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THE MUTUAL DEPENDANCE OF M_1 FERTILITY AND M_2 MUTATIONS IN RICE

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Knowledge on the interrelation of fertility in the M_1 generation and mutations in the M_2 generation enables the formulation of suitable selection criteria in mutations breeding programmes. If induced sterility and mutations are interrelated, selection of M_1 ears based on fertility can alter the frequency and spectrum of M_2 factor mutations. The present investigation in rice was undertaken to study the mutual dependance of M_1 fertility on the one hand, and M_2 mutation frequency, segregation ratio and spectrum, on the other.

Materials and Methods

Seeds of the rice variety Co-29 were irradiated with gamma rays and treated with ethylmethane sulphonate (EMS). Gamma irradiation was done using the Co^{60} gamma cell at the IARI, New Delhi. The dose range employed was 10 to 50 krad. EMS treatment was done by presoaking seeds for 16 hours in water and then in the mutagen solution for 8 hours. The dose range employed was 38 to 384 m*M*. The M_1 and M_2 effects of these treatments have already been reported (Nair, 1977).

Seed fertility of M_1 ears collected at random in each dose was estimated. Based on the percentage of fertility, the M_1 ears were classified into 5 groups viz.. more than 80, 61 to 80, 41 to 60, 21 to 40 and less than 20. Chlorophyll mutation frequency was estimated on M_1 ear basis and M_2 seedling basis in the different fertility classes. The percentage of mutants in mutated ears (segregation ratio) and the relative percentage of different types of mutants (spectrum) were also estimated.

Results and Discussion

The chlorophyll mutation frequency estimated as mutations per 100 M_1 ears and mutants per 100 M_2 seedlings in each of the fertility classes in the different doses of gamma rays and EMS are presented in Table 1. The pooled frequency of mutations indicates that the mutagens at the doses employed were effective. The frequencies in the fertility classes, mutagen wise but doses combined, are presented in Table 2. These data reveal the interrelation of M_1 fertility and M_2 mutation frequency. The number of mutations per 100 M_1 ears increased progressively with decreasing fertility upto the fertility class of 21 to 40%, but thereafter decreased. When frequency was estimated as number of mutants per 100 M_2 seedlings, a similar trend was noticed with gamma rays. With EMS, the frequencies increased upto the lowest **class** of fertility viz., less than *20%.* The trend was the same irrespective of whether the frequencies were considered dosewise in each mutagen (Table 1) orwith doses

Table 1

M_2 *Chlorophyll mutation frequency*

Mutagen and dose	Mutation frequency in the different M_1 fertility classes (% fertility)					Pooled frequency
	>80	61-80	41-60	21-40	<20	
			i. Per 700 M_1 ears			
/ *Gamma rays*						
10 krad	2.0	6·3	7.9	4.1	—	5.2
20 krad	8.2	10.0	4.5	5.4	—	5.7
30 krad	20.0	3.7	4.9	7.1	5.5	6.3
40 krad	—	14.6	21.3	32.2	13.5	21.1
50 krad	—	—	5.2	4.7	—	3.8
2 *EMS*						
38 m*M*	1.1	—	—	—	—	0.9
77 *mM*	0.4	2,0	8.3	—	—	0.9
115 m*M*	4.5	6.7	7.1	—	—	5.2
154 m*M*	16.2	20.0	29.1	34.6	8.9	20.3
192 m*M*	10.9	22.0	29.3	37.2	15.1	21.1
240 mM	9.0	18.2	20.9	20.4	24.1	17.3
288 *mM*	19.1	17.8	29.4	24.4	16.2	20.4
336 m*M*	1.3	18.8	35.4	40.0	28.4	20.4
384 *mM*	8.3	12.2	26.7	34.7	27.1	19.5
			ft. Per 100 M_2 seedlings			
1 *Gamma rays*						
10 krad	0.1	0.6	0.8	0.5	—	0.4
20 krad	1.2	1.1	0.7	1.2	—	0.9
30 krad	2.2	0.8	0.6	1.4	1.1	0.9
40 krad	—	1.1	3.9	7.6	5.7	4.0
50 krad	—	—	0.8	0.7	—	0.7
2 *EMS*						
38 m*M*	0.2	—	—	—	—	0.2
77 m*M*	0.1	0.1	2.8	—	—	0.1
115 m*M*	0.5	1.2	1.0	—	—	0.7
154 m*M*	2.1	3.1	3.9	4.4	2.0	2.7
192 *mM*	1.0	3.5	4.5	6.9	3.8	2.4
240 m*M*	1.2	3.7	3·4	4.1	7.9	3.9
288 m*M*	3.7	3.1	4.3	5.6	5.6	3.9
336 m*M*	1.2	2.8	5.6	7.8	9.0	2.5
384 m*M*	1.8	1.7	2.8	5.5	7.8	2.3

Table 2

Interrelation of M_1 seed fertility and M_2 chlorophyll mutation frequency (Mutagen wise, dose combined)

