], J. Souframanien[2] and S. Ganeshram[3]

[1]Departmentof Plant Breeding and Genetics, Agricultural College and Research Institute, Madurai, Tamil Nadu Agricultural University, Madurai - 625 104 (Tamil Nadu), India.

[2]Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Trombay,Mumbai (M.S.), India.

[3]Department of Plant Genetic Resources, C.P.B.G., Tamil Nadu, Agricultural University, Coimbatore - 641 003 (Tamil Nadu), India.

Abstract

Impact of hybridization and irradiation in isolation of superior segregants in six crosses of black gram varieties were studied in the F_1M_1 progenies. The F_1 seeds were exposed to 200 Gy of gamma rays to study for isolation of superior segregants their effect on various characters like plant height at 30th day, survival percent at 30th day, plant height at maturity, number of clusters per plant, number of pods per plant, hundered seed weight, single plant yield. In F_1M_1 generation the results revealed that there was reduction in at 200 Gy doses of gamma rays compared to female and male parent for all characters. The present study indicated that 200 Gy gamma rays can be effectively utilized to increase the variability for various quantitative traits of black gram.

Key words : Black gram, irradiation, F_1M_1 population, quantitative character.

Introduction

Black gram [*Vigna mungo* (L.) Hepper] is a tropical crop belonging to the Asiatic *Vigna* species. Among the pulses, it stands fourth in production and acreage in India. It belongs to the family leguminosae. The chromosome number of this crop is 2n = 2x = 22 (Bhatnagar *et al*., 1974). It is a highly self pollinated crop with cleistogamous nature. Creation of variability through pollination and artificial hybridization is very difficult as the flowers are cleistogamous. Even, if hybridization is carried out the seed set is less than 5 per cent. Also, this crop lacks proper male sterility system commercially to be utilized for hybridization.

Mutation induction has become an established tool in plant breeding to supplement existing germplasm and improve cultivars in certain specific traits (Kurobane *et al*., 1979). Induced mutations represent the same kind of changes that occur from natural causes (Govindan, 2000). Mutagenesis has been widely used as a potent method of enhancing variability for crop improvement (Singh and Singh, 2001). Mutation breeding, involving refined selection and detection method is of great use in crop improvement (Stegemann and Shah, 1990).

Gamma rays are the most energetic form of electromagnetic radiation; their energy level is from ten to several hundred kilo electron volts and they are considered as the most penetrating compared to other radiations (Kovacs and Keresztes, 2002). It has been reported to best on crops both beneficial and deleterious effect. One of such deleterious effect is cytogenetic aberrations and delayed metabolic processes in crops. But gamma rays had been used to improve yield in some crops such as rice, millet, sorghum (Mudibu *et al.*, 2011).

Mohan and Sharma (1995) experimentally demonstrated in pea that additional variation could be generated in the F_2 by irradiation at F_1 seeds. This is also evident from the fact that many mutant varieties have resulted by using induced mutations in crossing programme in comparison to those which resulted through direct release of mutants (Kharkwal *et al*., 2001). Kajjidoni *et al*. (2008) have developed new improved variety in black gram by utilizing both gamma rays induced and hybridization. For this, mutagenic treatments can be

Author for correspondence : E-mail: anandhi.saro19@gmail.com

applied to the F_1 seeds. The most useful application of mutagenic treatment in the segregating generation may be to a cross in which the parents are widely divergent. The present investigation was, therefore, undertaken to make a comparative assessment of the effects of gamma irradiation (200Gy) of F_1 seeds on induced variability for some quantitative traits.

Materials and Methods

Two indeterminate black gram varieties ADT-3 (suitable for rice fallow) and MDU-1 (high arabinose content and resistant to yellow mosaic disease) was crossed with black gram varieties TU-40, TAU-1 and TU94-2.

The experimental material comprised irradiated and unirradiated F_1 seeds of six crosses, *viz*., ADT 3 × TU 40 (Cross 1) , ADT 3 × TU 94 – 2 (Cross 2) , ADT 3 × TAU - 1(Cross 3) , MDU 1 × TU 40 (Cross 4) , MDU 1 × TU 94 – 2 (Cross 5), MDU 1 × TAU - 1 (Cross 6).

These seeds of ADT 3 were collected from the Department of Plant Breeding and Genetics, Tamil Nadu Rice Research Institute, Aduthurai and MDU 1 were collected from the Department of Plant Breeding and Genetics, Agricultural College and Research Institute (AC & RI), TNAU, Madurai. TU 40, TU 94- 2, TAU 1 were collected from the Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai, India. The trials were laid out in randomized block design with tow replications at Agricultural College and Research Institute (ACRI), TNAU, Madurai *Kharif* 2016.

