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Estimation of genetic variability, heritability and genetic advance in mutant breeding lines of sesame (*Sesamum indicum* L.)

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Abstract
The experiment was conducted during *Kharif* 2011 and 2012 at Agricultural Research farm, R.B.S. College, Bichpuri, Agra on the variety Gujarat Til-1 variety of sesame. The seeds were treated with different doses of gamma rays at CIMAP Lucknow, U.P and with different chemical mutagen at laboratory of R.B.S. College, Bichpuri, Agra. The evaluation of phenotypic variability, heritability and genetic advance is important for both plant breeders and germplasm curators to optimize the use of the variability available. Analysis of variance revealed significant difference for all the characters studied except test weight. The highest GCV and PCV were observed for the characters *viz.* number of capsule per plant, seed yield per plant and number of seed per capsule. High heritability was recorded for days to maturity, seed yield per plant, and number of capsules per plant, indicating that these characters are controlled by additive gene effect and phenotypic selection of these characters would be effective for further breeding purpose.

Keywords: Mutation, genetic variability, heritability and sesame

Introduction
Sesame (*Sesamum indicum* L.), an important and ancient oil seed crop also known as Til, gingerly Benni seeds, Simsim, Tillinuvrulavellvor and Rasi. The world produced 6.5 million tonnes in 10.9 million hectares area with an average yield of 485 kilogram per hectare. In India, it was grown on 15.62 Lakh hectare of land with the production of 7.84 lakh tonnes with the average yield of 502 kg/ha (FAO, 2018) [1].

Sesame has remarkable antioxidant function due to the presence of lignin and tocopherol. The seed, highly rich in quality proteins and essential amino acids, especially methionine is considered rejuvenative and anti-aging for human body. The oil with 85 percent unsaturated fatty acid, is highly stable and has reducing effect on cholesterol and prevents coronary heart diseases. Sesame is grown in all seasons of the year and being a short duration crop, fits well into various cropping systems (Mohsina and Datta, 2006) [3].

Since the yield of sesame is very low in our country. So, the foremost objective is to evolve high yielding, high oil content and short duration cultivars. Due to self-pollinated crop species and having been grown under poor farm management there is a lack of genetic variability in it and to generate variability attempts have been made by crossing to some extent, but desirable success could not have been attained although. The conventional breeding methods used the natural genetic variability due to the spontaneous mutation and / or hybridization. Furthermore, mutagenesis is the best tool to improve genetic architecture of plant within a short time. (Uzun *et al.*, 2003) [2].

Therefore, the present investigation was under taken to induce variability parameters with higher oil content through mutation breeding. The study is also concerned with the comparative evaluation of effect of physical mutagen (gamma rays) chemical mutagen (mailchydrazide and hydroxyl amine) and combination of both the mutagens.

Material and methods
The experiment was conducted during *Kharif* 2011 and 2012 at Agricultural Research farm, R.B.S. College, Bichpuri, Agra. The experimental material consisted of Gujarat Til-1 variety of sesame, which was procured from National Seed Corporation, as a certified seed. The seeds were treated with different doses of gamma rays at CIMAP Lucknow, U.P and with different chemical mutagen at laboratory of R.B.S. College, Bichpuri, Agra. A detailed account of treatments is tabulated in table 1.

Table 1: A detailed account of mutagenic treatments

Single Treatment	Combined treatments of radiation and chemical
1. Dry Control	9. 15 kR + 0.1% HA
2. 15 kR	10. 15 kR + 0.1% MH
3. 20 kR	11. 20 kR + 0.2% HA
4. 25 kR	12. 20 kR + 0.2% MH
5. 30 kR	**Single & Combined Treatments of Chemicals**
6. 45 kR	13. 0.1% HA
7. 60 kR	14. 0.1% MH
8. Wet control	15. 0.2% HA
	16. 0.2% MH
	17. 0.1% HA + 0.1% MH
	18. 0.2% HA + 0.2% MH

Raising the M_1 Generation

To raise the M_1 generation the above treated 200 seed of each of the treatment were sown during *Kharif* 2011 in Randomized Block Design with three replications, each accommodating 5 rows of 4 meter length and spacing of 45X10 cm. Before sowing, seeds treated with chemicals were thoroughly washed in running water for 30 minutes. Untreated dry seeds were used as dry control and untreated seeds soaked in water for six hours as wet control (Boranayaka *et al*. 2010) [4].

Raising of M2 generation

To grow M_2 generation seeds were collected from all the competitive M_1 plants of 3 middle rows were grown to raise the M_2 in succeeding year (July 2012) in Randomized Block Design (RBD) trial with 4 replications. Each row of 4 m length and the spacing was maintained as 45X15 cm.

