

Effect of Mutagens on Quantitative Characters in M₂ and M₃ generation of Sesame (*Sesamum indicum* L.)

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ABSTRACT

The mutagenic effects of different dose/concentrations of gamma rays (30, 40 and 50 KR) and ethyl methane sulphonate (1.0, 1.5 and 2.0 mM) on sesame (*Sesamum indicum* L.) varieties VRI-1 were investigated. The characters studied include; days to first flower, plant height, number of branches per plant, number of capsule per plant, number of seeds per capsule and seed yield per plant in M₂ and M₃ generations. Both negative and positive shifts in mean values were recorded as a result of the physical and chemical treatments. The results indicate the possibilities of evolving higher yield variants through proper selection. Thus, economic traits like number of capsule per plant, number of seeds per capsule and hundred seed weight in M₃ generation offer scope for selection and improvement.

1. INTRODUCTION

Sesame plays an important role in human nutrition. Most of the sesame seeds are used for oil extraction and the rest are used for edible purposes (El Khier *et al.*, 2008). Sesame is grown primarily for its oil-rich seeds. Before seeds were appreciated for their ability to add nutty flavour or garnish foods, they were primarily used for oil and wine (Ghandhi, 2009). Sesame seed is rich in fat, protein, carbohydrates, fibre and some minerals. The oil seed is renowned for its stability because it strongly resists oxidative rancidity even after long exposure to air (Global Agri Systems, 2010).

Mutation breeding is one possible alternative to conventional breeding for crop improvement. Exposing plant genetic material to mutagens enhances the chance of isolating unique genetic material. In the past, induced mutations have effectively been utilized in development of new and valuable alterations in plant characteristics that have contributed to increased yield potential. Induced mutations can rapidly create variability in quantitatively and qualitatively inherited traits in crops (Maluszynski *et al.*, 1995; Muduli and Mishra, 2007). Mutation breeding not only creates variability in crop species, but also shortens the time taken for the development of cultivars via induced mutation compared to those via hybridizations. The average time elapsed from initial mutation treatment to the release of the mutant cultivars was approximately 9 years, while the time was more than 9 years for cultivar arising from crossing programmes (Brock, 1977). Moreover mutations induced both qualitative and quantitative characters in a short time altering new alleles of known and previously unknown genes, and modify the linkages (Konzak *et al.*, 1977). The present investigation was undertaken study the effect of mutagens on quantitative characters in M₂ and M₃ generation of sesame and results are discussed.

2. MATERIALS AND METHODS

The dry and dormant seeds of the sesame (*Sesamum indicum* L.) were treated with gamma rays and EMS was used in the present study. Healthy seeds packed in moist germination paper were selected for each treatment in the gamma chamber at 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 KR doses of gamma rays in ⁶⁰CO gamma source (irradiation source capacity to release 3000 Ci delivery

7200 r/min). The gamma irradiation was carried out at sugarcane breeding institute (ICAR), Coimbatore, India. For EMS treatment, the seeds were presoaked in distilled water in 3 hours. The presoaked seeds were treated with 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 and 5.0 mM freshly prepared solution for 3 hours. After the EMS treatment, the treated seeds were washed thoroughly for 1h in running tap water to terminate the residual effect of the mutagenic chemicals. After the completion of the treatment the treated seeds were sown immediately in the field along with their respective controls to raise the M_1 generation in a randomized block design with three replications. M_2 generation seeds were raised from M_1 generation; the seeds were collected from different individual mutagenic treatment. Seeds harvested from individual M_2 plants were grown as M_3 generation in the field during kharif season. All the necessary plant production methods like irrigation and weeding were carried out during the period of crop growth and also measured the morphological and yield parameters *viz.*, days to first flowering, plant height, number of branches per plant, number of capsule per plant, number of seeds per capsule and seed yield per plant were also studied.

3. RESULTS

Quantitative characters in M_2 and M_3 generations

In the present investigation, gamma radiations and EMS proved to be very effective to induce variability in quantitative traits in M_2 and M_3 generations (Table-1 and 2).

M_2 GENERATION

Days to first flower

A slight decrease in number of days to first flower was observed in gamma rays and EMS treatment than in the control. Whereas, there was an increase in number of days to first flower was noticed in EMS treatment. The treatment at EMS 2.0 mM treatment took more number of days to first flower (42.00 days) while the minimum number of days (38.00 days) to first flower was observed at 40 KR of gamma rays.

Plant height

There was a general increase in plant height at all mutagenic treatments than in the control. It was maximum plant height was observed at 1.5 mM of EMS (95.35 cm) while the minimum plant height was observed at 50 KR of gamma rays (83.10 cm).

Number of branches per plant

In general, there was an increase in number of branches in all the treatments when compared to control. The maximum number of branches (9.00) was observed at 40 KR of gamma rays. The minimum number of branches (4.00) was observed at 2.0 mM of EMS.

