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Effects of gamma rays on some yield parameters of four Indian sesame (*Sesamum indicum* L.) cultivars in M_2 generation

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ABSTRACT

Field studies were conducted at the Experimental Farm of Calcutta University during 2010 and 2011. Dry, uniform and healthy seeds of four extensively grown cultivars SW-22, GT-2, TKG-22 and DSS-9 of sesame were irradiated with different doses of gamma rays viz. 50, 100, 150, 200, 250, 300, and 450 Gy. M_1 and M_2 generation were raised during pre-kharif 2010 and pre-kharif 2011, respectively. In M_2 generation, it had been observed that there was a gradual reduction in performance with the increase in doses for all the characters. Useful and viable macro-mutants were individually selected in all the treatment, maximum being at 250 and 300 Gy in M_2 generation. The yield related macro mutants types like capsules length, no. of seeds capsule^{-1}, no. of capsule plant^{-1} were identified. All individually selected plants will be carried forward further generation(s) for the confirmation of segregating loci.

***Keywords* :** Gamma irradiation, M_2 generation, radio-sensitivity, selection, sesame, traits

Sesame (S*esamum indicum* L.) is one of the most important oilseed crops in the World. Archaeological findings revealed its cultivation in Asia since ancient times (Nayer, 1984; Bedegian and Harlan, 1986). It's a major source of high quality edible oil and good quality protein. The seeds of sesame are rich in protein, fat, calcium, phosphorus and B vitamins, trace elements and fatty acids (Anon, 1988). India, with 2.5 million hectares under cultivation for this crop, is a major sesame producer. Sesame is generally unimproved and many collections have been made from local land races since centuries, but knowledge on modern genetic information that can lead to its commercial utilization in breeding programs is scarce in India and other countries. Some factors affecting the sesame improvement programs are as follows. Firstly, the current germplasm of sesame is not as large as it is in other crops (Ashri, 1982). Secondly, the architecture of sesame is poorly adapted to the modern farming system because of its indeterminate growth habit, sensitivity to wilting under intensive management and seed shattering at maturity (Cagirgan, 1994, 2001; Uzun and Cagirgan, 2006). This is where mutation techniques may offer a possible solution. Mutations induced by radiations or chemicals provide variation in plant structure and function from which breeders can select plants having useful traits. Moreover, when genetic variability is narrowed using traditional breeding methods for a long period, induced mutation are one of the most important approaches for broadening the genetic variation to circumvent the bottleneck conditions. The induced variability can be exploited to develop new varieties of sesame with improved agronomic traits. Induced mutation has been employed successfully in sesame by many researchers (Das and Haque, 1997; Govindarasu and Ramamoorthi, 2000; Sheeba *et al*., 2003, 2005; Chowdhury *et al*., 2009; Diouf *et al*., 2010; Begum and Dasgupta, 2010, 2011). The present study has been undertaken to select mutant lines having more capsule in internodes, better plant architecture, capsule cluster in nature, more locules in capsule and other morphological yield attributing traits to ensure higher yield in M_2 generation.

MATERIALS AND METHODS

The present study was carried out at the Agricultural Experimental Farm of University of Calcutta, Baruipur, South 24 Parganas, West Bengal, India during pre-*kharif* seasons of 2010 and 2011. The experimental site was geographically located at 22°212 562 2 N latitude, 88°262 142 2 E longitude with an altitude of 9m above the mean sea level. Plant materials and their basic characteristics are provided in table 1. Pure and uniform dry seeds (10 - 12% moisture content) of each of the four genotypes were treated with 50, 100, 150, 200, 250, 300, and 450 Gy doses of gamma-rays at CRIJAF, Barrackpore, West Bengal, using ^{60}Co as source. The irradiated seeds along with control (un-irradiated seeds) were grown separately for each genotype in the field (treatment and variety wise) in a Randomized Block Design (RBD) during pre-*kharif* season of 2010 to raise M_1 generation. In M_1 generation, individual plants were harvested separately to raise the M_2 generation. To select the desirable mutant types and study the mutagenic sensitivity in M_2 generation, plant to progeny rows were

