Studies on heritability and genetic advance in mutant populations of sesame (*Sesamum indicum* L.)

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ABSTRACT

An investigation was undertaken to elucidate information on induced variability for yield and yield components in sesame (*Sesamum indicum* L.). The study consisted of two genotypes treated with physical (gamma rays) and chemical (EMS) mutagens. Two sesame varieties were treated with gamma rays ^{60}Co source with doses of 10, 20, 30, 40 and 50 krad followed by Ethyl methane sulphonate with concentrations of 0.8, 1.0, 1.2, 1.4 and 1.6 per cent. The LD_{50} values based on germination reduction in the M_1 generation were fixed at 30krad and 1.2 per cent for gamma rays and EMS, respectively. High GCV for the traits plant height and number of capsules per plant in both the varieties was observed. Induced genetic variability was more in Cardeboriga than SVPR 1.The high heritability and genetic advance combined with increased genetic variability was realized for the characters *viz*., number of seeds per capsule and number of capsules per plant. The enhanced genetic variability observed for seed yield and its components in M_2 generation of the present study indicated the scope for effective selection.

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Key words : Sesame, Gamma rays, EMS, Mutant population, Variability studies

INTRODUCTION

Mutational genetic manipulation of crop plants has been used very successfully to reconstruct crop ideotypes and improve a number of productive characteristics, in effect increasing the yield potential. This has been amply demonstrated in many crop species as exemplified by Xue Bai *et al.* (2000) in soybean, Shadakshari *et al.* (2001) in rice, Sharma (2001) in pea, Singh *et al.* (2001) in blackgram, Muthusamy and Jayabalan (2002) in cotton, , Samiullah (2004) in blackgram, Singh (2006) in cowpea and Janila *et al.* (2007) in groundnut. More than 1500 mutant cultivars of crop plants with significantly improved attributes have been released worldwide in the last 30 years through induced mutation.

Sesame is probably the most ancient oilseed known and used by man. Success in any breeding programme depends on the amount of genetic variability present for the different characters in population. The genetic variability offered by mutagenic agents is of extreme importance in plant breeding. The variability in quantitative characters increases considerably by treating the biological materials with different mutagenic agents. An estimation of the extent of variability induced in M_2 generation will be of great value to provide useful information for carrying out further selection.

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 variety of two hundred seeds of each variety, for each treatment were presoaked in distilled water for four hours then treated with different concentrations of 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. The normal good looking plants based on base population randomly selected in each treatment in the M_1 generation were

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advanced to M_2 generation. They were sown in family rows in a Randomized Block Design replicating four times with a spacing of 30 cm between rows and 30 cm between plants. Five normal looking plants chosen randomly from each family in a replication were subjected to record biometrical traits such as (i) Plant height (ii) Number of branches per plant (iii) Number of capsules per plant (iv) Capsule length (v) Number of seeds per capsule (vi) 1000 seed weight and (vii) Single plant yield.

M_2 generation:

The mean and variances of the M_2 generation of the different treatments were subjected to appropriate statistical analysis. The overall sum of squares due to treatments was partitioned among the different sources following the method of Allard (1960) and Sharma (1998).

Sources of variation	Mean squares	Expectation of mean squares
Between families	M_f	$\sigma^2_e + r\,\sigma^2_g$
Within families	M_e	σ^2_e

where

σ^2_g - Variance due to genotypes

σ^2_e - Variance due to environment

r - Replication

The genotypic variance among the progenies was estimated as

$$\sigma^2_g = \frac{M_f - M_e}{r}$$

The phenotypic variance was calculated as

$$\sigma^2_p = \sigma^2_g + \sigma^2_e$$

Coefficient of variation (Burton, 1952):

Phenotypic coefficient of variation (PCV) and Genotypic coefficient of variation (GCV) were computed by using the following formulae:

$$PCV\ (\%) = \frac{\sqrt{\sigma^2_p}}{\bar{x}} x100$$

$$GCV\ (\%) = \frac{\sqrt{\sigma^2_g}}{\bar{x}} x100$$

where,

σ^2_p - phenotypic variance

σ^2_g - Genotypic variance

$\bar{x}$ - Grand mean

Heritability:

Heritability in broad sense was computed for each character using the following formula (Lush, 1940).