Recording observation on quantitative characters in M_2

The observation on quantitative characters in M_2 generation were taken on the character *viz.* days of flowering, days of maturity, number of capsules per plant, number seeds per capsule, seed yield per plant, 1000 seed weight and oil content.

Result and Discussion-

Analysis of variance

The analysis of variance RBD made character wise in M_2 presented in ANOVA Table 2. A perusal of table reveals that treatments differed highly significantly for all the characters except 1000 seeds weight under study (Panse and Sukhatme, 1967) [5].

Table 2: ANOVA for the characters under study

Source of variation	Characters						
	Days to flowering	Days to maturity	No. of capsules/plant	No. of seeds/capsule	Yield per plant	1000 seed weight (g)	Oil Content
	Error Mean squares						
Replication	0.1797	0.0013	0.054	0.0022	0.092	0.0020	0.0092
Treatments	34.04**	17.468**	230.99**	105.252**	3.058**	0.0515	8.81**
Error	0.638	0.0104	0.19	0.0074	0.1146	0.0024	0.0058

Estimates of Variability Parameters

Different parameters of variability for seven characters viz. range, mean co-efficient of variation, environmental genotypic and phenotypic variances, genotypes and phenotypic coefficient of variance, heritability, genetic advance in percent of mean have been presented in table 3. The highest GCV and PCV were observed for the characters no. of capsule per plant, seed yield per plant and no. of seed per capsule. High heritability was recorded for days to maturity, seed yield per plant, and number of capsules per plant.

Mean Results (Table 4)

The attributes days to flowering showed a mean range between 49.75 days (100.08% over control) in 30 kR and 59.34 days (119.37% over control) in 0.2% HA + 0.2% MH as compared to 49.71 days (100%) in control.

The attributes days to maturity showed mean range from 79.50 days (99.56 percent) 30 kR to 88.23 days (110.49 percent) in 20 kR + 0.21% MH treatment as compared to control 79.85 days. The result showed that all the mutagenic treatments enhanced the days to maturity except 30 kR.

The mean for capsule per plant exhibits minimum capsules per plant 34.42 (64.25%) in 20 kR + 0.2% MH following by 35.33 capsules (65.95%) in 0.1% HA and 35.42 (66.12%) in 15 kR + 0.1% HA treatments and maximum 62.00 (115.74%) in 15 kR as compared to 53.57 capsules per plant (100%) in control.

The maximum mean seed per capsule 72.12 (103.13%) who recorded in 15 kR + 0.1% MH followed by 70.23 (100.43%) in 20 kR and minimum 50.43 (72.11%) in 0.1% HA + 0.1% MH treatment as compared to 69.93 (100%) in control.

The maximum seed yield 13.20 gm (135.24%) was recorded in 0.1% HA treatment and minimum 8.03 gm (82.27%) in 0.2% HA + 0.2% MH treatment as compared to 9.73 gm (100%) in control.

The maximum mean 1000 seeds weight 3.35 gm (106.34%) in 20 kR + 0.2% HA and 3.34 gram (106.03%) in 0.1% HA 3.32 (105.40%) in 45 kR treatments and minimum 2.86 gram (90.79%) in 0.1% HA + 0.1% MH treatment.

The maximum oil content 53.33 (112.12%) was recorded in 0.1 HA treatment and minimum 45.30 (97.06%) in 15 kR + 0.1 HA treatment as compared to 46.67 (100%) in control.

Conclusion

From the above results, it could be concluded that the characters, number of seeds/capsule, number of capsules/plant, number of branches/per plant and test weight be supposed to be given prime importance as they revealed a significant positive correlation and a high positive direct

effect compared to other traits. It was interesting that through capsule weight had positive significant association with seed yield, it's contribution was negative both directly and through several traits indirectly. Contrary, days to maturity was no way related with seed yield yet it also had negative contribution through most traits. is indicates that capsule weight and days to maturity are also to be considered, negatively, to increase the yield. From the above results, it could be concluded that the characters, number of seeds/capsule, number of capsules/plant, number of branches/per plant and test weight be supposed to be given prime
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Table 3: Estimates of statistical and Genetic variability parameter for the characters under study