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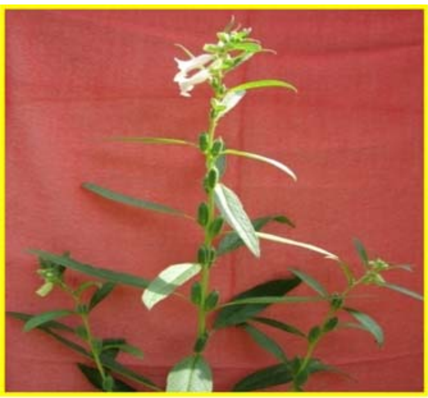
Table 1: Varietal description of four genotypes of sesame

Characters	**Genotypes**			
	SW-22	**GT-2**	**DSS 9**	**TKG-22**
Plant Height	Tall (80-100)	Dwarf (70-95)	Tall (95 – 110)	Dwarf (70 – 90)
Leaves	Long, narrow, lanceolate, entire margin, no pigmented, with smooth surface	Long, narrow, lanceolate, entire, no pigmented with smooth surface	Long, broad, lanceolate, slightly serrated with rough surface	Long, narrow, lanceolate, entire margin, with smooth surface.
Branching	Medium branched (2-5)	Less branched (0-4)	Medium branched (3-7)	Less branched (0-4)
Flowers	Pinkish white	White, hairy	White	Pinkish white
Capsules	Medium sized, no hairs	Small,sized, hairy, >2 and more capsules in per node	Large sized, no hairs	Medium sized, few hairs.
Seed	Light brown, rough and dull, medium sized	White, rough and glossy, medium sized.	White, rough and dull, medium sized	White, rough and dull, medium sized
Maturity	Medium (92-102)	Early (75 - 95)	Late (99-105)	Early (75-95)
Origin	West Bengal	Gujarat	Karnataka	Madhya Pradesh
Seed colour				

grown (along with the control) with row to row and plant to plant spacing of 40 and 15cm, respectively during pre-*kharif* season of 2011. Data taken from ten randomly selected plants of each plant-to-progeny rows against each of the doses along with the control were analyzed using suitable statistical methods. During the vegetative stage, all potential macro mutants were tagged and selected. In addition, agro-morphological data were also recorded.Other standard agronomic practices and plant protection measures were taken throughout the experiment. All Data were analysed statistically using SPSS 20.0 (IBM 2011) and MS Excel 2007.

RESULTS AND DISCUSSION

In M_2 generation, the analysis of variance for nine characters revealed that mean squares were highly



TKG-22 Control

TKG-22 250 Gy having cluster capsule

Fig. 1: Desirable macro mutants of TKG-22 in M2 generation

Table 2: Analysis of variance for nine characters in M_2 generation

Source of variation	df	Plant height	Internode length	Branches plant^{-1}	Capsules plant^{-1}	Flower duration	Capsule length	Seeds capsule^{-1}	100 seed weight	Yield plant^{-1}
Replication	1	794.04	0.12	1.00	86.61**	2.11	0.002	35.72	0.03	0.07
Variety	3	1522.45**	1.77**	0.57	69.11**	51.28**	0.24**	433.80	0.13**	77.92**
Treatment	7	418.30**	0.80	0.30	36.46**	2.64	0.11**	34.15**	0.01	1.98
Variety × Treatment	21	247.80**	1.65	0.47	30.65**	1.43	0.01	48.24*	0.01	3.05**
Error	31	67.025	3.243	0.272	12.293	2.436	0.020	11.953	0.009	1.217

*Note: **,* significant at 1% and 5% level, respectively*

Table 3: Some promising plants with improved performance in M_2 generation

Variety	Treatment	Mutant spectrum in M_2 generation						
		Plant height (cm)	Branches plant^{-1}	No. of capsules plant^{-1}	Flower duration	Capsule length (cm)	No. of seeds capsule^{-1}	Inflorescence
SW-22	Control	97.70	3.20	10.02	65.80	2.47	56.40	Solitary
	200 Gy	55.86	5	11.23	-	-	66.42	-
		-	-	-	63.08	-	60.69	Cluster
		63.48	5	15.63	60.10	2.5	-	Cluster
	300 Gy	-	-	-	-	-	-	-
		51.40	5	18.22	56.10	-	66.40	-
GT-2	Control	73.62	1.97	22.40	61.00	2.61	59.00	Cluster
	150 Gy	45.26	-	-	-	2.70	-	-
	200 Gy	50.60	2.80	29.59	59.60	2.65	63.21	-
	300 Gy	54.35	2.00	31.45	56.22	-	-	-
TKG-22	Control	78.80	1.20	15.9	62.80	2.52	58.7	Solitary
	250 Gy	51.52	2.01	21.22	51.20	3.21	63.25	Cluster
	450 Gy	56.59	2.25	22.31	-	3.20	62.22	-
DSS-9	Control	95.55	2.4	5.00	65.80	2.29	59.96	Solitary
	250 Gy	-	3.0	5.21	-	3.02	-	-
	300 Gy	74.20	3.25	5.26	-	3.26	69.45	Cluster
		67.52	3.21	-	56.99	2.89	71.45	-
	400 Gy	-	-	-	48.33	2.66	70.55	Cluster