$$\text{Heritability} = \frac{\text{Genotypic variance}}{\text{Phenotypic variance}} x\,100$$

Heritability was classified as follows (Robinson, 1966)

Above 60 per cent - High

30 to 60 per cent - Moderate

Below 30 per cent - Low

Genetic advance:

Genetic advance for a particular trait was estimated adopting the method as suggested by Johnson *et al.* (1955a).

$$GA = h^2\ x\ \sigma_{ph}\ x\ K$$

where,

h^2 - Heritability

σ_{ph} - Phenotypic standard deviation

K - Selection differential (2.06) at 5 per cent selection intensity

$$\text{Genetic advance as percentage of mean} = \frac{GA}{\text{General mean}}\ x\ 100$$

Genetic advance was classified as follows (Robinson, 1966)

Above 20 per cent - high

10 to 20 per cent - moderate

Below 10 per cent - low

RESULTS AND DISCUSSION

The estimates of phenotypic and genotypic coefficients of variation, (PCV and GCV), heritability and genetic advance as a percentage of mean are given in the Tables 1 and 2. Among different methods available to detect the induced variability in the mutagenic population, mean and components of variance serve as suitable statistical parameters (Scossiroli, 1977). The genotypic co-efficient of variation provides a mean to study the genetic variability generated in quantitative characters (Johnson *et al.,* 1955a). According to Chaudhary *et al.* (1977) high heritability alone does not signify on increased

Table 1 : Heritability (h^2), genetic advance (GA) as % of mean for eight characters in M_2 generation in SVPR 1

Characters	Heritability and GA as % of mean	Treatments - Gamma rays (Krad)						Treatments - EMS (%)				
		0	10	20	30	40	50	0.8	1.0	1.2	1.4	1.6
Plant height	h^2 (%)	65.9	56.2	94.8	30.5	15.4	85.2	85.5	59.6	85.3	61.4	15.2
	GA as % of mean	7.97	8.16	12.75	4.10	2.04	10.61	12.38	9.28	12.63	8.55	2.29
No. of branches	h^2 (%)	38.8	29.1	54.2	12.1	25.6	23.5	60.9	55.9	85.4	45.2	60
per plant	GA as % of mean	15.80	18.72	14.32	6.33	12.97	16.36	21.13	18.44	9.88	17.67	19.43
No. of capsules	h^2 (%)	92.4	70.4	72.4	87.3	80.3	90.4	91.0	89.40	93.7	86.8	82.2
per plant	GA as % of mean	18.90	17.12	15.52	11.17	15.37	19.17	14.54	8.19	18.22	15.40	18.79
Capsule length	h^2 (%)	60.7	89.36	92.40	85.41	78.50	97.90	22.17	54.40	25.40	35.25	65.60
	GA as % of mean	4.61	12.51	11.32	12.24	11.12	12.50	1.61	4.03	1.85	2.54	3.29
No. of seeds per	h^2 (%)	25.40	35.12	9.24	18.42	28.10	25.0	27.80	35.42	78.12	8.40	15.90
capsules	GA as % of mean	7.19	11.67	2.33	5.53	7.61	11.05	7.14	10.47	21.23	1.94	4.20
1000 seed weight	h^2 (%)	89.30	99.40	98.24	92.12	85.20	91.40	96.80	85.22	99.40	85.12	80.0
	GA as % of mean	9.0	12.69	11.50	12.75	10.34	11.98	9.50	8.90	9.66	8.67	7.36
Oil content	h^2 (%)	45.0	61.22	60.00	75.22	59.80	80.10	91.09	86.55	78.81	97.01	93.20
	GA as % of mean	2.94	4.03	3.74	4.75	4.35	4.96	5.30	4.93	4.24	5.28	5.50
Single plant yield	h^2 (%)	24.7	31.2	20.8	26.1	15.2	30.5	8.24	12.20	10.52	4.70	10.20
	GA as % of mean	14.46	20.11	17.77	10.93	7.67	12.76	5.19	7.63	7.33	2.45	4.12

Table 2 : Heritability (h^2), genetic advance (GA) as % of mean for seven* characters in M_2 generation in Cardeboriga