F_1M_1 generations

Samples consisting of 100 F_1 seeds of six the crosses were irradiated with 200 Gy gamma-rays (F_1M_1). Seeds were exposed to gamma irradiation of 2000 curie ^{60}Co gamma source for appropriate time at 25^{0}C by moving down the cylindrical gasket carrying the seeds at the Bhabha Atomic Research Centre, Navi, Mumbai, India.

After mutagenic treatment, seeds were sown immediately in the field in a randomized block design along with control (The untreated seeds). The spacing adopted was 30 cm between rows and 10 cm between plants. The following characters were measured at 20 single plants. All F_1M_1 plants were harvested individually and forwarded to F_2 M_2 generation.

Plant height on 30th day

Plant height on 30th day and at maturity was measured from ground level to tip of the plants on 30th day and maturity.

Survival

Plant survival was recorded by counting the number of plants which survived.

Plant height at maturity (cm)

The plant height was measured from ground level to the tip of the plant on maturity stage.

Number of clusters per plant

The pod bearing clusters in each plant were counted and recorded.

Number of pods per plant

The total number of pods per plant was counted at harvest.

Hundred seed weight

The weight of 100 seed was recorded and expressed in grams.

Single plant yield

The total seed yield of the randomly selected plants was weighed and recorded in grams.

Results and Discussion

In the present investigation, various morphological characters such as plant height at maturity, number of cluster per plant, number of pods per plant, hundred seed weight and single plant yield in differentcrosses were studied under field conditions.

Effect of mutagens on quantitative traits in F_1 M_1 generation

Plant height at 30th day

The maximum plant height (19.72 cm) at 30th day was observed in cross 4 (F_1M_1 (MDU 1 × TU 40) and followed by cross 1 (18.76 cm) (F_1M_1 (ADT 3 × TU 40). All the six crosses treated with 200 Gy dose of gamma rays showed decreased mean height over female and male parent. The height reduction may be either due to physiological damage or chromosomal aberrations caused by irradiation. On contrary induction in plant height after irradiation of the F_1 seeds in black gram was reported in rice and wheat (Saini and Sharma, 1970; Virk *et al*., 1978).

Survival on 30th day

The maximum survival of 67.9% and 66.5% was observed in the cross 6 F_1M_1 (MDU 1 × TAU-1) and cross 3 (ADT 3 × TAU-1), respectively. The minimum survival was recorded in the cross 2 (ADT 3 × TU 94 – 2) 54.2% and followed by cross 5 (MDU 1 × TU 94 – 2) 56.2%. Survival rate was less in all the six crosses compared to female and male parent on 30th day. The differential sensitivity of genotypes may be attributed to

Table 1 : Mean values for different characters in the F_1M_1 population of six black gram cross.

