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Gamma rays and ethyl methane sulphonate induced pollen sterility in sesame (*Sesamum indicum* L.)

M.B. BORANAYAKA, S.M. IBRAHIM, G. RAJESHA, T.V. SHADAKSHARI, K.R. ASHOKA AND K. RAGHAVENDRA

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SUMMARY

Five dosages of gamma rays ranging from 10 ($V_1 T_1$) to 50 krad ($V_1 T_5$) with an interval of 10 krad and five concentrations of Ethyl methane sulphonate (EMS) ranging from 0.8 ($V_2 T_1$) to 1.6 per cent ($V_2 T_5$) with an interval of 0.2 per cent were employed to study pollen fertility in two sesame genotypes *viz.,* SVPR 1 and Cardeboriga. Both the mutagens exhibited significant differences for pollen fertility. All the treatments in both the genotypes produced considerable pollen sterility indicating that the mutagens were capable of bringing about either large or cryptic structural differences. The pollen fertility of M_1 plants showed decreasing trend as the dosage of mutagen increased in both the genotypes.

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Key words : Sesame, Gamma rays, Ethyl methane sulphonate, Pollen sterility

The mutagen induced sterility is attributed by chromosome mutation, factor mutations, cytoplasmic mutations and physiological effects. Sterility was mainly due to detectable chromosomal aberrations and cryptic structural deficiencies. As a result, malformed pollen grains and wrinkled seeds were observed. It is reasonable to support that various physiological and chromosomal damages resulting from the chemicals are responsible for production of large quantities of non viable pollen and hence the pollen sterility. The present study was undertaken to asses the effect of gamma rays and EMS in inducing pollen sterility and thus provide information on pattern of variation in mutagenic experiments using the mutagens on sesame plant.

Correspondence to:
M.B. BORANAYAKA, P.C. Unit (Small Millets), Zonal Agricultural Research Station, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA
Email : mbboranayak@gmail.com

Authors' affiliations:
S.M. IBRAHIM, G. RAJESHA AND T.V. SHADAKSHARI, Department of Plant Breeding and Genetics, Agricultural College and Research Institute (T.N.A.U.), MADURAI (T.N.) INDIA

K.R. ASHOKA, Department of Soil Science and Agricultural Chemistry, College of Agriculture, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA

K. RAGHAVENDRA, Department of Crop Physiology, College of Agriculture, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA

MATERIALS AND METHODS

Two promising sesame genotypes namely, SVPR 1(ruling popular white seeded type) and Cardeboriga (monostem African type) were treated with the two mutagens *viz.,* gamma rays and EMS. Two hundred well filled dry seeds were sealed in butter paper covers and exposed to 10 to 50 krad doses of gamma rays from ^{60}Co source at Indira Gandhi Centre for Research, Kalpakkam, Tamil Nadu. Another two hundred seeds of each variety, for each treatment were presoaked in distilled water for four hours then treated with different concentrations of Ethyl methane sulphonate (EMS) ranging from 0.8 to 1.6 per cent for three hours. After the treatment, the seeds were thoroughly washed with tap water ten times and dried with blotting excess water. The treated seeds were sown in the field along with control in a Randomized Block Design with Four replications by adopting a spacing of 30 cm between rows and 30 cm between plants. Pollen grains were collected on clean glass slides by dusting anthers of single flower that were about to dehisce and stained with Iodine potassium iodide. Well filled and fully stained pollens were counted as fertile, while the unstained and shrunken ones as sterile and expressed in percentage.

RESULTS AND DISCUSSION

The data on pollen fertility were furnished in Table 1 for both the mutagens and the varieties. The relevant regression lines were shown in Fig. 1 and 2 for SVPR 1 and Cardeboriga, respectively. Both the mutagenic treatments revealed the existence of significant differences for pollen fertility between treatments in both the varieties. In SVPR 1, the per cent reduction for pollen fertility ranged from 5.36 (V_1T_1) to 37.57 (V_1T_5) for gamma rays and from 8.29 (V_1T_6) to 20.22 (V_1T_{10}) for EMS. An increase in dose / concentration of the mutagens led to an increase in per cent reduction in pollen fertility. The relationship was directly proportional and linear. In Cardeboriga, the range was between 11.36 (V_2T_1) and 42.69 per cent (V_2T_5) for gamma rays and between 3.50 (V_2T_6) and 25.39 per cent (V_2T_{10}) for EMS.

Reduction in pollen fertility occurs due to inactivation of certain genes, thereby upset genetic and physiological equilibrium, physiological disturbances, chromosome structural changes and point mutations (Rana and Swaminathan, 1964 and Gaul, 1977). Both the mutagens exhibited significant differences for pollen fertility. All the treatments in both the genotypes produced considerable pollen sterility indicating that the mutagens were capable of bringing about either large or cryptic structural differences. In gamma ray treatments the pollen fertility