Characters	Heritability and GA as % of mean	Treatments - Gamma rays (Krad)						Treatments - EMS (%)				
		0	10	20	30	40	50	0.8	1.0	1.2	1.4	1.6
Plant height	h^2 (%)	25.5	10.5	25.7	59.2	45.1	12.1	67.9	85.4	92.0	15.2	25.4
	GA as % of mean	2.45	0.95	2.38	5.51	4.16	1.13	9.61	1.75	12.17	2.19	3.62
No. of capsules	h^2 (%)	65.24	71.60	71.20	68.20	72.81	80.82	55.75	77.20	84.20	6.75	70.47
per plant	GA as % of mean	17.69	19.06	15.96	19.58	22.02	18.64	15.49	18.29	16.31	19.93	21.11
Capsule length	h^2 (%)	35.60	55.46	87.50	42.70	91.60	55.92	11.0	55.42	8.41	12.12	25.24
	GA as % of mean	2.88	5.0	7.43	3.68	7.70	4.78	1.01	4.80	0.74	1.03	2.24
No. of seeds per	h^2 (%)	15.42	21.98	32.80	18.0	22.11	45.80	15.50	13.42	8.20	18.45	21.40
capsules	GA as % of mean	4.06	5.04	9.03	5.04	6.18	12.90	2.42	5.64	1.36	3.12	3.82
1000 seed weight	h^2 (%)	96.89	97.80	92.90	87.20	71.12	93.45	87.10	98.42	99.55	89.58	95.60
	GA as % of mean	7.88	7.68	7.74	6.82	5.40	7.88	9.22	10.74	11.12	8.73	8.62
Oil content	h^2 (%)	38.66	44.40	38.10	55.70	64.15	39.10	23.46	46.70	69.90	86.50	49.0
	GA as % of mean	1.49	1.09	0.91	1.34	1.54	0.93	0.91	1.84	1.01	3.40	1.88
Single plant yield	h^2 (%)	52.70	39.20	25.05	54.20	12.10	35.20	79.33	91.29	61.90	50.0	80.40
	GA as % of mean	17.03	12.35	10.50	17.15	3.65	13.43	18.09	9.12	13.40	15.39	10.25

*Note: Cardeboriga genotype is monostem and non branching African type

genetic advance. In SVPR 1, the characters *viz*., number of capsules per plant, capsule length and oil content showed high heritability with moderate genetic advance whereas oil content noted high heritability with low genetic advance as percentage of mean for gamma rays. In case of EMS, the plant height, 1000 seed weight and oil content were recorded high heritability accompanied with low genetic advance as percentage of mean. High heritability and low genetic advance as percentage of mean which reveals the dominant gene action and may not be rewarded. In Cardeboriga, number of capsules per plant, capsule length and 1000 seed weight in gamma rays and the number of capsules per plant, 1000 seed weight and single plant yield in EMS showed high heritability but moderate to low genetic advance as percentage of mean. These traits may not be required as they were under the control of non additive gene action and will not respond to early selection. This was similar to the reports of Raut *et al.* (1991), Thirugnanakumar (1991) and Govindarasu *et al.* (1997).