Cross and generation	Plant height at 30th day (Mean±SE)	Survival percent at 30th day (Mean±SE)	Plant height/ plant (cm) (Mean±SE)	No. of clusters/ plant (Mean±SE)	No. pods/ plant (Mean±SE)	Hundred seed weight (g) (Mean±SE)	Single plant yield(g) (Mean±SE)
ADT 3 Crosses							
ADT 3	20.04±0.37	95.00±0.45	45.34±0.68	24.6±0. 66	45.6±0.48	4.91±0.10	11.01±0.56
TU 40	19.96±0.35	89.04±0.59	42.96±0.70	15.8±0.69	42.8±0.61	4.55±0.18	9.41±0.33
TU 94 2	18.80±0.55	89.10±0.61	40.74±0.71	16.2±0.61	40.6±0.66	4.23±0.18	9.20±0.52
TAU 1	17.80±0.26	89.52±0.49	38.6±0.45	17.4±0.85	38.2±0.57	4.42±0.13	10.04±0.43
F_1M_1 (ADT 3 × TU 40 (Cross 1)	18.76±0.68	63.40±0.64	43.33±0.74	23.7±0.47	43.8±0.65	4.56±0.19	11.12±0.51
F_1M_1(ADT 3 × TU 94 – 2 (Cross 2)	18.02±0.59	54.28±0.57	45.89±0.86	18.5±0.65	38.3±0.56	4.27±0.17	9.59±0.33
F_1M_1(ADT 3 × TAU - 1(Cross 3)	17.43±0.81	66.50±0.49	40.89±0.49	20.4±0.73	37.9±0.60	4.12±0.12	10.04±0.26
MDU 1 Crosses							
MDU 1	22.38±0.71	96.00±0.35	49.18±0.82	27.8±0.61	46.40±0.66	5.12±0.07	12.38±0.33
TU 40	19.96±0.35	89.04±0.59	42.96±0.70	15.8±0.69	42.8±0.61	4.55±0.18	9.41±0.33
TU 94 2	18.80±0.55	89.10±0.61	40.74±0.71	16.2±0.61	40.6±0.66	4.23±0.18	9.20±0.52
TAU 1	17.80±0.26	89.52±0.49	38.6±0.45	17.4±0.85	38.2±0.57	4.42±0.13	10.04±0.43
F_1M_1(MDU 1 × TU 40 (Cross 4)	19.52±0.83	62.50±0.53	45.69±0.71	26.3±0.54	41.1 ±0.80	4.99±0.18	10.33±0.55
F_1M_1 (MDU 1 × TU 94 – 2 (Cross 5)	18.71±0.41	56.25±0.51	42.5±0.79	23.9±0.64	40.5±0.54	4.73±0.14	11.27±0.57
F_1M_1(MDU 1 × TAU - 1 (Cross 6)	17.31±0.38	67.90±0.42	40.28±0.56	22.1±0.60	40.1±0.60	4.42±0.12	9.99±0.41

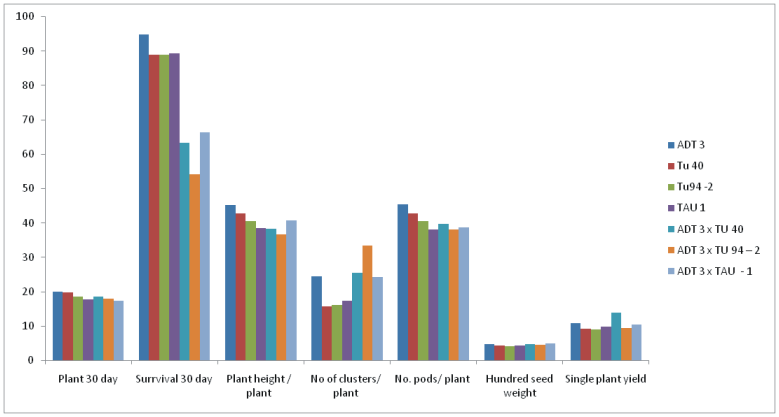

Fig. 1 : Effect of 200Gy doses of gamma rays on mean value of quantitative characters in ADT 3 Crosses and parents.

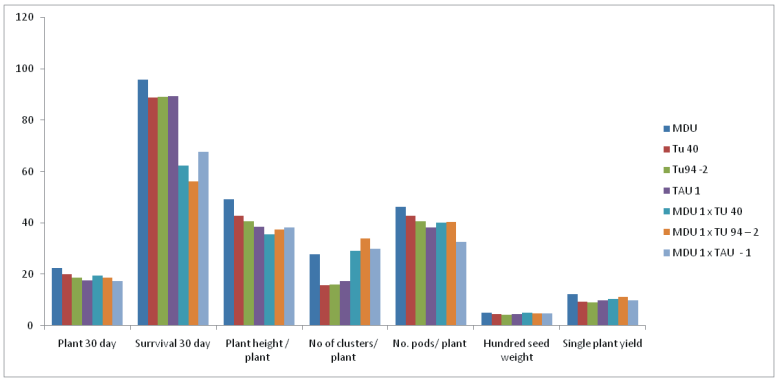

Fig. 2 : Effect of 200Gy doses of gamma rays on mean value of quantitative characters in MDU 1 Crosses and parents.

their metabolic processes affected in differential manner, either by mutagen uptake or degradation and sites of action in the embryo (Ahmed John, 1996).

Qualitative characters

Data on effect of mutagens on quantitative characters in M_1F_1 generation was recorded for plant height, number of clusters per plant, number of pods per plant, 100 seed weight and single plant per yield (table 1).

In the present study, the plant height at maturity showed a decreasing trend in 200 Gy dose of gamma rays in six crosses when compared to female and male parent. Similarly, effect of radiation induced effects in various morphological characters of F_1M_1 were reported in rice (Saini and Sharma, 1975).