Seed fertility of M_1 ear (%)	Mean No, of seed-lings per ear progeny	Number of M_1 ear progenies		MO. of M_2		Muta-tions per 100 M_1 ears	Mutants per 100 M_2 seed-lings	% of mutants in mutated ears (segregation ratio)
		Scored	Segre-gating	Seed-lings	Mutants			
i. Gamma rays								
> 80	55	234	10	12958	53	4.3	0.41	11.7
61-80	47	300	23	14245	111	7.7	0.78	10.9
41-60	31	558	43	17185	192	7.7	1.12	14.7
21-40	17	357	45	6064	162	12.6	2.67	20.3
< 20	6	230	14	1290	23	6.1	1.78	30.7
ii. EMS								
> 80	70	1523	97	106258	855	6.4	0.80	15.2
61-80	50	746	102	36251	736	13.7	2.03	16.7
41-60	33	503	135	16545	614	26.8	3.71	15.8
21-40	17	328	106	5555	329	32.3	5.92	17.8
< 20	6	321	66	1993	124	20.6	6.32	26.7

Table 3

Relative percentages of different types (spectrum) of M_2 chlorophyll mutants in the different M_1 fertility classes

Seed fertility of M_1 ear (%)	Total No. of mutants	Relative % of mutants							
		Albina	Xantha	Viridis	Chlorina	Albo-viridis	Striata	Tigrina	Others
i. Gamma rays									
> 80	53	73	23	—	4	—	—	—	—
61-80	111	27	26	9	26	12	—	—	—
41-60	192	34	11	23	21	11	—	—	—
21-40	162	58	2	14	16	8	2	—	—
< 20	23	74	13	9	4	--	—	—	—
ii. EMS									
> 80	855	42	9	19	11	15	4	—	—
61-80	736	47	1	17	23	10	1	—	1
41-60	614	36	3	29	17	11	1	2	1
21-40	329	36	6	26	18	8	4	—	2
< 20	124	27	—	15	37	15	3	3	—

combined (Table 2). Therefore when M_1 ears were selected at random, mutation frequency increased with decreasing seed fertility. However, at the lowest fertility level the frequencies were low. Thus the frequency of mutations was highest at 21-40% fertility. There was apparently no difference between gamma irradiation and EMS treatment in this respect. Bekendam (1961) following X-irradiation in rice found that the frequency of chlorophyll mutations was low at the lowest and highest fertility classes. The low frequency at the highest class was explained to be due to low induction, whereas the reduction at the lowest fertility class might be due to elimination of mutations.

D' Amato (1962) observed significant negative correlation between M_1 fertility and M_2 mutation frequency in durum wheat after treatment with ionizing radiations. Significant negative correlation between seed fertility and M_2 mutation rates was also reported by Ramanna and Natarajan (1965) in barley; Wellensiek (1965) in peas and Vanderveen and Hildering (1966) in tomato. Gaul (1965) on the other hand suggested that M_2 mutation frequency was independent of the degree of M_1 sterility in barley. Rana and Swaminathan (1967) in bread wheat also obtained similar results. This was explained to be due to the independent induction of chromosomal aberrations and gene mutations in the M_1.

The percentage of mutated ears (segregation ratio) increased as fertility decreased in both gamma rays and EMS (Table 2). Ando (1968) also reported that the segregation ratio decreased as fertility increased. The spectrum of chlorophyll mutants in the different fertility classes is presented in Table 3. The distribution of the various types of mutants over the different fertility classes in either of the mutagens was uniform. Bekendam (1961) has also reported that the distribution of *albina* and *viridis* mutants was the same in the different fertility classes. Alteration in the M_2 mutation spectrum is therefore not possible by making selection for fertility in the M_1 generation,

Summary

The mutual dependance of M_1 fertility and M_2 mutations in rice was studied after treatment with gamma rays and EMS. The frequency of chlorophyll mutations increased with decrease in seed fertility when M, ears were selected at random. However, at the lowest fertility class the mutation frequency was low. This reduction is attributed to the elimination of mutants in the high sterility class. The mutation yield can therefore be significantly enhanced by selecting M_1 ears of low fertility. The segregation ratio of mutants increased as fertility decreased. Mutation spectrum was however not influenced by M_1 fertility. This makes selection for fertility quite ineffective in altering the mutation spectrum.

സംഗ്രഹം

M_2 ഉൽപരിവർത്തന ആവൃത്തി M_1 കതിരുകളിലെ വന്ധ്യതയുമായി ബന്ധപ്പെട്ടിരിക്കുന്നു. വന്ധ്യത അധികരിക്കുന്നതനുസരിച്ച് ഉൽപരിവർത്തന ആവൃത്തിയും സന്ത

തികളിലെ ഉൽപരിവർത്തിത അനുപാതവും വർദ്ധിക്കുന്നു. പക്ഷെ ആപേക്ഷിക ഉൽപരിവർത്തിത ആവൃത്തി വ്യത്യാസപ്പെടുന്നില്ല. M_1 തലമുറയിൽനിന്നും ഭാഗികമായ വന്ധ്യതയുള്ള (9) തിരുകരം തിരഞ്ഞെടുക്കുന്നതുവഴി M_2 ഉൽപരിവർത്തന rar^aj rattnl ഗണ്യമായി വർദ്ധിപ്പിക്കാമെന്ന് ഇതിൽനിന്ന് അനുമാനിക്കാം.

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