Number of capsule per plant

The number of capsules was increased at all dose/concentration of treatment when compared to control. The maximum number of capsule per plant was observed at 40 KR of gamma rays (38.00) while the minimum number of capsule per plant was observed at 2.0 mM of EMS (25.00).

Number of seeds per capsule

The number of seeds per capsule was increased in all treatments, but decreased in high doses of gamma rays 40 KR and EMS 2.0 mM. The maximum number of seeds per capsule was recorded at 40 KR of gamma rays 39.00 while the minimum number of seeds per capsule was recorded at 2.0 mM of EMS 32.00.

Seed yield per plant

In general, a slight increase in seed yield per plant was observed among the mutagenic treatments than the control. The maximum seed yield per plant 6.00 g was observed at 1.5 mM of EMS while the minimum seed yield 4.30 g was observed at 50 KR of gamma rays. There are all the parameters were observed in Fig. 1.

M₃ GENERATION

Days to first flower

There was a slight decrease in number of days to first flower was noticed in gamma rays and EMS treatment while the increase in days to first flower was noticed in EMS. The plants treated at 50 KR gamma rays took more number of days (40.00 days) to first flower while the minimum number of days (37.00 days) to first flower was observed at 40 KR gamma rays when compared to the control (41.00 days).

Plant height

The plant height was increased in all the mutagenic treatments in this genotype. The maximum plant height was recorded at 40 KR of gamma rays (90.10 cm) while the minimum plant height was recorded at 50 KR of gamma rays (81.75 cm).

Number of branches per plant

The number of branches increased in all the mutagenic treatments when compared to control. The maximum numbers of branches were observed in 40 KR of gamma rays 9.00, while the minimum numbers of branches were observed at 50 KR of gamma rays 5.00 and also 2.0 mM of was observed in 6.00.

Number of capsule per plant

In general, there was an increase in number of capsule in all treatments when compared to control. The maximum number of capsule was recorded at 40 KR of gamma rays 48.00 while the minimum number of capsule was recorded at 2.0 mM of EMS 27.00.

Number of seeds per capsule

In general there was an increase of number of seeds per capsule in all the treatments when compared to control. There was a decrease in number of seeds per capsule with increase in the dose/concentration of mutagens. The maximum number seeds per capsule were observed at 40 KR of gamma rays 41.00 while the minimum number of seeds per capsule was recorded at 50 KR of gamma rays 30.00.

Seed yield per plant

A slight increase in seed yield per plant was observed in all mutagenic treatments than the control. The maximum seed yield per plant 6.00 g was observed at 40 KR of gamma rays while the minimum seed yield per plant 5.00 g was observed at 50 KR of gamma rays. While all the quantitative traits was observed in Fig. 2.

Table 1. Effect of mutagens on quantitative characters in M₂ generation of sesame (*Sesamum indicum* L.)

Mutagens	Treatment/ Conc.	Days to first flowering (Mean ± SE)	Plant height / plant (cm) (Mean ± SE)	No. of branches/plant (Mean ± SE)	No. of capsule/ plant (Mean ±SE)	No. of seeds / capsule (Mean ±SE)	Seed yield / plant (g) (Mean ± SE)
Gamma rays	Control	41.00 ± 1.23	84.15 ± 2.52	5.00 ± 0.15	27.00 ± 0.81	34.00 ± 1.02	4.85 ± 0.14
	30 KR	40.00 ± 1.20	85.88 ± 2.57	7.00 ± 0.21	30.00 ± 0.90	36.00 ± 1.08	5.20 ± 0.15
	40 KR	38.00 ± 1.14	88.24 ± 2.64	9.00 ± 0.24	38.00 ± 1.14	39.00 ± 1.17	5.86 ± 0.17
	50 KR	41.00 ± 1.23	83.10 ± 2.49	5.00 ± 0.15	26.00 ± 0.78	33.00 ± 0.99	4.30 ± 0.12
	1.0 mM	41.00 ± 1.23	88.50 ± 2.65	5.00 ± 0.15	29.00 ± 0.87	35.00 ± 1.05	5.40 ± 0.16
EMS	1.5 mM	39.00 ± 1.17	95.35 ± 2.86	8.00 ± 0.24	34.00 ± 1.02	38.00 ± 1.14	6.00 ± 0.18
	2.0 mM	42.00 ± 1.26	83.25 ± 2.49	4.00 ± 0.12	25.00 ± 0.75	32.00 ± 0.96	4.90 ± 0.14

Table 2. Effect of mutagens on quantitative characters in M₃ generation of sesame (*Sesamum indicum* L.)