In the M_1F_1 generation, all the treated progenies revealed that yield and yield component characters were progressively decreased in all the six crosses when compared to female and male parent. The maximum number of clusters per plant (26.3) recorded in MDU 1 × TU 40 followed by ADT 3 × TU 40 (23.7). Hundred seed weight was maximum (4.99) in MDU 1 × TU 40 followed by ADT 3 × TU 40 (4.56).

Regarding the effect of irradiation on induction of variability in the F_1M_1 generation, it has been observed that MDU 1 × TU 40, ADT 3 × TU 40 recorded high number of clusters per plant, number of pods per plant, hundred seed weight as compared to remaining crosses.

Gregory (1965) also reported that in terms of standard deviation, there was more variation generated in the irradiated hybrids than the unirradiated ones. It has been advocated that the M_1 plants are chimeric in nature and the immediate change in the genetic composition and physiological disturbances comprise the phenotypic expression of M_1 plants. However, the effects of physiological disturbances are eliminated almost completely in the subsequent generations.

Conclusion

In general the results of present investigation indicated the effect of irradiation on various quantitative traits of F_1M_1 generation. Irradiation has been reported to be enhancing recombination between linked traits thereby increasing the contribution of limiting traits and also useful to recover the promising genotypes over normal breeding procedure adopted. Therefore, it would offer better chance for the breeder to isolate number genotypes having desirable combination of characters leading to higher seed yield. The selfed progenies of these six crosses would show useful segregants in the next generation.

References

Bhatnagar, C. P., R. P. Chndola, D. K. Saxena and S. Sethi (1974). Cytotaxonomic studies genus phaseolus. *Indian J. Genet.*, **34** : 800-804.

Govindan, A. (2000). Studies on induction of mutations on black grams [*Vigna mungo* (L.)] varieties and hybridpopulations and mutational effect of genetic parameters through generation. *Ph.D., Thesis*. India.

Gregory. W. C. (1956). The comparative effect of radiation and hybridization in plant breeding. *Proc. 1st UN Conf. on Peaceful Uses of Atomic Energy*, **12** : 48-51.

Kajjidoni, S. T., K. Roopalakshmi, S. Immadi, R. Nagaral and I. Nagaral (2008). An innovative way of developing an improved variety utilizing both gamma rays induced and recombinational variability in blackgram (*Vigna mungo* (L.) Hepper). FAO/IAEA International Symposium on Induced Mutations in Plants 12-15 August, 2008, Vienna, Austria IAEA-CN-167-064, p. 142.

Kharkwal, M. C. (2001). Induced mutations in chickpea (*Cicer arietinum* L) V. Evaluation of micro mutants. *Indian J. Genet.* **61** : 115-124.

Kovacs, E. and A. Keresztes (2002). Effect of gamma and UV-B/C radiation on plant cell. *Micron.*, **33** : 199-210.

Kurobane, I. H., Yamaguchi, C. Sander and R. Nilan (1979). The effects of gamma irradiation on the production and secretion of enzymes and enzymatic activities in barley. Env. Exp. Botany, **19** : 75-84.

Mohan, D. and B. Sharma (1995). Increasing induced polygenic variability in pea, In: *Genetic Research and Education: Current Trends and the Next Fifty Years* (Eds.), B. Sharma *et al*. Proc. golden jubilee Symp. 12-15 Feb. 1991, New Delhi, Indian Society of Genetics and Plant Breeding, New Delhi, pp. 1333-1342.

Mudibu, K. K., Nkongolo, M. Mehes-Smith and A. Kalonji-Mbuyi (2011). Genetic Analysis of a Soybean Genetic Pool Using ISSR Marker : Effect of Gamma Radiation on Genetic Variability. *International Journal of Plant Breeding and Genetics*, **5(3)** : 235-245.

Saini, S. S. and D. Sharma (1970). Radiation induced variation in rice improvement. *Indian J. Genet*., **30** : 569-578.

Singh, M. and V. P. Singh (2001). Genetic analysis of certain mutant lines of urdbean for yield and quality traits in M4 generation. *Ind. J. Pulses Res*., **14(1)** : 60-62.

Stegemann, H. and A. A. Shah (1990). Biochemical approaches in identifying mutants and duplicates in germplasm collections. *Mutation Breeding Newsletter*, **35** : 16.

Virk, D. S., S. S. Saini and V. P. Gupta (1978). Gamma radiation induced polygenic variation in pure breeding and segregating genotypes of wheat and rice. *Env. Expt. Bot*., **18** : 185-191.