significant for all the traits except branches plant^{-1} (Table 3) indicating the existence of high genetic variability among the mutant lines for yield and yield components. In other words, mutation had induced substantial genetic variability among the lines. There was a gradual reduction in performance with the increase in doses for all the characters under study. Similar observations were also made by Sharma and Sharma (1981) in lentil, Sharma *et al.* (2005) in urd-bean Paul (2012) in field pea and by Kharkwal (1998) in chickpea. However, for some characters, like capsules length, no. of seeds capsule^{-1}, no. of capsule plant^{-1}, some individual plants were found to be better performer in 250 and 300 Gy than rest of the populations including control. Mutated plants, with desirable traits such as dwarf habit, profuse branching, more number and extra-long of capsule with high number of seed and additional seed yield were selected at different doses for each cultivar (Table 3) (Fig.1).

Plant height

The ANOVA revealed that genotypes, treatment and their interactions were significantly different (Table 2). Plant height is an important yield component in different ecological condition. Induction by gamma rays leads to dwarfing of plants (Shah *et.al.*, 1990). Ten dwarf plants were selected at different doses of gamma rays for all varieties (Table 3). Highest reduction (45.26 cm) was observed at 150Gy in GT-2 among all four genotypes. Consequently, a dwarf in nature should be considered as a desirable trait because resilience to lodging is important.

Number of branches plant^{-1}

The ANOVA (Table 2) showed significant differences of genotypes, treatments and their interaction, indicating considerable variation in treatments and genotypes. Ten mutants were selected with increasing number than control under this category with Sw-22 having the highest number at 200 and 300Gy (Table 3). Increase in number of branches in M_2 generation is also recorded by Khan *et al.* (2005), Savant (2008), More (2016).

Number of capsules plant^{-1}

The ANOVA table exhibited number of capsules plant^{-1} in genotypes (treated), treatments and their interactions between them were significantly different (Table 2). No. of capsules plant^{-1} is one of the important characters for determination of high yield. In this category nine mutants were selected which are significantly increased over control at different doses of gamma rays in SW-22, DSS 9 of GT-2 and TKG-22 (Table 3). Maximum increase was found at 300Gy

Flower duration

Treatments, genotypes and interaction were found significantly different (Table 2). Inconsistency among the treatments was found with regards to flower duration among the mutant population of four genotypes. Earliness in flowering has been an important objective of breeding in several crops under different environmental conditions (Diouf *et al*., 2010). Eight mutants were selected (Table 3). Highest flower duration for reduction was observed at the dose 400Gy in mutant population of DSS-9.

Capsule length (cm)

Treatments, genotypes and interaction were observed significantly different (Table 2). Broad siliqua mutants having bold seeds are a significant parameter to develop a desire plant type (More 2016). Nine mutants were selected under this category with DSS-9 having the highest length at 300 Gy (Table 3).The contribution of this character in plant seed yield may be investigated.

Number of seeds capsule^{-1}

The ANOVA revealed that the genotypes (treated) and treatments were statistically significant (Table 2). Another important yield attributing character, no. of seeds capsule^{-1} was significantly increased at different doses in the verity of SW-22 and TKG-22. Nine mutated plants in this category were selected in M_2 generation (Table 3).

Inflorescence

Multi-capsules per leaf axil (Fig. 1) as ideal plant type in breeding for high-yielding varieties. In this category, five mutants with up to 4 capsules per leaf axil were selected whereas the source parents have only one capsule per leaf axil (Table 3).

This study clearly indicates that genetic variability induced through mutation can be exploited successfully in developing new varieties of sesame with improved agro-morphological traits. The traits capsule number, number of seeds capsule^{-1}, capsule length and seed yield and other useful and viable macro-mutants within the doses 200, 250 and 300 Gy could offer good scope of selection as the exhibited better performance than control and other given doses in M_2 generation. Thus, during selection more emphasis should be given to those plants for a further segregating generation(s).

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