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Studies on induced chlorophyll mutation in sesame (*Sesamum indicum* L.)

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Abstract : The effectiveness and efficiency of gamma rays and EMS in relation to chlorophyll mutations were studied in two varieties of sesame (*Sesamum indicum* L.) *viz.* SVPR 1 and CO 1 in M_2 generation. Four types of chlorophyll mutants namely xantha, chlorina, striata and *Xantha viridis* were observed. Xantha viridis was observed in maximum proportion followed by chlorina and striata in both the varieties. Gamma rays was found to be more efficient and effective than EMS in both the varieties. The effectiveness and efficiency of both the mutagens was more in SVPR 1 than CO 1.

Key words: Mutagen, Chlorophyll mutant, Mutagenic effectiveness and Efficiency.

Introduction

Mutations are important from both, theoretical and applied points of view and mutation breeding is one of the most effective tools of plant improvement. In mutagenesis, the choice of the mutagen is most important and various methods have been developed to ascertain the most effective and efficient mutagens and mutagenic treatments for the induction of desirable characters in a cultivated crop. The chlorophyll mutation rate is conveniently being used as preliminary index of effectiveness of mutagens and mutability of the variety which in turn could be helpful to realize the spectrum of desirable mutations in the treated populations. It also serves as a good index for determining the doses of different mutagens. The present paper deals with the observations on effectiveness and efficiency in terms of seedling injury, lethality and pollen fertility in M_1 generation and chlorophyll mutations in M_2 generation in sesame (*Sesamum indicum* L.) induced by gamma rays and EMS.

Materials and Methods

Two sesame varieties *viz.* SVPR 1 and CO 1 were treated with gamma rays (30 to 70 krad) and EMS (0.8 to 1.6%). The treated seeds along with their respective controls were sown immediately in the field to raise the M_1 generation with two replications in a Randomized Block Design during Aug-Oct (2001) at AC & RI, Madurai. Each M_1 plant was harvested individually and raised as M_2 progeny in separate rows during Jan-Mar (2002). The progeny of each M_1 plant constituted one M_2 family. The spacing between rows and plants were 30 and 15cm respectively. In M_2 generation, chlorophyll mutants were scored in seven to fifteen day old seedlings and chlorophyll mutants were classified following the classification of Gustafsson (1940). The chlorophyll mutation frequency was calculated on M_1 plant and M_2 seedling basis. The mutagenic ettectiveness and efficiency were estimated following the method of Konzak *et al.* (1965).

Results and Discussion

The most extensive studies to alter the spectrum of mutations and to achieve some degree of spectrum of mutagen specificity in higher plants have been carried out with the chlorophyll deficient mutations because of their ease in detection and frequent appearance following mutagenic treatment (Nilan, 1967). This was successfully procured through the following.

The number of plants segregated for chlorophyll deficiency on the basis of M_1 plant and M_2 seedlings were computed and furnished in Table 1. The frequency of chlorophyll mutation in SVPR 1 varied from 0.02 (50 krad) to

Table 1. Frequency and spectrum of chlorophyll mutants in M2 generation

Treatment	Mutation frequency				Relative percentage of chlorophyll mutants							
	M_1 plant basis		M_2 plant basis		Chlorina		Xantha		Striata		*Xantha viridis*	
	SVPR 1	CO 1	SVPR 1	CO 1	SVPR 1	CO 1	SVPR 1	CO 1	SVPR 1	CO 1	SVPR 1	CO 1
λ-ray (krad)												
30	0.08	0.07	0.009	0.010	63.67	21.74	18.18	8.70		30.43	18.18	39.13
40	0.07	0.02	0.069	0.004	38.89	28.57	27.78	14.29	19.44	14.29	13.89	42.86
50	0.02	0.02	0.012	0.004	28.57	37.50	-	-	-	25.00	71.43	37.50
60	0.04	0.01	0.014	0.001	42.11	50.00	5.26	-	21.05	50.00	31.58	-
70	0.05	0.01	0.020	0.001	57.14	-	14.29	-	4.76	-	23.81	100.00
EMS (%)												
0.8	0.02	0.01	0.002	0.002	-	20.00	40.00	60.00	-	20.00	60.00	-
1.0	0.03	0.02	0.006	0.009	23.08	93.75	7.69	6.25	7.69	-	61.54	-
1.2	0.01	0.02	0.002	0.007	-	-	-	10.00	-	80.00	100.00	10.00
1.4	0.02	0.04	0.006	0.014	16.67	77.78	-	-	33.33	16.67	50.00	5.56
1.6	0.06	0.03	0.029	0.080	18.52	62.50	14.81	-	44.44	25.00	44.44	12.50

0.08 per cent (30 krad) on M_1 plant basis and from 0.009 (30 krad) to 0.069 per cent (40 krad) on M_2 seedling basis for gamma rays. For EMS treatments, the range was from 0.01 (1.2 %) to 0.06 per cent (1.6%) on M_1 plant basis and 0.002 (0.8 and 1.2%) to 0.029 (1.6%) on M_2 seedling basis. No clear trend could be observed for number of chlorophyll mutants in gamma rays, as there was a decline at 50 krad with sudden increase at 60 krad, followed by gradual increase at 70 krad. In EMS also, the frequency values followed an irregular trend.