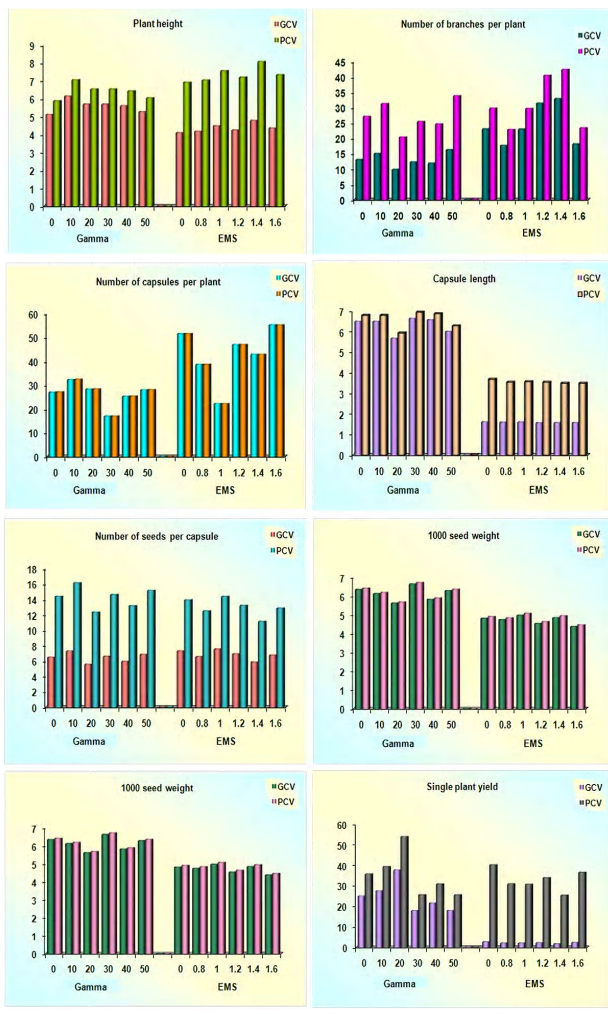

Fig. 1 : Components of variance- SVPR 1

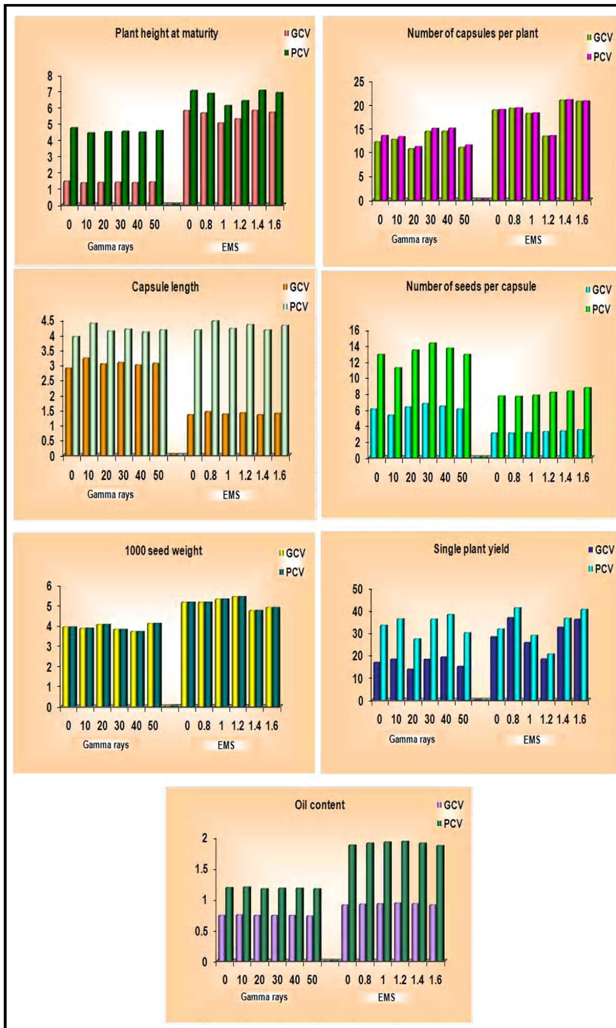

Fig. 2 : Components of variance- Cardeboriga

In SVPR 1, low heritability (31.2%) and high GA (20.11%) as percentage of mean was observed at 10 krad of gamma rays in SVPR 1 for single plant yield which reveals the dominant gene action. The low heritability was exhibited due to high environmental effects. Selection may be effective in such cases. In case of EMS, high heritability (78.12%) accompanied with high genetic advance as percentage of mean (21.23%) for number of seeds per capsule at 1.2 per cent indicates that most likely the heritability was due to additive gene effects and selection may be effective.

In Cardeboriga, high heritability (72.81%) and high GA as percentage of mean (22.02%) in 40 krad gamma rays and high heritability (70.47%) and high GA as percentage of mean (21.11%) at 1.6 cent of EMS for number of capsules per plant were observed. Johnson *et al.* (1955a) stated that high heritability and GA for a character would indicate the predominance of additive gene action on the trait and as such, this trait is likely to respond effectively for phenotypic selection. Thus, high heritability and genetic advance combined with increased genetic variability realized in the present study for the characters *viz.,* number of seeds per capsule and number of capsules per plant revealed the scope of improving yield through effective selection based on these characters.

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