Table 1 : Effect of mutagens on pollen fertility in M_1 generation

Treatments	SVPR 1 Mean	SVPR 1 Per cent over control	SVPR 1 Per cent reduction	Treatments	Cardeboriga Mean	Cardeboriga Per cent over control	Cardeboriga Per cent reduction
γ - ray				γ - ray			
V_1T_0 (0 krad)	81.80	64.74	-	V_2T_0	80.95	64.12	-
V_1T_1 (10 krad)	76.90	61.27*	5.36	V_2T_1	70.05	56.82*	11.36
V_1T_2 (20 krad)	74.05	59.37*	8.29	V_2T_2	59.70	50.23*	21.66
V_1T_3 (30 krad)	68.43	55.81*	13.79	V_2T_3	48.66	44.23*	31.02
V_1T_4 (40 krad)	49.74	44.85*	30.372	V_2T_4	39.04	38.67*	39.69
V_1T_5 (50 krad)	42.05	40.42*	37.57	V_2T_5	35.80	36.75*	42.69
EMS				EMS			
V_1T_0 (0.0 %)	81.80	64.74	-	V_2T_0	80.95	64.12	-
V_1T_6 (0.8 %)	74.05	59.37*	8.29	V_2T_6	77.78	61.87*	3.51
V_1T_7 (1.0 %)	68.43	55.81*	13.79	V_2T_7	72.08	58.10*	9.39
V_1T_8 (1.2 %)	76.90	61.27*	5.36	V_2T_8	67.50	55.24*	13.85
V_1T_9 (1.4 %)	64.85	53.64*	17.15	V_2T_9	63.66	52.92*	17.47
V_1T_{10} (1.6 %)	61.50	51.65*	20.22	V_2T_{10}	54.95	47.84*	25.39

Treatments	Mean	S.E.±	C.D. (P=0.05)	CV (%)	Treatments	Mean	S.E.±	C.D. (P=0.05)	CV (%)
γ-rays	51.90	0.68	1.39	17.51	γ-rays	55.70	0.64	1.33	17.66
EMS	57.74	0.57	1.18	15.70	EMS	69.48	0.67	1.38	16.83

* indicates significance of value at P=0.05

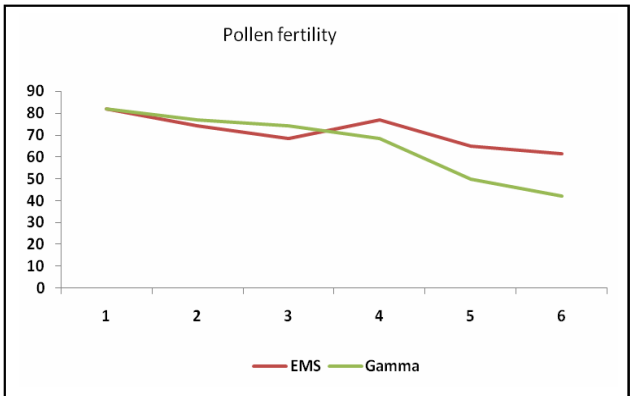

Fig. 1 : Effect of gamma rays and EMS on pollen fertility in M_1 generation – SVPR 1

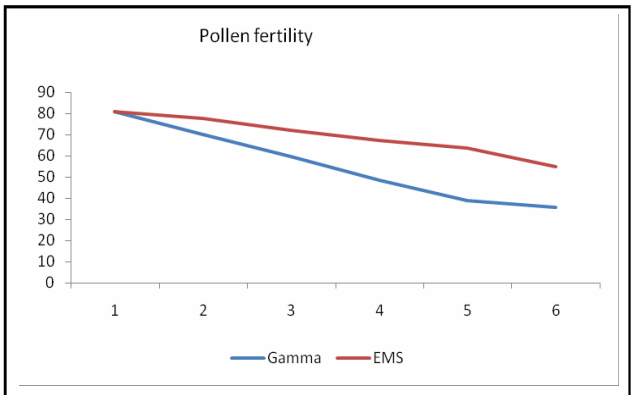

Fig. 2 : Effect of gamma rays and EMS on pollen fertility in M_1 generation – Cardeboriga

ranged from 42.05 (50 krad) to 76.90 per cent (10 krad) in SVPR 1 and from 35.80 (50 krad) to 70.05 per cent (10 krad) in Cardeboriga. In case of EMS treatments the range varied from 61.50 to 74.05 per cent (0.8 to 1.6 per cent) in SVPR 1 and from 54.95 to 77.78 per cent (0.8 to 1.6 per cent) in Cardeboriga. The pollen fertility of M_1 plants showed decreasing trend as the dosage of mutagen increased in both the genotypes. The results obtained are in accordance with the reports of Rangaswamy and Rathinam (1982), Prabhakar (1985), Datta and Biswass (1987) and Anitha Valine (1998) in sesame.

Pollen sterility may be due to cumulative effects of various aberrant meiotic stages as well as physiological and genetic damages that were induced probably by the breakage of chromosomes through formation of antimetabolic agents in the cell or may be due to irregular disjunction of chromosomes at anaphase. The disjunction of chromosome may result from the orientation of chromosomes at metaphase I (Kumar and Das, 1973) or formation of interchanges and multivalents (Larik, 1975) and as a result malformed pollen grains. Radiation induced sterility might have been also due to small or minute deficiencies in chromosomes (Gaul, 1970). Radiation induced sterility was mostly haplontic, while EMS induced sterility was diplontic (Sato and Gaul, 1967).

It is reasonable to support that various physiological and chromosomal damages resulting from the chemicals are responsible for production of large quantities of non viable pollen and hence the pollen sterility. It is noted that despite the occurrence of high level of pollen sterility at higher dosages of M_1 generation, seed formation was apparently not affected, because the crops are self fertilizing and hence only a minimum amount of pollen was required to effect seed formation. Similar observations have been reported by Sapra and Constantin (1976) in wheat and Mensah *et al*.(2007) in sesame.

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