In CO 1, the frequency rate showed a decreasing trend with an increase in dosage of gamma rays on both M_1 plant and M_2 seedling basis and this was maximum in 30 krad on both M_1 plant and M_2 seedling basis. In case of EMS, the frequency rate was in an increasing trend upto 1.4 per cent on both M_1 plant and M_2 seedling basis. The maximum value was recorded by 1.4 per cent. When comparing the two mutagens, gamma rays induced greater magnitude of chlorophyll mutants than EMS in both the varieties. Among the two genotypes, SVPR 1 registered more frequency rate than CO 1. The frequency of chlorophyll mutants in general were low in this crop and it may be due to the fact that oil seed crops are resistant to induced chlorophyll mutations as reported by Rajan (1969) and Rangaswamy (1973). It may be further attributed to the probable reasons of the elimination of gametes carrying mutations or zygote inviability.

Spectrum of chlorophyll mutants

The relative proportion of chlorophyll mutants is furnished in Table 1. The following different kinds of chlorophyll mutations were identified in accordance with the classification of Gustafsson (1947). 1. Chlorina - Seedlings pale, dull green yellow (Lethal). 2. Xantha - Seedlings straw yellow or pale yellow (Lethal). 3. Striata Longitudinal

Treatment	SVPR 1					CO 1				
	Chlorophyll mutant per 100 M_2 plants	Effectiveness	Efficiency			Chlorophyll mutant per 100 M_2 plants	Effectiveness	Efficiency		
			Lethality basis	Injury basis	Sterility basis			Lethality basis	Injury basis	Sterility basis
λ-ray (krad)										
30	0.94	3.13	0.06	3.43	32.30	1.01	3.36	6.06	11.49	30.33
40	1.61	4.03	9.66	6.68	40.76	0.36	0.90	2.70	-36.00	32.82
50	0.39	0.78	2.34	1.89	8.52	4.45	8.90	22.25	-37.11	34.27
60	1.38	2.30	6.90	4.25	10.99	0.14	0.23	0.52	-38.88	3.00
70	1.96	2.80	9.80	5.32	7.74	0.00	0.00	0.00	0.00	2.72
EMS (%)										
0.8	2.22	0.93	22.2	6.86	78.17	0.24	1.44	1.44	-1.07	10.87
1.0	0.64	0.51	2.13	2.39	10.81	0.95	4.75	4.75	-2.91	7.48
1.2	0.24	0.06	1.80	0.93	2.23	0.70	0.88	0.88	-1.30	56.15
1.4	0.59	0.14	1.77	1.86	2.64	1.40	1.75	1.75	-12.77	8.68
1.6	2.92	0.61	6.26	6.65	11.04	0.84	2.1	2.10	8.52	6.16

streaks of white / yellow on leaves (viable). 4. *Xantha viridis* - Initially Yellow and later becomes normal plants (viable). In SVPR 1, both gamma rays and EMS treatments recorded the maximum number of Xantha viridis. The relative percentage of this mutant varied from 13.89 (40 krad) to 71.43 per cent (50 krad) in gamma rays and from 44.44 (1.6 %) to 100 per cent (1.2 %) in EMS treatments. Chlorina occurred in all the treatments of gamma rays at larger proportion. In EMS treatments, 1.4 per cent and 1.6 per cent registered higher proportion of striata. In CO 1, among the four chlorophyll mutants, *Xantha viridis* was found to be the maximum followed by chlorina and striata in gamma ray irradiated population. They appeared in all the dosages of gamma rays except 70 krad in which 100 per cent of xantha viridis was observed. Xantha occurred only at lower concen- trations/dose of EMS and gamma rays. In EMS treated population, chlorina type of mutant occurred more than other types. The reason for the appearance of greater number of xantha viridis type may be attributed to the involvement of polygenes in chlorophyll formation (Gaul, 1964).

The data on mutagenic effectiveness and efficiency are furnished in Table 2. Mutagenic effectiveness denotes the frequency of mutations induced by a unit dose of mutagen (factor mutations/ dose). Gamma rays at 40 krad (4.03%) in SVPR 1 and at 50 krad (8.90%) in CO 1 were found as the most effective doses. In case of EMS, the maximum effectiveness was observed at 0.8 and 1.4 per cent concentrations in SVPR 1 and CO 1 respectively. In general gamma rays was found as the most elective when compare to EMS in both the genotypes.

The mutagenic efficiency is a measure of the proportion of mutation inrelation to undesirable changes like sterility, injury and survival etc. In SVPR 1, the mutagenic efficiency was observed maximum at 70 krad (9.80%) on seedling survival basis and 40 krad on both injury (6.68%) and sterility basis(40.76%). In case of EMS, it was maximum at 0.8% on survival (22.2%), injury (6.86%) and sterility (78.17%) basis. In CO 1, it was found maximum at 50 krad (22.25%) on survival basis and at 30 krad on injury (11.49%) and sterility (30.33%) basis in gamma ray treatments. In EMS, the maximum efficiency was at 1.0 per cent on injury basis and at 1.2 per cent (26.72%) on sterility basis. The efficiency based on sterility basis was more than the efficiency based on lethality and injury basis. It indicated that it reduced fertility to a smaller magnitude.

Among the two mutagens, gamma rays was found to be more effective and efficient than EMS. The effectiveness and efficiency of both the mutagens were more in SVPR 1 than CO 1. The higher mutagenic effectiveness and efficiency at lower doses are due to the fact that the biological damage increased at a faster rate in higher doses than the mutations.

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