Characters	Parameters									
	Range	Mean	CV	$\sigma\frac{2}{e}$	$\sigma\frac{2}{g}$	$\sigma\frac{2}{p}$	GCV	PCV	$h\frac{2}{(b)}$	GA
Days to flowering	49.71 – 59.34	52.87	0.479	0.064	11.328	11.392	6.306	6.3847	99.4	6.911
Days to maturity	79.50 – 88.23	83.13	0.120	0.01	5.819	5.830	2.901	2.9044	99.8	4.964
No. of capsule per plant	34.42 – 62.00	46.86	0.293	0.0188	76.99	77.009	18.7231	18.7254	99.95	18.068
No. of seeds per capsule	50.43 – 72.12	65.17	0.132	0.0074	35.08	35.089	9.089	9.09	94.979	11.590
Yield per plant	8.03 – 13.20	10.27	1.045	0.0115	2.0155	2.070	13.827	13.8679	99.43	2.947
1000 Seed weight (gm)	2.86 – 3.35	3.16	1.584	0.0025	0.0163	0.0188	4.0502	4.3437	86.94	0.246
Oil content	45.30 – 52.33	47.57	0.160	0.0058	2.9346	2.940	3.6013	3.6049	99.8	3.525

Table 4: Estimates of Means and Expressed as percentage over the control for the characters under study in M_2 Generation

Characters	Treatments																	
	Dry Control	**15kR**	**20 kR**	**25 kR**	**30 kR**	**45 kR**	**60 kR**	**Wet Control**	**15 kR + 0.1%HA**	**15 kR + 0.1%MH**	**20 kR + 0.2%HA**	**20kR + 0.2%MH**	**0.1% HA**	**0.1% MH**	**0.2% HA**	**0.2% MH**	**0.1%HA + 0.1%MH**	**0.2%HA + 0.2%MH**
Days to flowering	49.71 (100.00)	50.22 (101.03)	50.40 (101.39)	52.12 (104.85)	49.75 (100.08)	55.24 (111.12)	59.12 (118.93)	50.14 (100.87)	51.30 (103.20)	50.23 (101.05)	56.24 (113.14)	58.73 (118.15)	53.34 (107.30)	50.43 (101.45)	51.78 (104.16)	52.33 (105.27)	51.20 (103.00)	59.34 (119.37)
Days to maturity	79.85 (100.00)	81.75 (102.38)	81.60 (102.19)	84.22 (105.47)	79.50 (99.56)	84.54 (105.87)	86.25 (108.02)	81.90 (102.57)	82.50 (103.32)	82.34 (103.12)	84.21 (105.46)	88.23 (110.49)	84.57 (105.91)	82.82 (103.72)	82.24 (102.99)	82.18 (102.99)	80.42 (100.71)	87.25 (109.27)
No. of capsule per plant	53.57 (100.00)	62.00 (115.74)	58.80 (109.76)	53.40 (99.68)	55.16 (102.97)	45.16 (84.30)	40.25 (75.14)	54.20 (101.18)	35.42 (66.12)	54.12 (101.03)	37.57 (70.13)	34.42 (64.25)	35.33 (65.95)	45.43 (84.80)	42.21 (78.79)	48.43 (90.41)	50.38 (94.05)	37.73 (70.43)
No. of seeds per capsule	69.93 (100.00)	65.23 (93.28)	70.23 (100.43)	68.42 (97.88)	69.12 (98.84)	60.27 (86.19)	58.57 (83.76)	61.12 (87.40)	67.27 (96.20)	72.12 (103.13)	66.54 (95.15)	67.02 (95.84)	68.28 (97.64)	70.12 (100.27)	66.24 (94.72)	67.83 (97.00)	50.43 (72.11)	54.21 (77.52)
Yield per plant	9.76 (100.00)	11.34 (116.19)	12.37 (1236.74)	11.78 (120.70)	10.12 (103.69)	10.67 (109.32)	8.10 (82.99)	10.18 (104.30)	10.24 (104.92)	11.23 (115.06)	8.93 (91.50)	9.82 (100.61)	13.20 (135.25)	10.53 (107.89)	9.95 (101.95)	10.42 (106.76)	8.12 (83.20)	8.03 (82.27)
1000 Seed weight (gm)	3.15 (100.00)	3.05 (96.83)	3.16 (100.32)	3.30 (104.76)	3.24 (102.86)	3.32 (105.40)	3.12 (99.05)	3.14 (99.68)	3.13 (99.37)	3.04 (96.51)	3.35 (106.35)	3.28 (104.13)	3.34 (106.03)	3.18 (100.95)	3.04 (96.51)	3.02 (95.87)	2.86 (90.79)	3.10 (98.41)
Oil content	46.67 (100.00)	46.89 (100.47)	45.68 (97.88)	47.24 (101.22)	46.90 (100.49)	48.42 (103.75)	47.23 (101.20)	46.68 (100.02)	45.30 (97.06)	50.16 (107.48)	48.54 (104.01)	46.40 (99.42)	52.33 (112.13)	48.23 (103.34)	46.23 (99.06)	48.87 (104.71)	46.25 (99.10)	48.20 (103.28)

(Figures in parentheses indicate percentage over dry control)

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