Mutagens	Treatment/ Conc.	Days to first flowering (Mean ± SE)	Plant height / plant (cm) (Mean ± SE)	No. of branches/plant (Mean ± SE)	No. of capsule/ plant (Mean ±SE)	No. of seeds / capsule (Mean ±SE)	Seed yield / plant (g) (Mean ± SE)
Gamma rays	Control	41.00 ± 1.23	83.00 ± 2.49	5.00 ± 0.5	26.00 ± 0.78	32.00 ± 0.96	4.80 ± 0.14
	30 KR	39.00 ± 1.17	87.45 ± 2.65	7.00 ± 0.21	32.00 ± 0.96	38.00 ± 1.14	5.35 ± 0.16
	40 KR	37.00 ± 1.11	90.10 ± 2.70	9.00 ± 0.27	48.00 ± 1.20	41.00 ± 1.23	6.00 ± 0.18
	50 KR	40.00 ± 1.20	81.75 ± 2.45	6.00 ± 0.18	28.00 ± 0.84	30.00 ± 0.90	5.00 ± 0.15
EMS	1.0 mM	39.00 ± 1.17	85.34 ± 2.56	7.00 ± 0.21	30.00 ± 0.90	36.00 ± 1.08	5.50 ± 0.16
	1.5 mM	38.00 ± 1.14	89.78 ± 2.69	8.00 ± 0.24	38.00 ± 1.14	40.00 ± 1.20	5.90 ± 0.17
	2.0 mM	39.00 ± 1.17	82.00 ± 2.46	6.00 ± 0.18	27.00 ± 0.81	32.00 ± 0.96	5.05 ± 0.15

**Fig. 1. Field view on M₂ generation of sesame (*Sesamum indicum* L.)****Fig. 2. Field view on M₃ generation of sesame (*Sesamum indicum* L.)**

4. DISCUSSION

M₂ GENERATION

Mutation, in quantitatively inherited characters, would depend on number of genes involved. The increase or decrease in the relative proportion of genes with positive or negative effects would have caused the shift in the mean of the treated genotypes. The change in mean value was generally accompanied with increase in range and variance for most of the characters. The range of variation as shown by different mutagenic treatments was wider than the respective controls for all the quantitative traits of rice in M₂ and M₃ generations (Siddiqui and Singh, 2010).

In the present study a significant positive shift in quantitative mean performance was observed in days to first flower, plant height, number of branches per plant, number of capsule per plant, number of seeds per capsule and seed yield per plant were also due to effect of gamma rays and EMS. In M₂ generation there was a gradual increasing for all the quantitative characters while comparing to M₁ generation. Among the mutagens, 40 KR of gamma rays and 1.5 mM of EMS provided remarkable increase in above mentioned traits than control. Similar results were recorded in cowpea (Odeigah *et al.*, 1998), chickpea (Wani and Anis, 2001), wheat cultivars (Baylon *et al.*, 1991 and Wicks *et al.*, 2004) and chilli (Yadwad *et al.*, 2008).

The significant reduction of days to first flowering at 40 KR (38.00 days) of gamma rays and 1.5 mM of EMS (39.00 days) observed early maturity plants. The development of early maturing variety in any crop primarily depends upon the reduction in the number of days to first flowering. Similar findings for various crops were also reported in rice (Wang *et al.*, 2003), chilli (Jabeen and Mirza 2004), lentil (Solanki *et al.*, 2004) and barley (Ramesh and Kumar, 2005).

The treated population was higher than the control in all the yield traits, namely, plant height, number of branches per plant, number of capsule per plant, number of seeds per capsule and seed yield per plant at 40KR of gamma rays and 1.5 mM of EMS respectively. The increase in the number of capsule was due to an increase in the number of flowers. The increases in the number of capsule and yield characters in some other variety using ethyl methane sulphonate, nitrosomethyl urea, hydroxylamine and gamma rays in bread wheat (Singh *et al.*, 1979), mungbean (Tickoo and Chandra, 1999) soybean (Mehetre *et al.*, 1999) and grasspea (Waghmare and Mehra, 2000). Significant increase in capsule number, seed weight, capsule length and number of seeds/color was also observed at a relatively lower concentration of the mutagen. Since capsules are seed bearing structures their increase has a positive correlation with the yield of a seed (Sureja and Sharma, 2000). Hoballah (1999) also reported that there was an increase in the number of capsule per plant among sesame mutants.

M₃ GENERATION

In M₃ generation a significant improvement was observed with mutagenic treatments. A gradual enhancement was observed in all mutagenic treatments. Among the mutagens, quantitative mean performance increased in EMS followed by gamma rays and control plants. Gamma rays at 40 KR achieved more number of variations when compared to other mutagenic dose/conc. The highest number of mean values was noted in M₃ generation than in M₂ generation of gamma rays and EMS treated plants when compared to control. Similar results were documented in *Cajanus cajan* (Manohar *et al.*, 1988), grass pea (Kumar and Dubey, 1996) and *Lathyrus* (Girhe and Choudhary, 2002).

5. CONCLUSION

In these generations a significant positive shift of mean performance was observed in days to first flower, plant height, number of branches per plant, number of capsule per plant, number of seeds per capsule and seed yield per plant. Among the mutagens, 40 KR of gamma rays and 1.5 mM of EMS showed higher results in the above mentioned characters when compared to control and other dose/concentration. The results indicated the possibilities of evolving higher yield

variants through proper selection. Mutagenic treatments increase the genetic variability, which can be utilized for selection and improvement of sesame plants.

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